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From Eco-Design to Sustainable Design:
A Contribution of the Precautionary Principle

par
Carmela Cucuzzella

Faculté de l'aménagement

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présentée par :

Carmela Cucuzzella

a été évalué par un jury composé des personnes suivantes :

Sylvain Plouffe

_____

président-rapporteur

Pierre De Coninck

_____

directeur de recherche

Rabah Bousbaci

_____

membre du jury

Abstract

In seeking to move towards sustainability, decisions must consider economic, environmental and social impacts. Therefore, assessment of impacts is a critical element for evaluating progress towards sustainability. Life cycle thinking is an integrated approach which considers the set of impacts of product or service systems from resource extraction to end-of-life (from cradle to grave); Life Cycle Analysis (LCA) is the privileged tool. However, LCA is based on a preventive approach. This approach presents an obstacle when decisions are taken in spite of uncertainties concerning the consequences of an eventual action. In addition, there are no tools that lean specifically towards the evaluation of social impacts using a global and long-term point of view. Existing methods that do consider social impacts are based in a preventive approach; on a socio-economic perspective. Although such an approach is pertinent, humans are more than socio-economic beings. Therefore in seeking a more comprehensive assessment of social impacts, a perspective that considers the quality of life using a more global point of view becomes fundamental in addition to existing research using a socio-economic viewpoint. This mode of assessment requires an ethic in decision making that moves beyond the realm of experts alone, a realm that is essentially based on risk analysis and preventive methods. Responsibility and a participative approach can constitute the basis of such an ethic.

This research suggests that to move towards sustainability, decision makers must adopt decision processes that are not only preventive, but also precautionary. A commitment to precaution encourages a global perspective and the search for innovative alternatives to potentially harmful situations. This study is seeking to validate the use of the precautionary principle as a foundation for constructing new social indicators that will provide a way to assess the progress towards sustainable development, but require both expert and community review in cases where there is a high level of potential harm and a low certainty of knowledge. Therefore they will be based on the 4th pillar of sustainable development – governance, which is over and above the other three pillars of economy, environment and society. A stakeholder approach becomes fundamental in the elaboration and evaluation of indicators so that the decision making process during conception will result in a justified course of action in cases of uncertainty of potential harm. In essence, this research is seeking to

demonstrate the adoption of a precautionary approach in complement to existing preventive methods for resolving situations that present potential catastrophic dangers on society or the environment, enabling a shift from eco-design to sustainable design. Methods such as alternative assessment and precautionary deliberation through stakeholder engagement can assist in this shift towards sustainable design.

The justification of this approach for design practice arises from the fact that nature and society cannot be analyzed only through a cause-effect perspective because of the existence of emerging phenomenon in technological, social, political, or environmental innovations; which means that uncertainties in discoveries can no longer be ignored. The emergence of an epistemological barrier with respect to current methods of decision making becomes evident because of long-term, global, invisible effects. So beyond the professional deontological responsibility, there is a need to consider the process of conception based on an ethic of the future and therefore to develop a new ethical framework which is more global and fundamental. This will expose the justifications for choices, present these in debates with all the stakeholders, and ultimately adopt an axiology of decision making for conception. Such an ethical framework is useful for sustainable reporting, assessments, and audits; all of which are gaining importance at the international level.

Keywords: Sustainable design, eco-design, precautionary principle, prevention principle, empowerment, assessment methodology, life cycle analysis (LCA).

Résumé

En visant le design durable, tout processus de prise de décisions doit tenir compte des impacts économiques, environnementaux et sociaux. C'est ainsi que, l'évaluation des impacts est devenu aujourd'hui un élément critique pour appréhender le progrès vers la durabilité. La pensée de cycle de vie est une approche intégrée qui considère l'ensemble des impacts des systèmes de produit ou de service, et ce, de l'extraction des matières premières a son élimination (du berceau à la tombe); l'analyse de cycle de vie (ACV) est l'outil privilégié. Cependant, l'ACV est fondée sur une pensée préventive. Cette approche se confronte à différents obstacles dès que les décisions doivent prendre en compte des incertitudes. En outre, il n'existe a l'heure actuelle aucun outil qui permette de faire une évaluation des impacts sociaux en utilisant un point de vue global et à long terme. Par conséquent, le développement d'un mode d'évaluation des impacts intégrant une réflexion éthique dans la prise de décision au-delà de la prévention et des connaissances des experts est nécessaire. La responsabilité et l'approche participative pourraient constituer la base d'une telle éthique.

Ce projet de recherche suggère qu'il faut adopter une vision de durabilité afin de permettre aux décideurs d'adopter les méthodes de décision qui sont, non seulement de nature préventive, mais aussi de nature précautionnaire. Un engagement à la précaution encourage une perspective globale et la recherche de solutions innovatrices aux situations potentiellement risquées. Cette étude cherche à valider l'utilisation du principe de précaution comme base pour construire de nouveaux indicateurs sociaux qui fourniront une manière d'évaluer le progrès vers le développement durable, mais qui exige, en retour, l'avis des experts et de la communauté dans les cas où le niveau de danger potentiel est élevé ou dans les cas où la certitude des connaissances laisse à désirer. Par conséquent, ils seront basés sur le 4e pilier du développement durable, la gouvernance, qui chapeaute les trois autres piliers, l'économie, l'environnement et la société. Une approche basée sur les parties prenantes devient fondamentale dans l'élaboration et l'évaluation des indicateurs; ce processus décisionnel peut rendre une action justifiée dans les cas des dangers potentiels. Essentiellement, cette recherche vise à démontrer l'adoption d'une approche de précaution complémentaire aux méthodes préventives déjà existantes.

Elle permettrait d'éviter les situations qui présentent des risques potentiels très élevés pour la société et l'environnement, ce qui entraînerait un passage de l'éco-design au design durable. Les méthodes telles que l'évaluation d'alternatives innovatrices et la délibération dans un contexte de précaution avec les parties prenantes peuvent aider à ce passage vers le design durable.

La justification de cette approche provient du fait que l'environnement et la société ne peuvent plus être étudiés seulement dans une logique de cause à effet en raison de l'existence de nouveaux phénomènes qui découlent des innovations technologiques. On ne peut plus ignorer l'incertitude entourant les risques potentiels de certaines découvertes. L'apparition d'une barrière épistémologique, en ce qui concerne les méthodes courantes de prise de décision, devient évidente en raison de ces effets à long terme et globaux. Ainsi, au-delà de la responsabilité déontologique professionnelle, il faut considérer les processus de conception basés sur une éthique du futur et donc développer un nouveau cadre éthique qui est plus global et fondamental. Ceci permettra de mettre en évidence les justifications des décisions, afin de les présenter au cours des discussions avec les parties prenantes, ce qui permettra d'adopter une axiologie de la prise de décision pour la conception. Un cadre éthique est utile pour les évaluations et les audits dans un contexte de développement durable et l'importance de ce cadre est encore plus grande au niveau international.

Mots clés: Design durable, éco design, principe de précaution, prise de décision, cadre éthique, consommation durable, qualité de vie, analyse de cycle de vie (ACV).

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List of Abbreviations

CIRAIG	Interuniversity Research Center for the Life Cycle of Products, Processes and Services
CSD	United Nations Commission on Sustainable Development
EI99	Eco-indicator 99
FIDD	Fonds d'investissement en développement durable
GRI	Global Reporting Initiatives
JPOI	Johannesburg Plan of Implementation
LCA	Life Cycle Assessment
LCIA	Life Cycle Impact Assessment
NGO	Non-governmental Organization
PP	Precautionary Principle
RD&D	Research, development and design
SA	SustainAbility
SD	Sustainable Development
SETAC	Society of Environmental Toxicology and Chemistry
SLCA	Social Life Cycle Analysis
SME	Small and Medium Enterprises
UNEP	United Nations Environmental Program
WCED	World Commission on Environment and Development
WSSD	United Nations World Summit on Sustainable Development

Dedication

I would like to dedicate this work to my children, Mark and Jordan, for their patience, support and encouragement.

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General Introduction

At the start of the 21st century, it has become evident that humans face environmental and social challenges that are unprecedented in the history of this planet (Des Jardins, 1995). International concern about the problems facing humanity began as early as 30 to 40 years ago. The United Nation Conference of Environment and Development (UNCED) in 1992, was critical in placing environmental concerns at the top of international agendas (UNEP, 1972). Agenda 21, a plan of action towards sustainability, was devised at this conference. However, ten years later at the Johannesburg World Summit on Sustainable Development (WSSD), very little progress towards sustainable development had been achieved (UNEP, 1972). One primary obstacle being the inequalities between the developed and developing countries; their economic differences have had significant implications. In particular, the proportionately greater responsibilities for the developed countries for providing solutions towards a global sustainable mode of development have been a dividing issue (Aubertin & Vivien, 2006).

However, the world's environment has continued to be devastated by the impacts of development. In some estimates, approximately one hundred species are on the verge of extinction and this number is on the constant rise (Wilson, 1989). Natural resources fundamental for a basic quality of life, such as water, air and soil, are degrading at an alarming rate affecting the quality of life of humans and therefore resulting in the degradation to society as well (Des Jardins, 1995). In addition, the world population has been on a steady increase; since 1990 world population grew from approximately 5.2 million to 6.7 million[1]. This rise in population has and will continue to have significant negative impacts on natural resources. However, it is not only the increase in population that is of concern; the way in which humans conduct their lives has considerable consequences as well. This is because the most affluent societies consume the most natural resources, even if they do not constitute the majority of the population. Therefore over-consumption and not only over-population are a major concern in this crisis (Marchand, De Coninck & Walker, 2005).

[1] Population figures were taken from URL=< http://www.ibiblio.org/lunarbin/worldpop>.

There are various perspectives in dealing with this crisis. Pessimists feel that this situation is hopeless and that humanity is doomed. Others revert to science and technology in search for solutions; for example, cleaner energy, more efficient cars, etc. (Des Jardins, 1995). This represents a mode of efficiency that uses optimization methods to reduce impacts. This is a necessary condition, yet insufficient in today's crisis since a major consideration of this crisis is the way in which we consume and therefore optimizing current products and services alone will not provide long-term solutions (Princen, 2003). For many, science and technology seems the only way for resolving current problems. One main reason for this is because science is believed to provide objective and factual answers to problems. However, an approach based on science alone with the hope of quick solutions is an attitude destined to fail (Droz & Lavigne, 2006). These approaches do not consider the impact of individual and collective behaviours as pertinent for solving such problems. In fact, they do not recognize the power of citizens in a decision process (Sclove, 1995).

Even if it may seem tempting to resort to science and technology, the problem is that environmental problems are not inherently technical or scientific. They are in fact problems that reveal fundamental questions (Des Jardins, 1995). Among other questions: What is the place of humans among nature? What type of life can humans expect to continue to lead? Why are resources not shared more equitably? How can the current generation ensure the future of humanity and all life on earth? In essence then, ethical questions emerge as a result of this crisis (Droz & Lavigne, 2006). Looking solely at science and technology without considering the ethical issues may create as many problems as solutions. Leaving such decisions to the experts of science and technology implies that the decision will be based on the value system of these experts alone.

Problems that are measurable may be addressed using scientific and technological approaches; however the broader social and environmental problems that humans face today cannot be evaluated using such methods alone and therefore require alternate ways for assessment and resolution (Whiteside, 2006). In particular, potentially catastrophic problems (problems where there is little certitude of knowledge) must employ a different mode of assessment. This is because in these situations, the consequences or risks are non-observable, long-term or not

measurable. Therefore deterministic modes of evaluation are inadequate; these are based in statistical analysis and are considered preventive. Potentially catastrophic situations impose a precautionary attitude. In this mode of assessment, other means than statistical analysis are necessary (Dupuy & Grinbaum, 2005). The views of the community are integral since in these cases, the experts disagree on the risks or consequences. Therefore the values and visions of the experts alone are insufficient. By involving citizens in the decision process, they will develop an increased sense of responsibility towards others and their environment. In addition, they will provide a greater level of insight in the search for a resolution (Scolve, 1995). An attitude of sufficiency is necessary for arriving at sustainable solutions, since efficiency is clearly inadequate on its own in a context of sustainability (Princen, 2003).

Design has become an increasingly significant vehicle for achieving environmental, economic, and social policy goals at a regional, national, and international level (Fletcher & Goggin, 2001). In fact, the role of design has expanded and increased in complexity because the scale of environmental impacts does not depend on population size alone, but also on consumption choices, production choices, and in general, actions taken. Therefore to move towards sustainability, design has had to deal with the growing concerns that humanity faces.

Design strategies and approaches for dealing with the environmental crisis have progressed enormously over the past 30 to 40 years. These approaches have evolved from short-term solutions (green design), to medium (eco-design) and just recently have begun to consider long-term, global solutions (sustainable design) (Madge, 1997). Many analytical tools exist that can help optimize the eco-efficiency of products and service systems. These tools have been developed to enable designers and engineers to assess the life cycle of a product or service system from 'cradle to grave' (Consoli *et al.*, 1993), and are often considered as tools that can help identify medium-term solutions. They have helped (and continue to help) in the design and production of eco-products as well as the construction of environmental policies. The assessments of negative impacts using such tools are done using objective, available data, with estimated margins of error; a deterministic or probabilistic approach. In fact, these earlier approaches are, on the most part, limited to environmental issues alone. And if they do consider social impacts, these are

considered within a confined scale of vision (within a socio-economic scope); and not on the most global scale. Therefore there is a need to consider alternate methods of decision making if society is to move towards sustainable development.

The lack of an existing decisional framework in a context of uncertainty of harm, and the lack of an ethical knowledge base for developing sustainable solutions imply that there is a gap in decision making processes. The precautionary principle inverses the traditional logic of proof: one must act even in the face of uncertainty, and seriously consider the consequences even in a hypothetical danger. It is this condition; the uncertainty of harm, the uncertainty of what action to take, and the uncertainty of a desired outcome that puts the precautionary principle in a realm of ethics. All actions contain some level of risk, and therefore humans need to construct innovative ways to deal with such uncertainties.

Some questions that arise in this approach are: Through which debates can the plurality of such values be revealed? How can this process be defined so that it is effective in including the divergent visions of the world? When taking into account the various actors and their possibly diverse knowledge, values, and opinions, complexity arises from the decision making process since a practical decision must be made that will result in some action. This ethic takes into account the opinions of each seriously. Therefore methods to go from diversity of opinions to a practical concrete decision are necessary. There is a necessity to discover the value systems, to expose them and to confront them, so that they can contribute to the search for innovative solutions towards sustainability.

So the pertinence of moving beyond a theory of sustainable development and into an operational mode of sustainable development reveals several challenges as previously presented. Consequently, a question that arises from these challenges and that will be the primary focus of this study is: *How can an operationalization of the precautionary principle contribute to the shift from eco-design towards sustainable design?* A hypothesis that is prevalent in this research for dealing with this question is that design can contribute to the development of an improved rapport with the world through the exploration and creation of alternative solutions to current problematic lifestyles based on an ethic of the precautionary principle. The expected

results from this study based on the main research question are: (1) an understanding of the precautionary principle, and in particular its use within existing sustainable assessment methodologies as a decision support principle; (2) if this principle is used within such methodologies, how and when; (3) if not used, what are the obstacles; and (4) if not used, but is considered pertinent for sustainable design (based on the literature review and the field work), then propose preliminary ideas for its operationalization.

Given the emerging issues as a result of the difficulties in decision processes for design practice in situations of uncertainty, this research will seek to justify the establishment of an ethical framework for this principle. The intent of this framework is to encourage a new mode of decision making, and in turn, contribute to the creation of innovative solutions that respond to current environmental and social problems through a participative forum. In essence, it will seek to justify the participation of citizens in the process of conceptualizing solutions in a context of sustainable development using a precautionary approach.

This paper will develop the supporting arguments in a progressive manner. In the *first chapter*, a historical perspective will be presented, exposing the current crisis. In addition, the current methods used in decision making and their respective inadequacies in situations of fundamental uncertainties of harm will be provided. This will as a result justify the use of a precautionary approach for decision making in design practice when faced with situations of high uncertainty and potential harm. This approach will require the citizen as an active participant in the establishment and resolution of problems. Therefore the idea of empowerment and social change as a result of individual and community involvement will be presented as a foundational element for such an approach to succeed.

The *second chapter* presents the theoretical framework. The need for a complex framework for this research will be justified. This justification is based on the fact that current deterministic methods are inadequate, and therefore an increased level of complexity and depth for the comprehension of the relevant issues and possible methods for resolution will be exposed. Various concepts valuable for an eventual implementation of the precautionary principle for design will be proposed. A

stakeholder approach that is based on the consensus of the multiple values and visions of the participants will be presented as a way to arrive at fair and just actions that consider the common good. This is fundamental for an operationalization of sustainable development and in particular, the precautionary principle. At the end of this section, the key concepts emerging from the proposals and a general description of the data requirements regarding the field work will be established.

The *third chapter* presents the methodological framework. This section will describe the methods used in collecting the required data. The methods used for data collection will be qualitative. A justification for this approach will be elaborated and will be based on the question: *How do organizations incorporate the precautionary principle in their decision making process?* Semi-structured interviews and document analysis are the primary tools used for data collection. This section will also define the analytical grids that will be necessary for data classification and analysis.

The *fourth chapter* is the field work which entails data collection, the preliminary analysis, and final interpretation of the data using the analytical grids proposed in the third chapter. A *general discussion* will follow, summarizing the main elements from the literature review so that the key elements resulting from this can be revealed in the discussion of each of the methodologies studied.

The *conclusion* will underline the gaps that exist in existing assessment methods. The steps necessary to adopt a precautionary approach for the assessment of situations will be proposed. This may contribute to a shift from eco to sustainable design based on the fact that the considerations in this new approach of impact assessment address fundamental human needs. Some further areas for research are the establishment and assessment of new social indicators based on the proposed ethical framework, as well as an understanding of the type of participative process most appropriate for such deliberation. These new indicators will be founded on the concept of sufficiency; and not on the more conventional vision of establishing indicators based on a socio-economic perspective within an eco-efficiency framework. These new indicators can complement the indicators based on a socio-economic perspective as they are both essential for the improvement of quality of life.

1. Toward a New Developmental Paradigm

1.1. Critical Historical Events

A concern for environmental issues began as early as 40 years ago. During the '60's, if development was considered as an obvious strategy for growth, critiques of such an approach soon emerged, particularly those concerned with the situation of the environment. The 1962 book by Rachel Carson entitled *Silent Spring*, was a first cry for alarm; it alerted the world to the dangers associated with an indiscriminate use of pesticides. At the time, a fury against the ideas proposed in this book surfaced; it was a very controversial book and Rachel Carson was considered an outsider. As mentioned by Lear in the preface of the 2002 edition, the industry considered her as a "hysterical woman" (sic) whose vision of the future could be ignored because she had gone beyond the boundaries of her gender and her science (Lear, from Carson, 2002).

The 1972 conference in Stockholm (United Nations Conference on the Human Environment) was the first conference which dealt with issues relating to the preservation of the environment in order to provide a continued improvement in living conditions for all. One of the conclusions was that it could not be achieved without international cooperation. The emphasis was on solving environmental problems, but without ignoring social, economic and developmental aspects. This conference led to the establishment of the United Nations Environmental Program (UNEP), based in Nairobi, Kenya.

That same year, the Club of Rome published *The Limits to Growth* (Meadows, Meadows & Randers, 1972)[2]. This group was founded in 1968, and was vital for providing global awareness of the developmental crisis. Traditional development meant over consumption of fossil fuels, elimination of manual labor by automation, by use of non-renewable resource (petroleum), as well as water, all without the increase in employment. In fact, in the developmental paradigm of the time,

[2] This report, conducted by well-known researchers at MIT, used a systemic approach for their research for the first time in history.

sustainable development was perceived as a limitation as long as it meant that production levels of countries would decrease on its account. The key concept resulting from this book was that if the current growth trends in world population, industrialization, pollution, food production, and resource depletion continued, the limits to growth on this planet would be reached within the next one hundred years, with the probable outcome of an unanticipated decline in population and industrial capacity. Even if the predicted dates did not correspond with actual dates, this report had a major consequence; it succeeded in making people aware that natural resources were not infinite, as was commonly believed to be since the Industrial Revolution. This report attracted considerable attention; in the same magnitude as the attention given to the oil crisis of the early 1970s; which occurred one year after the publication of this report. In 1973, the book, *Small is Beautiful*, by Schumacher was released soon after the effects of the energy crisis of the same year. It had a disturbing vision of the world and dealt with the crisis by suggesting that humanity must act locally, yet think globally, to solve the problems that they were faced with.

In 1987, the World Commission on Environment and Development (WCED), which had been set up in 1983, published a report entitled *Our Common Future*. Also known as the Brundtland Report, it defined sustainable development as (WCED, 1987, p. 43):

> "*development, which meets the needs of the present without compromising the ability of future generations to meet their own needs.*"

This report alerted the world to the urgency of making progress toward economic development that could be sustained without depleting natural resources or harming the environment. In 1989, this report was debated in the United Nations General Assembly, and as a consequence, a United Nations Conference on Environment and Development (UNCED) was set up[3]. In June 1992, the United Nations Conference on Environment and Development held a conference in Rio de Janeiro, also known as the 1992 Rio Earth Summit. During this conference, five agreements were signed

[3] Further information available on URL=<http://www.are.admin.ch/themen/nachhaltig/00266/00540/index.html?lang=en>.

by participating countries: *Agenda 21*[4], *Rio Declaration on Environment and Development*[5], the *Statement of Forest Principles*[6], the *United Nations Framework Convention on Climate Change*[7], and the *Convention on Biological Diversity*[8]. The *Rio Declaration on Environment and Development* (UNCED, 1992) identified 27 principles that defined the rights and obligations of nations. This declaration recognized the precautionary and polluter-pays principles as guiding principles. It described the struggle against poverty as a significant policy, and the reduction of unsustainable forms of consumption and production along with the general involvement of citizens in decision-making processes as pertinent to the pursuit of sustainable development. Agenda 21, a global action plan for sustainable development, contained strategies and program measures that countries can implement to promote the sustained and responsible development of the planet. Sustainable development not only deals with environmental conservation, but equally with economic and social development. It ensures that human well-being is shared within all of society and across all societies. In addition, this summit resulted in the establishment of the United Nations Commission on Sustainable Development (CSD) at the end of that same year.

The purpose of the Rio+5 conference, held in New York, in 1997 was to renew and strengthen the commitment to sustainable development. In doing this, the failures and achievements were assessed, priorities were set and issues that had not been sufficiently dealt with in Rio were agreed on. The prevailing conclusion at this conference was that little improvement had been made. For example, social injustice, poverty, greenhouse gases, the release of toxic substances into the atmosphere and solid waste were on the rise since 1992[9].

In 2002, the United Nations World Summit on Sustainable Development[10] (WSSD) was held in Johannesburg. The objective of this summit (also known as the

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[4] Further information available on URL=<http://www.un.org/esa/sustdev/documents/agenda21/index.htm>.
[5] Further information available on URL=<http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>.
[6] Further information available on URL=<http://www.un.org/documents/ga/conf151/aconf15126-3annex3.htm>.
[7] Further information available on URL=<http://unfccc.int/2860.php>.
[8] Further information available on URL=< http://www.biodiv.org/convention/convention.shtml>.
[9] Further information available on URL=<http://www.un.org/esa/sustdev/documents/docs_csd5.htm>.
[10] The complete WSSD plan of implementation can be located at URL=<http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf>.

Johannesburg Summit) was to study the implementation of agreements made at the conference in Rio, in particular, Agenda 21. Issues including social injustice, dialogue between cultures and health, poverty eradication, unsustainable consumption and production patterns, were more thoroughly discussed than at the previous summits in Stockholm and Rio de Janeiro. In addition, more evident links were drawn between poverty and the environment. At the end of this summit, the Johannesburg Plan of Implementation[11] (JPOI) was adopted.

In the JPOI, even if each of the major concerns were addressed separately in this document[12], the themes were constantly reiterated throughout various other parts of the agreement[13]. This inter-relatedness of themes reflects the reality that sustainable development necessitates a holistic view in terms of not only development but also the involvement of all pertinent stakeholders for its implementation. It promoted the integration and interdependence of the three pillars of sustainable development; environment, economy, and society. This agreement also reinforced the principles as defined in the *Rio Declaration of Environment and Development* (1992), including the precautionary principle. With regards to the precautionary principle, it suggested an improved collaboration between not only natural and social scientists, but also between scientists and policy makers. The necessity of this collaboration was in seeking to change the unsustainable consumption and production patterns[14]. In fact, as a general recommendation, this agreement emphasized the importance of ethics for sustainable development and recommends the consideration of ethics in the implementation of Agenda 21 (UNCED, 1992).

The JPOI was a non-legally-binding plan intended to guide government activities related to sustainable development. The work of the CSD was then revised to better reflect the outcome of this summit. The CSD is now responsible for monitoring and pushing forward the implementation of Agenda 21 and the JPOI.

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[11] Further information regarding this plan is on URL=<http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIToc.htm>.

[12] The JPOI is separated in eleven chapters where each of the chapters focuses on one specific theme, such as health or poverty.

[13] Further information regarding this plan is available on URL=<http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIToc.htm>.

[14] Further information is available on URL=<http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIChapter10.htm>, specifically chapter 10, point 109 of the JPOI.

More recently, the *Stern Review Report* (2007) has provided an economic and international perspective of the effects of climate change. According to Stern (2007), if no action is taken for dealing with the current global crisis, tremendous economic costs and risks will result. An estimated 5% of global Gross Domestic Product (GDP) will be lost on a continual basis; and when considering the broader impacts, this loss could rise to at least 20% of GDP. This indicates that current action is an imperative at an international level since the effects of climate change are global. The inequality of this crisis is that the poorest countries, those that have contributed the least will be affected first and worst than the more developed countries. Stern claims that the costs of inaction far exceed those of taking 'sustained long-term action'.

These critical events have been paralleled with the on-going challenge of the integration of sustainable development into daily life; it has become a growing challenge within academic and professional circles of design. In fact, in the current global context, such global concerns have become progressively more prevalent in design practise. Design can contribute significantly to the process towards sustainability since it can help in the search for alternative solutions to current lifestyles (Levy, from De Coninck, 2005). This is possible through the consideration of various criteria; where the criteria is no longer limited to the scope of material, form and process, but includes the plethora of considerations which include political, environmental, economical, cultural and educational issues (Madge, 1997).

However, these considerations are often conflicting and it is not always obvious how design practise should proceed (Diani, 1988). This is why design has constantly been torn between two dominant cultures; industrial reality, which is manifested through progress in new technologies, and social utopia, which can be seen through human scale development (Diani, 1988). This dichotomy contributes to a constant 'tug of war' between what is socially and environmentally sound design and what is technically and economically viable (Diani, 1988). The complexity involved in integrating these realities into the context of design is that these realities; technical/economic development versus social/environmental development often seem contradictory in nature (Diani, 1988). The concerns, methods, values, ethics, and goals of this dichotomy often seem to challenge each other.

In this perspective, design must go beyond a multi-disciplinary approach and towards a trans-disciplinary approach which is evolutionary and complex (De Coninck, 1996). A move towards a systemic approach for design, which is increasingly global and dynamic in nature when establishing solutions, is recommended to shift towards a trans-disciplinary approach (De Coninck, 2005). An attempt to increasingly integrate complexity within design strategies – social as well as environmental issues need to be dealt, to move towards sustainable design (Madge, 1997). Therefore, through the adoption of this new approach, the designer could effectively respond to specific needs of individuals, while maintaining a short, medium and long-term global perspective (De Coninck, 2005).

1.2. A Perspective of Sustainable Development

The definition of sustainable development provided by the *Rio Declaration of Environment and Development* (1992) is a general description that is widely adopted. Sustainable development defines the integration among several elements: the consideration of economic growth, the protection of the natural and built environment, as well as meeting the needs of all without compromising the needs for future generations. In essence, sustainable development is a development mode that seeks to protect the future of humanity and the environment (Madge, 1997).

This research is aiming to move beyond a theory of sustainable development and into a mode of operation. In seeking this however, it becomes necessary to start with a definition of sustainable development that can be operationalized. Sustainable development can be defined as the convergence of the social, environmental and economic pillars. In particular, the ecological integrity is the *condition*, the economy is the *means*, and the social and individual development is both a *goal* and a *means* (Gendron & Reveret, 2000). The implementation of sustainable development assumes however a system of governance that assures the participation of all in the process of decision making (Bisaillon, Gendron & Turcotte, 2005). This may be considered as the fourth pillar of sustainable development. This fourth pillar will be

the main focus of a precautionary attitude toward decision making in a context of sustainable development.

1.2.1. Comparison of Development Paradigms

Development has varying definitions; in particular its definition is dependant on its context, such as: human, social, economic, political, software, etc. (Merriam-Webster Online Dictionary, 2005). In the framework of this paper, development will refer to the use of natural resources as a means to satisfy human needs and improve the quality of human life of individuals and their communities (WordNet, 2006). In this perspective then, development has had many transformations where its most fundamental one occurred during the Agricultural Revolution (between the 16th and the 19th centuries); which had as an effect the spawning of the Industrial Revolution. Since then, development has contributed to economic, social and human development where the quality of human life in developing countries has improved tremendously. However, because of a perspective of an infinite growth in development (Aubertin & Vivien, 2006), in particular after the second world war, where mass production and consumption imposed itself as a social model, environmental problems emerged. It became evident that this type of development was becoming detrimental to humans, their communities, and their environments, therefore the notion of a need for a different type of development surfaced (Aubertin & Vivien, 2006).

In fact, even within the last century, development has evolved immensely. The different modes of development can be looked at in terms of paradigms. According to Thomas Kuhn a paradigm[15] is the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed (Kuhn, 1970). When paradigms are in their infancy, their clarity and scope is limited; what they promise is a chance of success (of some goal). When a paradigm grows in magnitude (number of advocates and strength of beliefs) then the previous paradigm

[15]Normal science "means research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice (...) these achievements can be called paradigms" (Kuhn, 1970, p. 10). He states that (1970, p. 23) "(...) a paradigm is an accepted model or pattern". Paradigms can be defined by the predominant vision of human thought within a particular scope. Paradigms help to define the boundaries within this realm of thought. It can be thought of as a model of thought, based on a collective awareness.

languishes. Paradigm shifts[16] usually result from an awareness that an accumulation of anomalies occur through the use of the current paradigm. This exposes the difficulties in the continued adherence to a dominant paradigm, challenging it, and therefore opens the door to research new methods of explaining and comprehending phenomena. A paradigm shift is a revolution, a transformation, a sort of metamorphosis (Kuhn, 1970). It does not just happen, but rather agents of change drive it. Kuhn (1970) stated that:

> "*The decision to reject one paradigm is always simultaneously the decision to accept another, and the judgment leading to that decision involves comparison of both paradigms with nature and with each other.*" (p. 77).

Currently, the most prevalent mode of development in occidental society is the progress paradigm; established over a century ago. The strength of this paradigm is that it allows for economic and technological growth and in turn provides an improved quality of life for individuals and societies in general. In the progress paradigm the resources are perceived as unlimited, there is an exploitation of nature, and humans consider themselves as masters and owners of the universe (Descartes, 2000). This is a common belief since the Industrial Revolution. This paradigm relies on the certainty of knowledge; on the confidence that science has predictive powers and therefore can be used as a basis for the justification of actions taken (Morin, 1982).

However, some critical problems have emerged as a consequence of the progress paradigm. The level of pollution in water, land and air is consistently on the rise; not only are levels of toxicity extremely dangerous to humans, but they are also exceedingly dangerous to the species using these spaces as their habitats. Social responsibility is in demise; the social conditions emerging as a result of very high levels of consumption are, among others: unfit working conditions for people

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[16]The successive transition from one paradigm to another via revolution is the usual developmental pattern of mature science." (Kuhn, 1970, p.12). A transition from one paradigm to a new one is not a cumulative process, but rather a process of reconstruction from a fundamentally new basis of knowledge. This transition often results in new methods, applications, and/or rules. During the transition from one paradigm to another, there will always be some overlap with the problems to solve, but there will be a definitive difference in the way solutions are found. Kuhn states that (1970, p. 48) "The pre-paradigm period, in particular, is regularly marked by frequent and deep debates over legitimate methods, problems, and standards of solution".

producing products in developing countries, social segregation in industrialized societies as a result of individual social competition, loss of community interest, poverty ravaged areas are not given a chance to prosper, etc. (Boisvert & Vivien, from Aubertin & Vivien, 2006). In addition, the continual loss of natural resources at unprecedented rates has become a major concern. These are all outcomes of the progress paradigm.

Awareness that this paradigm was, and continues to introduce negative impacts led to the development of various strategies for dealing with such problems. It became evident that this type of development, namely a development spurred by a capitalist dynamic (Boisvert & Vivien, 2006, from Aubertin & Vivien, 2006), and its methods were no longer adequate; the reliance on knowledge from only a techno-scientific perspective became insufficient. This realization occurred at about the same time as various critical publications: these emphasized: (1) the limits of natural resources; and (2) the inability for the environment and society to continue to metabolize the negative effects resulting from this progress paradigm. In fact, an increased inability to measure the multitude of negative impacts imposed by technological innovations has become a significant driving force to move towards new methods of development (Princen, 2003).

As a consequence, an increased importance for adopting a mode of sustainable development emerged (De Leeuw, 2005). This was a direct consequence of the negative impacts that resulted from the continued growth in economy and technology without a comprehensive consideration of their consequences. The need to deal with this crisis on an international level developed. A shift towards a sustainable mode of development was encouraged for a more harmonious relationship between humanity and the environment (De Leeuw, 2005; Hertwich, 2005a).

If a transformation of paradigms is to occur, then changes in production, consumption, and decision making within society must undergo a radical change. This change would result in a paradigm shift. The concept of paradigm can then be used with the dominant and emerging modes of development. We can then refer to the current mode of progress in technology and the economy as the dominant paradigm of development. In contrast we can refer to the concept of sustainable

development as an emerging paradigm. As Kuhn stated however, this emerging paradigm will not become mainstream without agents of change driving this new paradigm shift.

Therefore, in the context of sustainable development, it is not only the growth in the economic sector that is essential; social and environmental growth is equally fundamental. In a market driven economy, monetary growth is a major measure of success; a driving force of the progress paradigm (Jackson, 2005). However, trying to achieve sustainability within a market-driven economy is not trivial. In a sustainable paradigm, the rules of success will change. Success will now refer to growth in the several paradigmatic spheres (economic, social, and environmental), and not only the success of the economic sphere alone. The successful interdependence of these three spheres is the goal of sustainable development. This refers to their co-presence and co-determinism; each requires the other to remain in equilibrium, in spite of the variations within this milieu (Morin, 2005).

With the three spheres sharing prominence, sustainable development can become viable. However, adopting solutions that consider each of the three spheres of sustainable development while seeking the common good requires the participation of all those affected. This implies that the fourth pillar of sustainable development – governance is equally prominent, and therefore a rupture from traditional decision making processes necessitate. Decisions made by experts alone, and in particular decisions that consider current techno-scientific consequences require a system that assures the participation of all those involved in the situation.

Moving towards sustainable development therefore requires a profound shift in the way shareholders, suppliers, designers, producers and consumers think about design, production and consumption, and in general decision making. It is not simply a measure added to the dominant developmental methods (Whiteley, 1995). This is because traditional modes of design, production and consumption do not address the issues of sustainable development; they are in fact, part of the progress paradigm. They are based on a paradigm of scientific certitude and a confidence that science alone can solve the problems that arise. However, it is increasingly apparent that science alone cannot answer these questions because of the level of uncertainty

prevalent in technological innovations and therefore in economic and social development. A need to support decisions based on shared values and visions emerges, and with this, an attempt to increasingly integrate complexity within development strategies becomes necessary. As a result, a shift from the progress paradigm towards a sustainable development paradigm will require transformational changes.

In the progress paradigm, the products that are produced are intended for a short lifecycle. Planned obsolescence is common for many types of products (Chapman, 2005), for example: in electronics (as the new version of a technology is introduced, the previous version is instantly considered obsolete); in home appliances (quality of products is intended to break down quickly); fashion (because of the continual new seasonal trends) and in many other product types. In this paradigm, there is little consideration, other than an economic motivation, of the resources necessary to produce this variety of products. Besides the costs of production (includes both internal and external costs), there is little consideration of: where the waste or discarded products will go; where and by whom the products are manufactured; the working conditions or wages of the people working in the factories that build the products; the chemical output of the factories producing these products. The main goal in the progress paradigm is the continual economic growth, and marketing has become the tool to introduce the plethora of new products created to satisfy human needs (Jackson, 2005). In this paradigm, the perception of sustainable development in fact refers to continued (or rather, 'sustained') development, since decelerating development signifies pushing back development, and therefore economically unviable (Aubertin & Vivien, 2006).

In the sustainable development paradigm, the idea of success extends to the health of society, the renewal of primary resources, as well as the growth of the economy. Therefore the dominant mode of production and consumption imposed as a social model through the progress paradigm is no longer feasible (Heiskanen & Pantzar, 1997). One of the main reasons for this is because in a market economy, the main responsibility for environmental and social deterioration stems from the consumer. This is because consumption is the reason why anything gets produced (Heiskanen

& Pantzar, 1997), and therefore both must be addressed in a solution towards sustainability.

According to Droz and Lavigne (2006), biodiversity and the need to preserve or renew resources are fundamental to environmental health. In achieving this then, a requirement to find alternative means to satisfy human needs becomes evident; in particular, satisfying such needs without the use of primary resources (Marchand, De Coninck & Walker, 2005; Schaeffer & Crane, 2005). This implies an attitude of sufficiency and simplicity towards the way in which humans base their decisions day-to-day (Princen, 2003). A need to work with the community, so humans can contribute to social change through a collaborative effort emerges. This would have as a result, individuals that have become responsible citizens (Marchand, De Coninck & Walker, 2005). And therefore working within a community implies that social issues have become a significant concern; equal to that of the economy or the environment (Whiteley, 1995). A sense of responsibility towards others, future and present, becomes a major concern; this responsibility must then be based on ethics (Jonas, 1985).

In the new developmental vision, a necessity for increased environmental and social responsibility by citizens becomes an imperative. Such citizens are either private organizations, public organizations, or individuals (Marchand, De Coninck & Walker, 2005), and are major contributors to sustainable development because they base their decisions not only on economic criteria, but also on social and environmental criteria. Therefore responsible individuals, one of the possible figures within the community concerned about sustainability, also referred to as responsible consumers, are concerned about everything behind the product such as: where it was produced; in what conditions it was produced; by whom it was produced; the source of the materials; etc. (De Leeuw, 2005).

According to Vigneron, Patingre, and Schiesser (2003), the convergence of the three dimensions of social (ethics), economic (equity), and environmental (ecology) aspects represents a responsible product for sustainable development. A responsible product is therefore based on concerns such as; encouraging solidarity within a community, decisions based on safety for members within the community,

organic products, fair trade goods, consuming electricity from renewable energy, using recycled paper, etc. Therefore combining responsible conception, responsible products, responsible distribution, responsible consumption, and responsible disposal of commodities can result in a significant contribution towards achieving sustainable development. This will entail a significant involvement of public organizations, private organizations, and individuals as well. Table 1 proposes a summary of the characteristics of the progress and sustainable development paradigms.

Table 1: A comparison of progress and sustainable development paradigms, (based on Jonas, 1985; Whiteley, 1995; Heiskanen & Pantzar, 1997; Princen, 2003; Jackson, 2004, 2005; Hertwich, 2005; Marchand, De Coninck & Walker, 2005; Schaeffer & Crane, 2005; Droz & Lavigne, 2006). © Cucuzzella, C., 2007

	Progress Paradigm	**Sustainable Development Paradigm**
environment	Resources used for production of goods and services seen as unlimited, at best, conservation is a consideration.	Resources are to be preserved or renewed. Biodiversity is fundamental for a healthy environment.
technology	Progress of innovation is an imperative; efficiency of resource use and production methods	Innovation based on an ethics of responsibility; beyond the idea of efficiency
economy	Success is solely based on the continued economic growth – commodification of all needs.	Idea of success spans the health of society, the renewal of primary resources and the growth of the economy (equally) – solutions for all needs based on elimination of resource use.
society	Attempt to deal with social issues as long as economy is not adversely affected.	Social issues are a significant concern – equal concerns as economy and environment.
global vision	Multi-national economic growth for affluent societies and support poorer societies through donations.	Providing well-being for all societies across generations by encouraging all societies to prosper.
globalization	Universality: notion of a Universe. Encourages unique thinking and generalizations	Diversity: notion of a Pluriverse. Encourages tolerance and openness.
culture	Culture of obsolescence, high consumption, following the 'American Dream'. Reveres unity and sameness.	Culture of sufficiency and of simplicity. Reveres difference and otherness,
individual	Acute sense of individualism; performance driven, self-serving.	Works with community to contribute to social change; informed responsible citizen; sense of collaboration.
needs	Satisfied primarily by goods and services from the market economy.	Finds alternative means to satisfy needs (if available not from the use of primary resources).

When seeking to comprehend the various elements that define a development paradigm, it is important to point out that each of the elements are closely interrelated. For example, when considering the technology component, in the progress paradigm, according to Table 1, the idea of efficiency, is fundamental. This implies that when developing new technologies, the idea of rendering the product or service system eco-efficient is a major concern. Yet this is not enough in a sustainable context. To move towards sustainability, over and above the efficiency of technologies, the idea of sufficiency (Princen, 2005) is essential. Sufficiency questions the need for the existence of the product or service system and in fact, seeks to consider the development of solutions based on fundamental human needs. Therefore the reflection that is needed when considering impacts occurs very early during the conceptualization of a product or service system. This reflection is done through an understanding of the way in which humans conduct their lives on a daily basis, therefore understanding consumption habits and fundamental human needs. From this comprehension, new lifestyles can be conceptualized rather than new products or service systems.

So by simply shifting from an efficient mode of *technological* development within a progress paradigm to a sufficient mode of consumption on a *cultural* basis within a sustainable development paradigm, the effects will ripple across several other developmental components. By adhering to the idea of sufficiency based on a new cultural perspective, the way in which technologies are developed within a sustainable development context will also change; innovation will be based on an ethic of responsibility. In addition, new methods of satisfying human *needs* will result; if possible, without the use of primary resources. This reflection will require the involvement of the community; therefore there is a need for the *individual* to shift from an individualistic mindset to a responsible citizen that can contribute to social change; therefore resulting in a societal shift as well. *Social* issues will no longer be based solely on economic considerations, but will be considered as equal to economic issues.

According to Princen (2003), two important concepts for sustainability are social cohesion and ecological integrity. These concepts can be used as a basis for understanding progress (or lack of) in sustainable development. The European

Committee of Social Cohesion (CDCS) has provided a working definition of social cohesion. *"(...) the capacity of a society to ensure the welfare of all its members, minimising disparities and avoiding polarisation. A cohesive society is a mutually supportive community of free individuals pursuing these common goals by democratic means"* (CDCS, 2004). Therefore a sense of a supportive community for all of its members is essential. A system of governance may contribute to an improved social cohesion because of its participative approach to decision making. Another important concept is ecological integrity; it is an overarching idea that includes the following (Westra, 1994, from Soskolne & Bertollini, 1998, p. 45):

- The health of the ecosystem and its well-being (successful functioning) at the present time;
- The ecosystem's ability to withstand outside stress and its ability to regenerate itself following such factors. This relates in particular to anthropogenic interference to the ecosystem;
- The systems' integrity reaches a peak when the best possible capacity for the most possible developments has been reached within its time/location;
- The system retains its integrity if it can continue its development, and is not constrained by human interference, past or present.

Both *social cohesion* and *ecological integrity* are fundamental values for sustainable development, according to Princen (2003). Concerns such as: too much resource use or too little regeneration, risk both these values, in particular when material benefits for current generations limit material benefits for future generations. In this perspective the concerns related with over-consumption are critical when seeking to move towards sustainable development. This refers to the idea that "*living within regenerative capacities*" (Princen, 2003, p. 33) becomes an essential goal for sustainability. Therefore seeking efficiency in the way resources are used is not an adequate consideration when aiming towards sustainability. This means that transformational and not marginal (or incremental) changes are necessary within our societies if a shift towards sustainable development is to occur (Princen, 2003).

The transformation from the progress paradigm into a sustainable paradigm therefore entails a battle against the promises that the progress paradigm provides

and a belief that the emerging sustainable development paradigm will not only provide humans an improved sense of well-being, but also a promise of a continued future for the human race (Jackson, 2005). This supports a new global vision for development. The choice of reducing consumption is not only a social choice on the individual, cultural, and societal level, but also one of necessity; one that can make a difference in the plight for the survival of humanity. The freedom for humans to make change in their own lifestyles is constrained by the infrastructure within which life needs to be organized, by habits and social expectations, and products available (Hertwich, 2005). However, such choices must be made in all legitimacy and consequently must involve the members of society, not only experts, since such decisions are essentially social choices. This implies that a system of governance as a framework for such choices becomes increasingly fundamental.

1.2.2. Evolution of Design Approaches and their Strategies

As a result of the developmental crisis due to the progress paradigm, design approaches have had to evolve to deal with the emerging problems. Therefore, over the past 40 years, design methods have expanded and with this change, corporate responsibilities and activities have shifted in parallel (Janin, 2000). The increased significance of design in achieving environmental, economic, and social policy goals at a regional, national, and international level is a reflection of the growing concerns that have come to be accepted as fundamental for design (Fletcher & Goggin, 2001). In fact, the role of design has expanded and increased in complexity because it is now a known fact that the scale of environmental impacts does not depend on population size alone, but on what the population does; consumption choices, human choices, production choices, and in general, actions taken (Fletcher & Goggin, 2001; Marchand , De Coninck & Walker, 2005). Therefore in seeking to shift from a progress paradigm towards a sustainable development paradigm, design has had to evolve to deal with the growing concerns necessary for such a transition to occur (Fletcher & Goggin, 2001).

In an attempt to understand how the transition from a progress paradigm to a sustainable development paradigm will take place, the three main approaches for design, namely *green*, *eco*, and *sustainable*, according to Madge (1997), will be

presented. However, a series of concepts will be initially identified as a basis for discussion in these sections.

Ecological Perspectives to help Understand Crisis

The term *ecology* was first used in 1866 by German scientist Ernst Heinrich Haeckel (1834-1919) (Stauffer, 1957). Ecology is a division of biology that studies the relationship among organisms and their environment (IES, 2007). The fundamental characteristic of ecology is its integrated and inter-related view of nature; not a fragmented view (IES, 2007). *Global ecology* is the largest scale of ecology. It includes the study of land, waters, atmosphere, organisms, habitats, material cycles, and their relationships (White, Belletire & St. Pierre, 2005). It is important to note that the economy is wholly dependant on the global ecology for its primary resources.

There are also various attitudes towards the way in which ecological problems are addressed. For example, *techno-centrism* is based on the notion of technological progress, sometimes referred to as a *technocratic* approach. There is a belief that human science and high technology can solve environmental problems (O'Riordan & Jäger, 1996; Madge, 1997). This approach adheres to an ideology of rationality where humans have control over nature (O'Riordan & Jäger, 1996).

Anthropocentrism grounds environmental concerns in human interests (Whiteside, 2006). Humans are perceived as superior to nature, since in this perspective nature depends on humans (O'Riordan & Jäger, 1996; Leclerc, 2004). This perspective is based on an affirmation from Descartes where humans are masters and owners of the universe (Millet, 1995, from Leclerc, 2004). Conservation of nature is a concern because of its value to humans as a resource (Melin, 1999).

Eco-centrism grounds environmental concerns in terms of rights, interests, or well-being of nature (Whiteside, 2006). This is based on bioethics and on a deep respect with nature; humans are perceived as being equal to nature (O'Riordan & Jäger, 1996; Leclerc, 2004). Therefore, all parts of nature, which include humans, have the same intrinsic value and the same rights. Humans have an obligation to nature, since humans depend on nature for their survival (Leclerc, 2004). In this respect then, the

widespread economic growth and industrial development are a major concern regarding environmental impacts (Madge, 1997). Preservation of nature is a major consideration; nature is to be preserved rather than conserved (perceived simply as a resource for human use). In this viewpoint, ecosystems including all parts of nature whether living or inanimate can have a value in themselves (Melin, 1999).

Bio-centrism is similar to eco-centrism in that it opposes the anthropocentric view. In this attitude, value is placed on all living organisms (Melin, 1999). This differs from eco-centrism, because eco-centrism includes all parts of nature (living and inanimate), whereas bio-centrism includes only living organisms.

Deep ecology[17] is an ecological perspective that emphasizes "*harmony with nature and the intrinsic worth of all forms of life, as well as simplifying material needs so as to reduce human impact on planetary ecology*" (Madge, 1997, p. 46). In this thinking, humans are no longer the center of the universe; they share the resources of the earth equally like any other living organism and are therefore valued similarly (Orton, 2003). Shallow ecology, the other end of the spectrum from deep ecology, is a perspective where major ecological concerns can be resolved within an industrial society (Orton, 2003).

Industrial Strategies for Dealing with Crisis

Various industrial strategies have been developed to deal with the ecological crisis. Very early strategies adopted an *end-of-pipe* approach which referred to the removal of contaminants from a waste stream as a last stage of a process (Environment Canada, 2006). It was a curative measure whereby it sought to treat air, water or soil through de-pollution techniques. Technologies such as catalytic converters on automobile tailpipes that reduced emissions of pollutants after they had formed were examples of end-of-pipe solutions (Environment Canada, 2006). This approach aimed to respect current environmental norms (Leclerc, 2004).

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[17] Deep ecology was first developed by Arne Naess in the early 70's. Please refer to Arne Naess, "The Shallow and the Deep, Long-Range Ecology Movement. A Summary", *Inquiry*, 16 (1973), and "Rethinking Man and Nature: Towards an Ecological World View", *The Ecologist*, 188, no. 415, (1988).

Subsequent industrial methods were m*iddle-of-pipe* strategies which adhered to a preventive approach and sought to minimize waste and strive for 'clean' production on the site of production. This strategy was often referred to as on-site prevention. This was a technological approach to preventing pollution, just as end-of-pipe. This was a method that integrated environmental, economic and social issues (Leclerc, 2004). In this context, the social issues that were considered were health and safety measures for individuals at the production site.

A *front-of-pipe* approach was fundamentally different from both end-of-pipe and middle-of-pipe. This did not entail a technological change or innovation to prevent pollution, but instead was primarily concerned with the development of products and design (Belmane & Charter, 1999, from Leclerc, 2004). It was essentially the implementation of eco-design (Boeglin *et al.*, 1999, from Leclerc, 2004).

Another approach addressing the management of pollutants is *environmental engineering;* it seeks to manage and control pollutants in water, air and soil. This approach covers the solutions obtained through end-of-pipe and therefore seeks to reduce environmental impacts based on the fabrication of a product (Janin, 2000). *Pollution prevention* is an approach that seeks to reduce or eliminate any pollution as a result of equipment or fabrication process required for the production of a product. This covers end-of-pipe and many middle-of-pipe strategies. It does not consider environmental impacts that may occur beyond the production phase, and therefore may take into account the modification of certain materials, the elimination of ineffective steps in the fabrication process that are polluting, or modifying certain technologies; this may be attained through a re-design of the product (Janin, 2000).

Industrial ecology is an approach that is no longer oriented towards *products* but instead oriented toward production *systems* (Janin, 2000). This is an approach that goes beyond the organization producing the product, and therefore spans several enterprises. In fact, the temporal span is no longer at the product level, but on the scale of *average human life span.* In this approach, the waste of one factory becomes the raw material for another factory, therefore the waste cannot be environmentally damaging, since it is re-introduced into a system that operates as a *closed circuit* (Janin, 2000). This approach is an integrated approach to managing

environmental impacts by introducing the idea of an industrial ecosystem (Sachs, 1984).

Eco-efficiency, a term that originated from the 1992 Rio Earth Summit, is considered an indicator for sustainable development (Janin, 2000; Stevels, 1997; TRNEE, 2001; WBCSB, 2000, from Leclerc, 2004). It refers to the idea of creating products and services by continuously using fewer resources that generate the least amount of waste and pollution (WBCSB, 2000, from Leclerc, 2004). Eco-efficiency cannot be addressed by reducing impacts alone. WBCSD (2000, from Leclerc, 2004, p. 27) recommends 4 areas of opportunity:

- Modify internal corporate processes so that less resources are consumed, there is a reduction of pollution, risks and costs;
- Find new markets that can valorize waste which can be considered as resources for other enterprises;
- Re-conceptualize products in function of the environment;
- Redefine the demand and rethink the markets by selling services instead of material products.

Design Approaches for Dealing with Crisis

Green Design Approach

The main goal of green design is to reduce pollution by reducing the amount of waste generated; therefore end-of-pipe and zero-waste are the main strategies in this approach. Both use environmental engineering methods and pollution prevention strategies (Madge, 1997). Green design seeks to reduce environmental impacts based on the production of a product using technological solutions. Green design also includes social considerations; these are based on the adherence to emerging health and safety norms (Janin, 2000). An example of a solution using this approach is the building of smokestacks in production sites to de-pollute the contaminated air released from the plant. Other solutions using green design are the use of compost bins to reduce matter going to landfills, recycling, eliminating pesticide use, and using efficient sources of energy. For example, green design tries to select materials that are easily replenished by the earth, for example bamboo or hemp. An example

of green design in architecture is when demolishing buildings; this approach attempts to reuse or recycle as much of the material as possible.

During the '80's, the practise of green design was ambiguous (Madge, 1997). It was difficult to define the level of adherence to green design. Therefore a spectrum from light green to dark green was used to indicate the degree of attachment to the ideas of green design. Light green meant a moderate approach to green design, whereas dark green meant a radical approach. Light green meant that organizations would instil changes slowly, whereas dark green was largely influenced by ecologists that adhered to the principles of deep ecology. In essence, the light green pole could be associated with techno-centrism, and the dark green pole could be associated with eco-centrism (Madge, 1997).

In 1982, an ecological checklist was created for designers and manufacturers and this formed the basis of a working group on ecology and design (Madge, 1997). This checklist placed a certain amount of pressure on manufacturers that wanted to be part of this agenda. It meant that they had to modify the way in which their products were manufactured. Most designers adopted a light green approach since this meant that they could still be considered green, without the pressure of any radical change to their processes. It became evident that a conflict between the ideas behind dark green design and the values of marketing and advertising existed. The danger in this conflict was that the efforts in promoting environmental goods would simply result in a growing consumer market in general (Robertson 1989, from Madge 1997).

Eco-Design Approach

Eco-design is the next evolution from green design (Madge, 1997). Eco-design or ecological[18] design is the activity of designing products or services whereby they are environmentally benign and economically viable (White, Belletire & St. Pierre, 2005). In this approach, there is a notion of continual improvement towards integrating environmental criteria into the design process; which is essentially the ISO 14001[19] norm – it signifies continual improvement towards environmental management

[18] The term 'ecological' dates back to the beginning of the environmental movement in the late '60's.
[19] More information relating to ISO 14000 environmental management standards is located at URL=<www.iso.org>, the official web site of International Organization for Standardization (ISO).

strategies (Janin, 2000). Social concerns such as human health and safety are included in this approach and are an integral part of the tools used (Consoli *et al.*, 1993).

Eco-design emerged during the '70's. This approach is essentially a multi-criteria and hierarchical approach; used to help in the decision making process. This approach is considered multi-criteria because it considers not only the traditional elements of design (form, material, process, function), but also includes environmental and social (health and safety) dimensions (Janin, 2000). Examples of some of these criteria are: Is there a way to use less material and produce an equally good product? Can a material that produces less negative environmental impacts be used? Could the material come from a local source so that transportation is minimized? Can the product be made so that it can be easily repaired? These questions are just a small fraction of the criteria that can be used in eco-design approaches. The main goal of eco-design is product and service process optimization (Madge, 1997).

Some strategies using eco-design approaches are: *Design for the Environment* (DFE), such as: Design for Recovery, Design for Disassembly, Design for Efficiency and Design for Recyclability (Janin, 2000). These strategies consist of the collection of various design methods referred to as DFX (Design for X). Each of these different methods for design (DFX) focus on at least one phase of the life cycle of a product (or one of its components).They are strategies that seek to integrate environmental criteria into the design of the product. These can be considered front-of-pipe strategies.

Life Cycle Design, another approach to eco-design is different because it is a first generation systemic[20] approach for design. In this approach, the benefit is that the entire life cycle of a product is taken into account when assessing environmental impacts, and therefore there is a higher chance that the environmental effects will be minimized and less probability that the environmental problems will be displaced (as in the case of environmental engineering or pollution prevention, both green design strategies). Engineering models, and analytical tools, the basis of Life Cycle Design, are developed to enable designers and engineers to assess the life cycle of a

[20] Section 2.1 of this paper provides further elaboration on this topic.

product from resource extraction to disposal (Lye, Lee & Khoo, 2001). These contribute not only to the design and production of eco-products but to the construction of environmental policies as well (Lye, Lee & Khoo, 2001).

Life Cycle Analysis[21] (LCA) tools emerged as a framework for eco-design practice during the '80's. The evaluation of environmental impacts of a product system, through all stages of its life cycle, involves a LCA. This evaluation is sometimes referred to as 'life cycle impact assessment', 'life cycle approach', or 'cradle to grave analysis' (Consoli *et al.*, 1993). This method facilitates decision making in the context of seeking to minimize the negative impacts of products and service systems. It is still used today because of its pertinence to the assessment of negative environmental impacts based on observable consequences of product and service systems. The eco-design approach, unlike green design, which is a downstream approach, considers also upstream impacts. There are five major life cycle stages of a product or service system (Tischner *et al.*, 2000; Plouffe, 2005, pp. 31-32; Leclerc, 2004, pp. 24-25): material[22], fabrication[23], distribution[24], utilization[25], and end-of-life[26].

There are numerous life cycle impact assessment methods available. They are characterised into two main categories: midpoint (problem oriented) and endpoint (damage oriented). These two categories are both based on the cause-effect chain; where midpoint refers to primary effects and endpoint refers to secondary effects. Example of methodologies that use a damage oriented approach (endpoint) are Eco-indicator 99[27] (EI99, from the Netherlands) and Environmental Priority Strategies[28]

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[21] LCA is based on the ISO 14 040 framework (Jenson *et al.*, 1997); this refers to the ISO norm: Environmental management - Life cycle assessment – Principles and framework (ISO, 1997a). Further details of the Life Cycle Analysis framework is provided in Appendix 1.

[22] This refers to the extraction and transformation of raw materials into the fabrication material: for example, the preparation of tree logs into sheets of lumber.

[23] This refers to the production of the fabrication material into a product or a product component. This includes the assembly of all components of a product, its packaging and its storage.

[24] This refers to all the transportation required so that the product reaches the distributor or retailer. This will include all types of transportation such as planes, trains, trucks, or boats, as well as any energy used in the process.

[25] This refers to the utilization of the product with respect to its intended function. The ways in which the product will be used are important considerations in this step. This step will also take into consideration the maintenance and repair of the product as well as any consumables that the product requires. A consumable is a secondary product essential to the proper functioning of the product. For example: an ink cartridge, electricity and paper are examples of consumables for a printer.

[26] This refers to the possible scenarios for the end-of-life of the product, at which point the product is no longer in use and the user wishes to depart with it: for example, the product could be reused, recycled, repaired, or discarded to a waste dump.

[27] Further information is available on URL=<http://www.pre.nl/eco-indicator99/>.

(EPS, from Sweden). Examples of methodologies that use a problem oriented approach (midpoint) are: EDIP[29], CML[30], EcoScarcity[31], JEPIX[32], and LUCAS[33]. There exist methods that use both approaches: IMPACT 2002+[34], LIME[35], EPS 2000[36], and ReCiPe[37] (Ménard & Margni, 2006).

Midpoint approaches allow comparisons at the level where the problem initially arises; for example, global warming, acidification, radiation, etc. A product system developer can use such impacts to assist him/her to make decisions based on their comparison. This interpretation is usually not a trivial task since units are not always compatible or easily comparable. This is the strength of endpoint approaches, such as Eco-indicator 99 (Goedkoop & Spriensma, 2001). In this approach, the designer can easily make an assessment since the units are normalized. Each of these is based on the life cycle analysis framework.

Life Cycle Analysis is fundamental for eco-design since it considers the entire chain of activities necessary to elaborate environmental impacts; these are usually summarized in five major life cycle stages as previously described. This allows an emergence of the collection of potential problems and therefore can help identify the most effective actions to take in order to reduce environmental impacts of a product or service. The way in which impacts are assessed is through the use of life cycle models. Life cycle models have been developed to help designers define accurate levels of environmental impacts (Lye, Lee & Khoo, 2001). These life cycle models are used to help estimate the energy and material flow of products and services through their entire process from purchasing of raw materials to the eventual disposal. Therefore, life cycle models help designers identify the impacts of the product or service system related to every activity within the life cycle stages (Lye, Lee & Khoo, 2001). With this information, designers could then analyze the product

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[28] Further information is available on URL=<http://eps.esa.chalmers.se/>.
[29] Further information is available on URL=<http://ipt.dtu.dk/~mic/EDIP2003>.
[30] Further information is available on URL=< http://www.leidenuniv.nl/interfac/cml/ssp/lca2/index.html>.
[31] Further information is available on URL=<http://www.e2mc.com/BUWAL297%20english.pdf>.
[32] Further information is available on URL=<www.jepix.org>.
[33] Further information is available on URL=< http://www.polymtl.ca/ciraig/ciraig.html>.
[34] Further information is available on URL=<http://www.epfl.ch/impact>.
[35] Further information is available on URL=<http://www.jemai.or.jp/lcaforum/index.cfm>.
[36] Further information is available on URL=<http://eps.esa.chalmers.se/>.
[37] Further information is available on URL=< http://www.pre.nl/pre/projects.htm#ReCiPe>.

process and optimize those areas that are the biggest energy drains. The tools associated with eco-design help designers make appropriate choices at a product or service system level and address environmental and social (limited to health and safety) impacts based on the life cycle of the product or service systems.

Sustainable Design Approach

Sustainable design is the activity of designing products or services whereby they are environmentally benign, socially equitable and economically viable (White, Belletire & St. Pierre, 2005). The main concern of sustainable design is the satisfaction of the fundamental needs of everyone (present and future) and understanding the limitations and impacts imposed on the environment and society by technology, production and consumption. Sustainable design is a more global concept when compared to eco-design, where the industrial context is integrated with cultural and social approaches at the level of humanity using a very long-term vision (Janin, 2000).

The result is that the role of the designer has changed. It is important for designers to regain the position of planners in a larger context of production and consumption. In sustainable design, designers, including industrial designers, engineers, architects, planners, or any designer of products or services regardless of scale, have acquired a new set of responsibilities when compared with previous design approaches. These responsibilities include the necessity to ensure that present society's needs are met without depriving the needs of future generations. Therefore when applying the ideas of sustainable development to design, designers must also incorporate the idea of *futurity* into their solutions. Futurity is a term that refers to the idea that the future of humanity cannot be compromised by meeting the needs of present generations. This refers to both inter and intra generational equity (Carter, 2001).

Sustainable design rethinks the way humans live in their societies. This is a global and systemic[38] vision because it seeks to establish new relationships with the environment and others, for the short, medium, long and very long-term. The

[38] Section 2.1 of this paper provides further details on this topic.

consideration of human consumption patterns is an example of issues addressed within a sustainable design context (Marchand, De Coninck & Walker, 2005). Problems associated with the degradation of the environment has historically been attributed to overpopulation alone, however, the problem of over-consumption is a fundamental consideration for sustainable development (Heiskanen & Pantzar, 1997; Fletcher & Goggin, 2001; Marchand, De Coninck & Walker, 2005). In this approach, innovative modes of living within a community become possible solutions (Marchand, De Coninck & Walker, 2005). In fact, the implication of the community is an integral part of sustainable design since solutions that address new modes of lifestyles will not be adopted unless the society has accepted them as beneficial for their communities. Therefore, sustainable design considers both production and consumption when evaluating social, environmental and economic impacts.

With this new approach, solutions will no longer be limited to a product level, but system based solutions will be conceptualized. What this means is that solutions will now be conceptualized within a larger scope which includes human needs, as well as societal and environmental impacts; this entails a more upstream approach to searching for long-term solutions. In fact the temporality of design solutions; meaning short, medium or long-term, become a fundamental dimension for designers in their practice. This will place designers in a position of developing new lifestyles rather than creating products that seek to 'commodify' human needs. This will require that designers integrate human beings into a broader ecological, cultural, social, economic environment (Margolin, 2002).

In a society where the designer's role shifts from a shaper of commodities (product-based society), to a shaper of lifestyles (system-based society), it is clear that the user's role will shift as well. In this type of society, the users will have more control of their daily experiences based on their level of engagement to their environment. The relationships between the users and their products will, as a consequence, evolve. Designers will need to adopt solutions that consider the common-good, as well as solutions that can satisfy the most needs by consuming the least resources. This is not a trivial task, and in fact will require that the designer understands the various concerns within a community. Therefore, this consideration will entail that the

designer engages the community in this deliberation, since the definition of common-good and the satisfaction of human needs[39] is subjective.

Summary of Design Approaches

Figure 1 is a synthesis of the concepts described above. It provides a perspective of design strategies that include the notion of time scale. In this figure, the time scale is divided into: process, product, average human life span, and civilization. This time scale can be considered as a short, medium, long-term and very long-term scale.

Pollution prevention and environmental engineering, which are strategies mainly used by the green design approach are considered short term strategies for finding solutions. Life cycle approaches are limited to a product or service; which signifies that eco-design, although a global approach to product design because of its cradle-to-grave perspective, is limited to the scale of the product or service, and therefore is considered as a strategy that seeks essentially medium term solutions. Sustainable design on the other hand is based on the scale of civilization, and therefore the solutions in this approach consider the well-being of humanity on a global scale; very long-term solutions. It becomes evident that the level of complexity and scope of vision increases with the emergence of each new design approach.

As the approaches evolved from green to eco and finally to sustainable design, the solutions employed required a greater level of reflection. In fact, there is an increased upstream reflection for sustainable design since a re-questioning of current modes of lifestyles is crucial in the search for solutions in the current crisis. Therefore for sustainable design, a global and systemic vision that considers social, biophysical, technical, economical, and cultural elements becomes fundamental.

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[39] Section 1.3 of this paper provides further details on this topic.

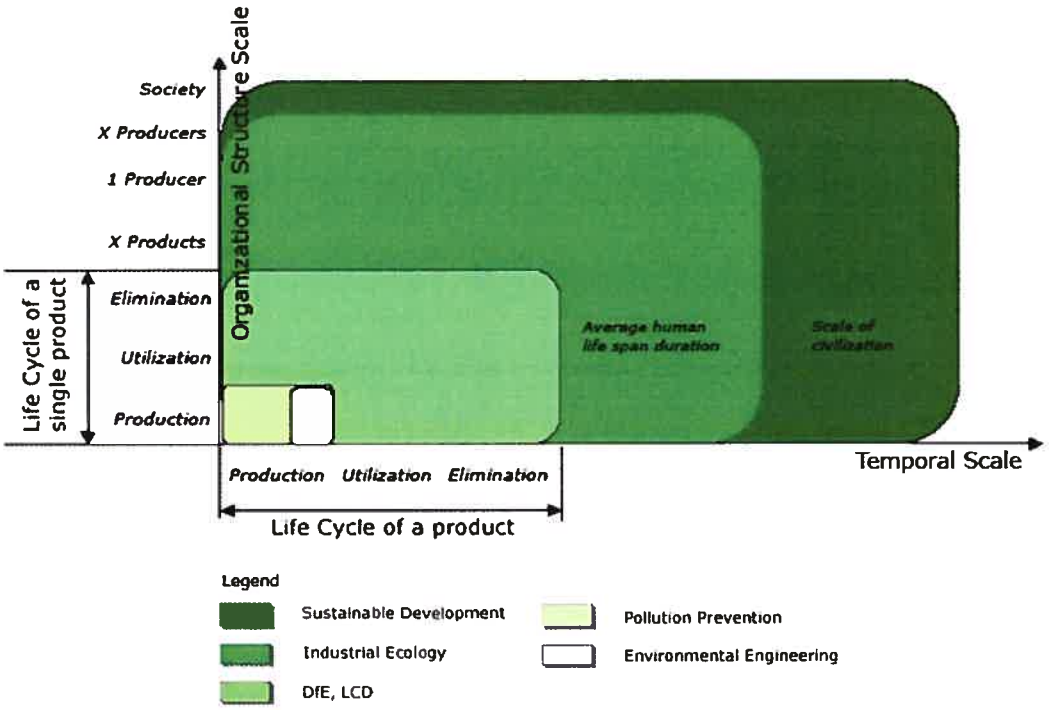

Figure 1: Incorporating environmental and social issues in product design and realization (based on Bras (1997), from Janin, 2000, p. 34).

Figure 1 provides a graphical representation of the various temporal and organizational structure scales of the design strategies described above. Table 2 presents the design strategies described through a slightly different perspective. This table is based on their different approaches, their hierarchical initiatives, the organizational structure required to support such a strategy, and motivations of the organization. It elaborates on each of them by presenting them from the simplest to the most elaborate design approach. Table 2 demonstrates that green design is a production process approach, eco-design is a product approach, and sustainable design is a system approach. This table therefore reflects the spatial and temporal scale of Figure 1, which classifies green design as a short term approach, eco-design as a short and medium term approach, and sustainable design as a short, medium, long, and very long-term approach.

Table 2: Various industrial approaches to design that consider one or more of: environmental, social, cultural, and ethical criteria (based on Dewberry, 1995; Madge, 1997; Janin, 2000; Leclerc, 2004).

Name of Design Approach	Scale of Approach	Type of Approach	Organizational Strategy
Green Design An approach that responds to evolving laws.	micro-level scope	**Process Approach** Industrial vision with short term solutions	An approach that comprises mostly of end-of-pipe solutions. Work is focused on reducing emissions of pollutants based on the process of fabrication. The motivation here is mostly abiding laws.
Eco-Design Approach to design that considers the environmental impacts based on the life cycle of a product or service.	meso-level scope	**Product Approach** Global vision with essentially short and medium term solutions	A strategic approach that considers all the levels of the enterprise. All the potential environmental impacts of a product are taken into consideration and the actions taken are an integral part of the policies of the enterprise. The motivation here is for the enterprise to differentiate itself from other enterprises, as well as to follow expected laws and norms.
Sustainable Design Global approach to design – requires a sense of inter-dependence among the organization, those affected by the activities of the organization, and the environment	macro-level scope	**System Approach** More global vision with short, medium, long and very long-term solutions	A global approach that considers environmental, social, cultural, and ethical aspects. In this approach, the organization is no longer considered isolated in its environment, but is considered as a part of the system with the environment and society that surrounds it. The motivation here is a strong commitment to sustainable development.

Historical Perspective of Design Approaches

In essence then, environmental issues, concerns and strategies have progressed enormously where discourses and solutions have evolved into those of the concerns of social conditions and the future of humanity in general. Although there is much value in the earlier approaches to the environmental issues, the current discourses seem to be attempting to tackle the issues through a global perspective. Challenging current thinking with respect to design, production and consumption practice are a way of seeking solutions at the source; where fundamental changes in human behavior have to occur, if lasting effects to the environmental crisis are to happen (Madge, 1997). Figure 2 illustrates the evolution of these design strategies with the aim of shifting towards a mode of sustainable development.

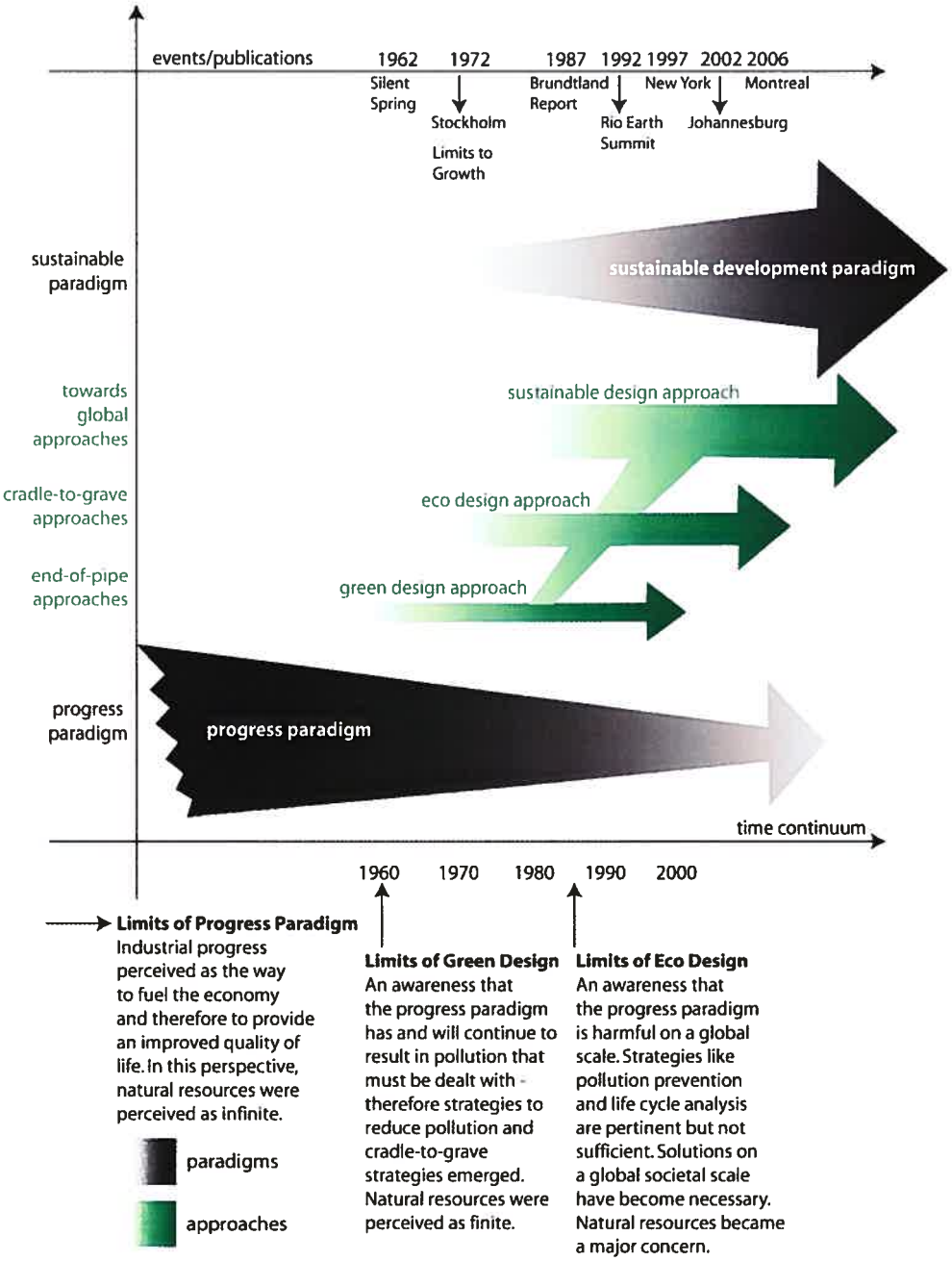

Figure 2: Emergence of sustainable development: from a dominant ideology to a new global vision (based on Madge, 1997). © Cucuzzella, C., De Coninck, P., 2007

Figure 2 illustrates the concerns and major events that took place in seeking to shift from a progress paradigm to a sustainable development paradigm. Evolutions from conventional design, to green design, to eco-design, and finally to sustainable design have been critical in seeking to achieve sustainable development. Green design strategies began as early as the '60's at about the same time as the publication of

the 1962 book *Silent Spring* (Carson). Eco-design strategies began at about the same time as the publication of the book *The Limits to Growth* (Meadows, Meadows & Randers, 1972). As a consequence the new set of tools developed for eco-design took on a first generation systemic approach[40] to understanding environmental impacts. In the '80's and '90's, second generation systemic approach[41] to research began. This approach is adopted for sustainable design, because it entails a new global[42] perspective, fundamental for sustainable development. Each of these design strategies builds upon the previous strategy, and therefore the scope of the responsibilities of the designer keep increasing with each new phase.

1.2.3. Limits of the Various Design Approaches

In the following sections the limitations of each of the approaches described earlier will be elaborated. This will reveal the need for adopting new approaches when searching for solutions to design problems in a context of sustainable development. The limitations of green and eco-design approaches will be described, and as a result the emergence of sustainable design and the need for new approaches this strategy implies will be developed.

Limitations of Green Design Approaches

During the '60's, environmental strategies for reducing pollution to help clean up the planet and end-of-pipe strategies were introduced. This was an industrial vision with a technical problem/solution approach; and considered mostly short term solutions with a low investment from the enterprise. These strategies were essentially reactive solutions to the emerging environmental problems of the time.

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[40] First generation systemic approach refers to a neo-mechanist approach. This refers to a closed system of elements and their relationships. In this paradigm, the subject will often be able to extrapolate universal laws. This will be done through a cause-effect analysis that reduces the object of study to generalizations; where deviations from these observations will be considered as errors and will not be considered in the generalization. In a mechanist approach, the observations and their interpretations are repeatable, structured, and controlled. Perception is disregarded since it is perceived as unreliable. Discovery of this reality is done through objective observation, experimentation, and the validation of newly established laws; deduction is the only method of acquiring knowledge (De Coninck, 1993).

[41] This refers to an open system of elements and their relationships. Please refer to section 2.1 of this paper for further details on this topic.

[42] This refers to the (totality + interrelations among elements within system + interrelation between elements within system and their environment) (Morin, 2005).

This approach adopted technical solutions to solve pollution problems, and because the solutions were solely within the perspective of the product's fabrication, it did not question the usefulness of the product itself. In this perspective, green design's approach to solving the environmental crisis was limited to problems within the fabrication process. Also, because of the way such problems were solved; seeking to clean up pollution at the end-of-pipe, it may have displaced environmental impacts by solving one problem and introducing another through the implementation of the solution. This is because the technology necessary to clean up the pollution may produce unknown detrimental effects to other areas of the environment. Also, by focusing solely on de-polluting air, water or contaminated soil within the perspective of a fabrication process, it did not consider more global solutions that may have eliminated the original problem of contamination.

Limitations of Eco-Design Approaches

Eco-design is more global than green design because it considers a cradle to grave perspective of the product or service in question and therefore seeks to optimize the product beyond the limits of the fabrication plant. Also, in eco-design the temporal perspective is not only short term, but medium term solutions as well. Yet they are still reactive strategies. It can be argued that eco-design is proactive: by looking at the entire life cycle of a product, the designer can select the most effective action in order to reduce the environmental impacts of this product, and therefore acts before the problem is manifested, and in this perspective eco-design strategies can be considered as proactive. However, there is still the more global question of the purpose and usefulness of the product; what fundamental needs[43] does it seek to address? In this perspective, eco-design is still a reactive approach. In fact, by not looking for long-term or very long-term solutions and not considering the necessity of the product in itself, eco-design remains a predominantly reactive approach.

The LCA tool

LCA is a comprehensive tool that helps decision makers assess product and service systems in order to try to reduce the negative environmental impacts, as well as

[43] Fundamental human needs will be further elaborated in section 1.3 of this paper.

optimizing the benefits (Consoli *et al.*, 1993). It is the privileged tool for eco-design. It has a rigorous code of practice, and therefore may be time-consuming and expensive to use, in particular for SMEs (Small and Medium Enterprises). The benefits of LCA are that it provides tremendous guidelines for optimizing product and service systems; it supports decision making with scientific data and competence, and in so doing it can make a distinction between scientific facts (as far as possible) and sets of values (Jenson *et al.*, 1997). In fact, by conducting LCA, knowledge is also gained by the practitioner. However, it has its limitations. The following sections will describe some of these.

Data Quality for LCA

The quality of an LCA is as good as the quality of the input data (Consoli *et al.*, 1993). However, the accuracy of all data is a difficult task. The limitation of data quality for LCA is primarily a technical limitation, and not a limitation based on the concept of a Life Cycle Analysis. The impacts that an LCA can assess are observable consequences of products or service systems. Non-observable, long-term consequences cannot be assessed using such a tool because this type of data is not available, and therefore cannot be used in a LCA. This limitation is a direct consequence of the social problems arising as a result of current techno-scientific innovations; the impacts of some of these technologies cannot be easily assessed through a tool such as LCA because the impacts are often either non-observable or not measurable.

Evaluation of Social Aspects

Current LCA assess social aspects based solely on health and security. The indicators used to make these assessments are mostly based on effects of toxic elements from the product or service system. So they are based on the degradation of human health (Jenson *et al.*, 1997). Many more social aspects can be assessed using LCA, such as quality of working environment; equity in pay wages; abuse of children for employment purposes, etc. (De Leeuw, 2005). These impacts are dealt with a predominantly statistical approach. Some of these impacts are currently under development by several LCA developers; for example, a method currently developed

within University of Stuttgart, called GaBi[44] uses a quantitative approach for assessing social aspects. These emerging methods that seek to assess social impacts beyond health and safety issues (based predominantly on existing norms and regulations) are considered Social Life Cycle Analysis (SLCA) methods. In fact, on a wider scope, social aspects can be assessed based on the consumption patterns of humans. How do the ways in which humans conduct their lives impact their communities, the environment, or societies in general? The approaches to dealing with social aspects are quite different from one SLCA method to the next.

Many SLCA methods for evaluating social aspects were recently presented at a conference in Sevilla[45]; these indicators are developed using the life cycle analysis methodology. Most of the approaches are deterministic, in that they approach the indicators as either cost-benefit or risk analysis using a quantitative[46] and statistical approach. In approaching such indicators in this way, many assumptions have to be made in the process of establishing the indicators and during evaluation. The consequence is that the assessments of social impacts from the various approaches will yield very different results. This is problematic because decisions are often based on these assessments, and as they differ from approach to approach, then it becomes less evident which assessment is closest to the actual problem. This is the primary downfall of using a solely deterministic approach for the evaluation of social impacts.

In addition, assessments of social impacts are based on a socio-economic perspective; they do not consider the combined social and cultural aspects that form the basis of human existence. Social aspects related to economic aspects are but one perspective; a more complex, more global perspective is necessary to integrate the inherent diversity from one culture to another. Therefore both quantitative and qualitative approaches are necessary to deal with this type of assessment.

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[44] L. Barthel, and J. Pflieger from the University of Stuttgart presented this approach at the1st International Conference on *Society and Materials 2007* (SAM1), in Seville, March, 2007.

[45] 1st International Conference on *Society and Materials 2007* (SAM1), in Seville, on March, 2007.

[46] Section 3.1 of this paper provides an elaboration of this idea.

Perspective of Problem to Solve

The point of view of the problem in question in a perspective of eco-design remains at the product or service in question and therefore evades a more global perspective; selecting between long, medium, and short term solutions; finding the balance among conflicting objectives such as conservation, development, equity and peace. In an eco-design approach, the idea that nature can be looked at as a predictable system is adopted.

During the late '70's, a new understanding of the world rejected the idea of nature as a static and balanced system, but instead adopted the belief that nature is unpredictable and self-adaptive in time; idea of homeostasis, dynamic yet stable system (Checkland, 1999). This is in contrast to the idea of science that has been adopted by green and eco-design (Worster, from Madge 1997). Because of the difference in approaches, the development of this new belief has had a huge impact on the modeling of eco systems. The idea of chaos and complexity in nature now throws the whole idea of the exact science of life cycle analysis systems into disarray (Madge, 1997). A rethinking of the priorities and attitudes in ecological design are necessary. This has led to a shift from discussions of ecological design to the ideas of sustainable design (Madge, 1997).

Limitations of Preliminary Approaches to Sustainable Design Strategies

Preliminary research on sustainable design sought to construct a tree of indicators to help decision making in a sustainable development context: the branches of this tree were the sustainable development pillars; economic, social and environmental (Droz & Lavigne, 2006). In this approach, each branch contained their respective level of complexity. There were limits to such methods; what are the coefficients and how to evaluate them? These methods adopted a technical approach; they sought to minimize harm. The implicit model was preservationist with a strong emphasis on certainty; therefore a predominantly anthropocentric approach that was based on determinism. However, with the uncertain outcome of innovations, this point of view is limiting as an approach to solving the problems faced today.

Emerging Strategies for Sustainable Design

Sustainable design deals with not only environmental but also social problems on a more global scale that requires short, medium and long-term solutions (Gendron & Revéret, 2000); this is a proactive approach. This leads to the idea that humanity must act locally in finding sustainable solutions, yet think globally in considering the impacts of these solutions (Schumacher, 1989). This is a fundamental attitude for the pursuit of sustainability.

The choice should be more than just to minimize harm, and this approach is often not well received within a technical approach (Tallachini, 2005). Possible solutions should consider not only a reduction of negative impacts, but the improvement of social and environmental conditions. This reveals a conservationist and preservationist challenge that is seen through an ethic of justice (Droz & Lavigne, 2006). This entails finding more value from rare resources and providing a better life for the majority of humans. Therefore a necessity exists for a better understanding of what methods are necessary so that both the environment and society are valorized; justice and equality become a central component in decision making (Droz & Lavigne, 2006).

Therefore, progress will be manifested through justice and equality; this implies a consideration of the common-good. In the context of sustainable design, a decision that is based solely on scientific analysis cannot be considered to be a decision based on a thorough understanding of the problem; a deeper comprehension of the problem through other means is necessary to be able to make a decision that is intended to be fair and just on various levels (Droz & Lavigne, 2006).

1.2.4. Assessing Progress in Sustainable Development

Assessing progress towards sustainable development is fundamental, since it will reveal if the transformation from a progress paradigm towards a sustainable paradigm is successful. One of the difficulties of assessing progress towards sustainable development is that, as Bell and Morse (1999) have mentioned; with every attempt to assess sustainability, the very idea keeps evolving; evolving not

only in the minds of those concerned with measuring its progress, but also in the minds of the growing number of citizens aware of its progress; or lack thereof.

Ambiguity in the definition of sustainability leads to confusion and an inherent inability to go forward at an observable pace; where progress cannot be easily assessed. A common method to assess the progress of sustainable development is through indicators; Indicators, although often a representation of complex phenomenon, are assessable, and therefore can reveal the progress towards sustainability. Indicators can be seen as a core concept in operationalizing sustainability. However, sustainability will continue to be an evolving entity where the indicators used to define its progress will also have to continue to evolve. So an understanding of how sustainability is assessed and how such assessments affect or support decision processes is fundamental for the progress toward sustainability.

Indicators within a LCA perspective are established based on a specific concern, whether it is environmental, human or resource. Variables are necessary for measuring indicators and for collecting the necessary data. In a LCA, these are calculated using process models and are based on the collected data and the inventory defined. The result of the calculation will define the impacts. These impacts can be midpoint or endpoint for a LCA. It is important to note that uncertainties are a constant concern in such calculations and are seriously considered using statistical methods. The evaluation of the impacts is done by experts and therefore the values of the experts are embedded in these assessments. Therefore indicators are a means to understand impacts and are pertinent as a guide for final decisions.

Current Global Situation for Assessing Sustainability

At the international level, UNEP (United Nations Environmental Program) has a mandate to "*provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations*" (UNEP, 1972). The United Nations Commission on Sustainable Development (CSD) established in December 1992, has a mandate to ensure an effective follow-up of United Nations

Conference on Environment and Development (UNCED), also known as the Earth Summit. This commission is responsible for reviewing progress in the implementation of Agenda 21[47] and the Rio Declaration on Environment and Development[48], among other responsibilities. This commission has developed a set of indicators and associated guidelines as a means to measure progress on sustainability at the international level. This set of indicators is pertinent as it serves as a basis for the development of assessment methodologies for sustainable initiatives on a national or corporate scale.

Assessment methodologies on a corporate scale are pertinent as they provide a global view of the adherence to sustainability with the capacity of measuring their progress. Organizations such as the GRI[49] (Global Reporting Initiatives) consider the reporting on economic, environmental, and social performance by organizations as comparable to financial reporting. The GRI Reporting Framework is intended to serve as a generally accepted framework for reporting on an organization's economic, environmental, and social performance. It is designed for use by organizations of any size, sector, or location. This reporting framework and its associated set of indicators and guidelines are used to report the progress towards sustainability of a corporation. GRI is unique as the only thorough sustainability reporting framework based on a global, multi-stakeholder process. This framework is considered best current practice in reporting methodologies (SustainAbility, 2006).

Examples of organizations that assess sustainable development reporting and publicly offer their reporting assessment methodologies are SustainAbility[50] from the United Kingdom, and IFSM[51] (Institute for Sustainable Management) from Switzerland, among others. These assessment methodologies aim to assess the level of sustainability reporting for corporations. They are pertinent since without such reporting assessments, there exists no simple way of assessing the quality of an organization's sustainability reporting. They allow the public to see how

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[47] This agreement was one of five agreements signed by participating countries at the 1992 Rio Earth Summit.
[48] This agreement was one of five agreements signed by participating countries at the 1992 Rio Earth Summit.
[49] More information regarding this organization is on URL=<www.globalreporting.org>.
[50] In 2000, the methodology underwent an extensive overhaul that took into account the growing consensus regarding various elements as they were emerging through the Global Reporting Initiatives and various other initiatives. For more information on this organization, please refer to URL=<http://www.sustainability.com/>.
[51] For more information on this organization, please refer to URL=<www.ifsm.ch/leitidee-engl.htm>.

organizations are ranked according to their quality of reporting, and therefore based on their performance, the public will decide if the reporting is trustworthy. Both SustainAbility and IFSM also provide consultancy services to facilitate the implementation of sustainable management in practice.

1.3. Moving Towards Sustainable Development

Sustainable development represents a transformation in human behaviour. In this section an elaboration of what such a transformation entails will be presented.

1.3.1. Sustainable Development through Social Change

If the progress paradigm has improved the quality of life of many individuals and their communities, it has also led to a plethora of environmental and social issues. This awareness has led to various approaches to assessing negative impacts, as described in the previous section. Many of these methods are used to help designers develop the most environmentally sound products and services. Some other methods have been developed to help raise awareness of the consequences of the daily habits of humans. For example, comparative ecological footprints[52] suggest that different responsibilities with respect to limiting or reducing material consumption would apply to different sections of the world population (Durning, 1992, from Schaefer & Crane, 2005). The strength of this indicator is that it allows rough comparisons of consumption patterns of individuals from different parts of the world; consumption habits are reduced to units that represent land surface. Ecological footprints of countries like the U.K. or the U.S differ significantly to that of developing countries[53]. In fact, high consumption is often attributed to affluence.

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[52] The term was jointly coined by Canadian ecologist and professor at the University of British Columbia, William Rees and Mathis Wackernagel who is currently the Executive Director of Global Footprint Network (Wackernagel & Rees, 1996). It is used around the globe as an indicator for evaluating environmental sustainability and is a way of determining relative consumption for the purpose of sensitizing people about their resource use.

[53] The carrying capacity of the Earth, based on the ecological footprint is (World Wildlife Fund for Nature 2002, from Schaefer & Crane, 2005): an average person worldwide is 2.28 hectares; the average U.S. American needing 9.7 hectares; the average UK citizen 5.35 hectares, and the average person in Mozambique 0.47 hectares. The carrying capacity is defined as (White, Belletire, & St. Pierre, 2005):

$$\text{carrying capacity} = \text{number of species} \times \frac{\text{population}}{\text{specie}} \times \frac{(\text{waste} + \text{resource depletion})}{\text{individual}}$$

Therefore if a population exceeds its carrying capacity, the population will be reduced through starvation, disease or excessive waste (White, Belletire, & St. Pierre, 2005).

Typically a growth in economic development results in higher disposable income and therefore higher consumption (Schaefer & Crane, 2005). This type of consumption is in high contrast to that of developing countries[54]. If the entire world population were to achieve the consumption levels of the average European citizen, we would need several planets of Earth to sustain them; it is worst when compared with a North American citizen. This is extremely critical if world populations follow the high fertility pattern proposed by the United Nation's report on *World Population in 2300* (UN, 2004, from Schaefer & Crane, 2005). Therefore this unsustainable mode of development is not only attributed to overpopulation and the production necessary to satisfy this population, but also to over-consumption (Marchand, De Coninck & Walker, 2005). A major concern of consumption at very high levels is that the distribution of well-being does not occur equally within generations, let alone across generations.

Yet, in current occidental societies, individuals are led to believe that if they consume high levels of commodities they have a better sense of well-being than those that cannot or choose not to. This ideology, that integrates itself within the myth of progress, is not meant to help improve the sense of well-being among humans, but is necessary for a continued economic growth. Well-being within a society is defined by the comparison to peers; therefore the choice of reducing consumption becomes a social choice on the individual, cultural, and societal level. The complexity inherent in shifting from a mode of high consumption, to a mode of sustainable consumption, is that our social and cultural needs will not cease to exist (Jackson, 2005). Yet a shift is fundamental, if humans living in occidental societies are to reduce their ecological footprint. The question remains as to how this change can occur.

The barriers that inhibit consumers from changing to a more sustainable lifestyle illustrate the need for a greater intervention than simply informing the consumers. Motivation is a huge factor in the failure/success of a sustainable lifestyle (Thøgersen, 2005). Knowing that certain behaviours are not sustainable does not seem to be the greatest motivating factor for a shift in behaviour (Dunlap, 2002, from

[54] For example: 80% of the world resources are consumed by 20% of the world population; the other 80% of the population want to achieve the same standard of living as the 20%; this is unattainable (Durning, 1992).

Thøgersen, 2005). The greatest contributor to the lack of motivation is the feeling of helplessness with respect to solving the problems (Thøgersen, 2005). Therefore the consumer will need to gather competencies to have the ability to adopt a sustainable lifestyle (Thøgersen, 2005); a feeling of empowerment is necessary to be able to fulfil his/her responsibilities to adopt a sustainable lifestyle.

It becomes evident then that sustainable development does not only address notions of sustainable production and consumption, but also includes characteristics of the decision making process with respect to the conceptualization of innovative solutions. Changes in production and consumption will then be reflected by changes in the way individuals take action within their societies and communities on a daily basis. Therefore a shift from a consumer to a consumer-actor is fundamental, where consumers have acquired more power and responsibility with respect to their influence on the products and services made available to them (Marchand, De Coninck & Walker, 2005;).

This implies a change from being passive to becoming an active consumer; this can be achieved through consumption choices and would ultimately have an influence on the enterprises. Enterprises would have to consider the types of products and services provided, and the way in which they are produced; by whom, in what conditions (De Leeuw, 2005). The idea of social acceptability then becomes a major concern as this will have an impact on the ways in which innovative solutions are proposed and manifested. According to Willard (2005), it takes 20% of a community to adopt a new idea before becoming a norm within society. What is necessary then, is a social change to help shift from a progress paradigm towards a sustainable development paradigm. In the context of sustainable development then, the idea of empowerment can be used as a means for social change; since the transition from one paradigm to another can be considered as a social movement. Such a social movement would require the acceptability of society and therefore their participation, and this is why a sense of empowerment is essential. This consequently necessitates a framework for such involvement, and is a justification for the fourth pillar of sustainable development – governance.

1.3.2. Social Change Manifested through Empowerment

An example of a model for collective and individual change through individual commitment and action is empowerment. At the heart of empowerment is a human developmental process that evolves over time (Raeburn & Rootman, 1997). There exist various definitions of empowerment based on the perspectives of the multiple disciplines that refer to this human developmental process. Some of the disciplines that provide definitions are: social psychology, community psychology, sociology, feminism, education, and theology (Clark & Krupa, 2002, from Lahaie, 2003). According to Rappaport (1981, from Raeburn & Rootman, 1997) empowerment has been at the core of the discipline of community psychology which has had the character of a social movement.

Empowerment refers to the way in which individuals/communities seek to change and improve the quality of their own lives and societies through learning processes where they build, appropriate and share knowledge. Through empowerment, individuals not only manage and adapt to change but also contribute to and generate changes in their lives and environments (Blurton, 1999). Empowerment also implies developing the skills and resources needed to confront the root sources which create and perpetuate victimization (Keiffer from Raeburn & Rootman, 1997). The fundamental empowering transformation is the transition from sense of self as helpless victim to acceptance of self as assertive and effective citizen. According to Raeburn and Rootman (1997), key characteristics of empowerment are control (autonomy), competence, self-esteem, contribution, and participation. The overall effect is a sense of 'real power' and strength, which ultimately leads to involvement and having an impact in the world (Raeburn & Rootman, 1997).

When considering empowerment through a motivational perspective, the theory of self-determination is a useful framework; this framework helps to understand the motivational aspect of empowerment (Deci & Ryan, 1985, 2000, from Thøgersen, 2005). Self-determination theory uses the assumption that people have inherent needs and drives which provide energy to act on their external/internal environment. Three needs are necessary for this functioning and development; *competence*,

relatedness, and *autonomy*[55]. These needs are inter-related; when an individual feels autonomous, they will also feel competent, and as a consequence will strengthen their social ties – feeling a sense of relatedness. These three needs drive humans to have a tendency to be curious, exploring and socially active (Ryan & Deci, 2000, from Thøgersen, 2005). However, a person's motivation can be hindered if the regulatory environment is too controlling or they cannot predict the outcomes of their actions. Then, the opposite of the feeling of empowerment occurs, which is "amotivation" – a feeling of helplessness (Seligman, 1975, from Thøgersen, 2005).

Therefore, to help foster the feeling of empowerment, the environment must encourage feelings of autonomy and competence, rather than a feeling of ineffectiveness – being a pawn in someone's game (Deci & Ryan, 1985, from Thøgersen, 2005). De Young (1993, from Thøgersen, 2005) found that helping people understand the nature of environmental and social problems (developing the competencies of individuals) compared with forced regulation, produced longer-lasting performance for environmentally friendly behaviour. However, it is not enough to approach empowerment through information alone. To encourage people into more ethically and environmentally responsible actions, in addition to education and information, the infrastructures must support such behaviour (De Young, 1993, from Thøgersen, 2005).

Therefore an empowered actor is essential for social change: an actor that feels a sense of connection (strengthened social ties – *relatedness*) to their society and is capable (*competent*) and willing (self-governing – *autonomous*) to contribute within their society in manifesting changes that they perceive beneficial for their community; either on a local or global scale. The societal milieu and the ways in which goods and services are produced must reflect an ongoing commitment to sustainability, without which sustainability cannot be achieved. If this is available to individuals within a society, then a shift from being individualistic and self-serving to becoming empowered and autonomous is possible. Such an individual will have the motivation and capacity to affect social change.

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[55] According to the Merriam-Webster Online Dictionary (2005), competence refers to the quality of being adequately or well qualified; relatedness refers to a sense of connectedness, and; autonomy refers to self-governance, the ability to make informed choices.

Therefore empowerment can be used as a tool in the shift towards responsible consumption. Responsible consumers, being empowered, have the knowledge of the links between consumption patterns and their consequences, and therefore have the power to act responsibly in the marketplace. With the feeling of empowerment, an individual is inclined to initiate action towards a goal and to persist in trying to achieve that goal (Deci & Ryan, 1985; Ozer & Bandura, 1990; from Thøgersen, 2005).

Early education, information exchange and transparency are fundamental for: (1) the acquisition of capabilities – encouraging competence; (2) for developing a sense of autonomy – awareness that choices are available, and (3) developing a sense of receptiveness and involvement – encouraging relatedness and participation. In this human development process, individuals become sensitized to their environment and eventually this sensitization may lead to a sense of responsibility, which will encourage the attainment of new capabilities necessary for involvement within their societies so that they may affect change. Sensitization occurs when the individual is exposed to a particular stimulus, and the response is the augmentation of awareness to the stimulus (Merriam-Webster Online Dictionary, 2005).

According to Thøgersen (2005), competence, relatedness, and autonomy are necessary for this type of development. This is similar to the characteristics that Raeburn and Rootman (1997) have defined for a sense of empowerment; autonomy, a sense of competence, and a sense of relatedness (participation within a community or society) are key elements. These characteristics can help in social change since empowered individuals are competent and willing to participate within a community or their society since they feel that they have a sense of control over this milieu. Empowerment therefore will not only improve the quality of life of an individual by enabling individual control over their life, but in turn will also improve the quality of life for the community and the environment at a local, regional and global level; rendering the responsible citizen a global citizen. By improving quality of life, then empowerment inherently contributes to the satisfaction of fundamental human needs.

1.3.3. Empowerment as a Model for Improving Quality of Life

Empowerment is a concept that can only be achieved by the individual's or community's own will; through an encouragement to be engaged in learning processes in order to change and improve the quality of their lives and that of their societies. Through empowerment, individuals not only manage and adapt to change but also contribute to and generate changes in their societies and environments. Therefore, autonomy, competence and relatedness, all part of an empowered human condition, are not only necessary in a context of sustainability, but equally significant for an improved quality of life by satisfying fundamental human needs and by respecting others.

The characteristics of empowerment, according to Max-Neef (1991), are part of a matrix of fundamental human needs (Table 3) and respond to several needs: *autonomy* refers to the needs of freedom, understanding, and protection; *competence* refers to the needs of creation and understanding and; *relatedness* refers to the needs of participation, identity and affection. These needs include satisfiers such as self-esteem, sense of connectedness, sense of values, autonomy, choice, sense of dedication, responsibilities, cooperation, among others, all of which are essential for the development of empowerment. Therefore empowerment in fact responds to a system of interrelated fundamental human needs that improve the quality of life of individuals and their communities; where these needs cannot be separated and satisfied in isolation, as in the widely accepted notion of satisfaction of human needs.

According to Max-Neef (1991, p.18), human needs are "*few, finite, and classifiable*", as distinct from the conventional notion of wants that are infinite and insatiable. He also claims that human needs are common across all human cultures and span historical time periods. The only dimension that changes across different cultures and times is the way in which these needs are satisfied (Max-Neef, 1991). This will vary across cultures and is the main reason why there is such diversity among cultures.

Table 3: Classification of fundamental human needs with examples of their satisfiers (based on Max-Neef , 1992).

Existential Categories / Axiological Categories	Being (qualities)	Having (things)	Doing (actions)	Interacting (settings)
subsistence	physical and mental health	food, shelter work	feed, clothe, rest, work	living environment, social setting
protection	care, adaptability autonomy	social security, health systems, work	co-operate, plan, take care of, help	social environment, dwelling
affection	respect, sense of humour, generosity, sensuality	friendships, family, relationships with nature	share, take care of, make love, express emotions	privacy, intimate spaces of togetherness
understanding	critical capacity, curiosity, intuition	literature, teachers, policies educational	analyse, study,meditate investigate,	schools, families universities, communities,
participation	receptiveness, dedication, sense of humour	responsibilities, duties, work, rights	cooperate, dissent, express opinion	associations, parties, churches, neighbourhoods
leisure	imagination, tranquillity spontaneity	games, parties, peace of mind	day-dream, remember, relax, have fun	landscapes, intimate spaces, places to be alone
creation	imagination, boldness, inventiveness, curiosity	abilities, skills, work, techniques	invent, build, design, work, compose, interpret	spaces for expression, workshops, audiences
identity	sense of belonging, self-esteem, consistency	language, religions, work, customs, values, norms	get to know oneself, grow, commit oneself	places one belongs to, everyday settings
freedom	autonomy, passion, self-esteem, open-mindedness	equal rights	dissent, choose, run risks, develop awareness	anywhere

Max-Neef classified nine fundamental human needs based on axiology (values) where their satisfiers are specified according to existential categories (being, doing, having and interacting). He organizes the basic human needs as: (1) subsistence; (2) protection; (3) affection; (4) understanding; (5) participation; (6) recreation (in the sense of leisure, time to reflect, or idleness); (7) creation; (8) identity; and (9)

freedom (1991). He claims that the nine categories must be satisfied in order to achieve human well-being. When one of the needs is not met, then this indicates a sense of 'poverty' for an individual.

Individual needs satisfied by individual consumption acts are of little importance; it is the system of needs affected by a minimum amount of satisfiers that is of relevance to this characterization of human needs. He claims these needs are interrelated and behave as a system; each of the values and their existential categorizations represent a complex web defining human well-being (Max-Neef, 1991). This means that when one need is affected one or more other needs may likely be affected. Max-Neef (1991) refers to these as trans-disciplinary since the needs, which are based on values, require existential categorizations to help define the satisfiers, and in turn the satisfiers refer to various disciplines for their identification.

For example, food and shelter are not considered as needs according to Max-Neef, but as satisfiers for the basic need of subsistence. Some satisfiers may satisfy several needs. For example, bottled milk may satisfy the need of subsistence for a baby, whereas breast-milk will simultaneously satisfy the needs of subsistence, protection, affection, understanding, participation, recreation, identity and freedom. This model is radically different from the model used by traditional economics. In traditional economics, needs are dealt with individually, without being conscious of the fact some types of satisfiers can actually be violators of other needs; for example, formal democracy, which is supposed to meet the need for participation often dis-empowers and alienates; the arms race, while satisfying the need for protection, in fact destroys the basic needs of subsistence, participation, affection and freedom (Max-Neef, 1991).

According to Jackson (2004), needs such as development and belonging are necessary to a *healthy social functioning* just as sustenance and protection are essential for proper physiological functioning. Therefore when translated into Max-Neef's categorization, healthy social functioning can be attained through needs of creation, understanding, participation, identity and freedom. It is not only one need that is affected for a healthy social functioning, but instead a system of needs that act

as a subsystem related to the notion of quality of life, and in this case the quality of life for a society as well.

In contrast, Maslow's (1970) hierarchy of needs is categorized within a pyramidal structure, where some needs take precedence over others. According to Maslow's hierarchy of needs, the basic concept is that the higher needs in this hierarchy only become accessible once all the needs that are lower in the hierarchy are sufficiently satisfied (Figure 3). This hierarchical constraint in accessing higher needs is difficult to apply in reality. It is unreasonable that individuals who have not, for example, satisfied their esteem needs cannot access their cognitive or self-actualization needs, since these needs are not yet accessible. In the Maslow perspective, a person who may have not yet achieved some level of esteem will not seek to better his situation through self actualization. By seeking to define human needs within such a hierarchy, anomalies cannot be ignored nor forced to work within a simplifying model. In reality self-actualization and an increase in self-esteem often occur simultaneously. It is more reasonable to accept the fact that human needs are dependant with one another and are in fact, interrelated. Then humans can work on improving different areas of their lives simultaneously.

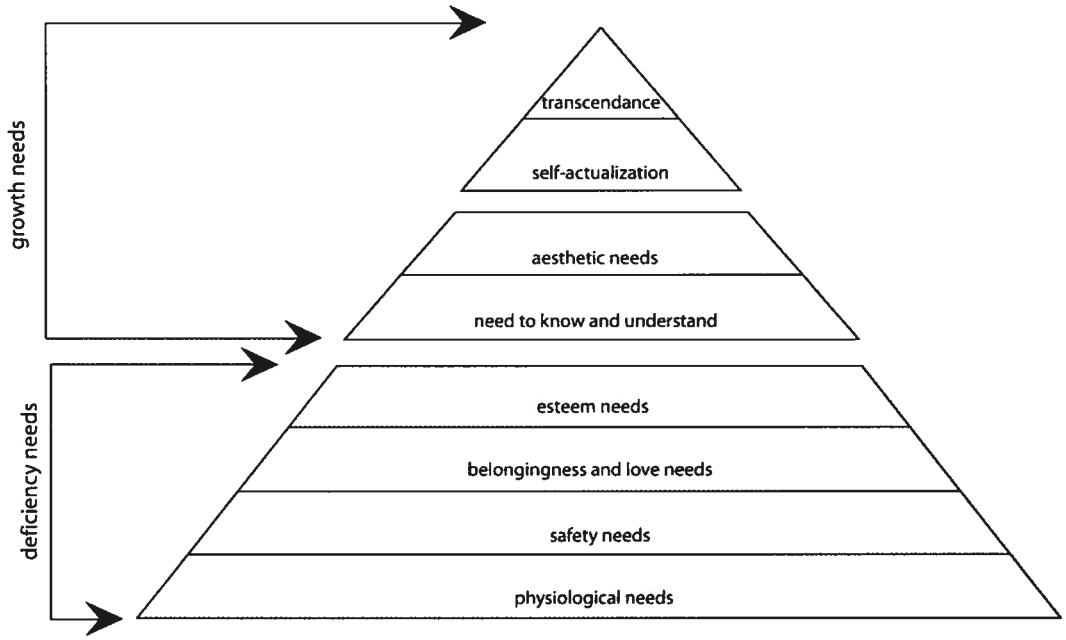

Figure 3: Maslow's hierarchy of needs (based on Maslow, 1970).

So according to Maslow's hierarchy of needs, it would be impossible to become empowered because the needs necessary for this human developmental process lie on various hierarchical levels and therefore cannot be accessed simultaneously. This is problematic since empowerment is achievable to humans, yet not achievable using this model. This illustrates that Maslow's hierarchy of needs is insufficient for developing the idea of empowerment since this anomaly cannot be ignored. In contrast, Max-Neef's representation of fundamental human needs adequately addresses the human development process of empowerment because the needs necessary for satisfying its characteristics are accessible simultaneously (Table 4).

Table 4: A comparison between Max-Neef's and Maslow's definition of human needs for achieving empowerment.

Empowerment Characteristics	**Max-Neef Fundamental Human Needs**	**Maslow Hierarchy of Needs**
Autonomy	Freedom, Understanding	Self-actualization (part of growth needs, level 7)
Competence	Creation, Understanding	Need-to-know and understand (part of growth needs, level 5)
Relatedness	Participation, Identity	Belongingness and love needs (part of deficiency needs, level 3)

Therefore, it seems that the need to contribute towards a society's improvement, whether on an environmental, cultural, social, or economic level, is intrinsic to human nature. In this perspective then the notion of empowerment is pertinent since such a human condition can effect social change through autonomy, acquired competences and participation.

1.3.4. Design as a Vehicle for Improving Quality of Life

Without empowerment individuals will not feel the need to participate because of their feelings of helplessness and inadequacy. Without a sense of empowerment individuals will not feel that they are capable of effecting change since they will not feel that they are competent enough to provoke the changes within their environment that could improve their living conditions. According to Sclove,

> "*Insofar as participatory design results in technologies or services that go on to help constitute the agenda for a democratic politics of technology, then RD&D can also embody that special dignity that attends helping consciously to evolve one's society's structural form*" (1995, p.182).

A feeling of empowerment then will enable actors to contribute to decisions through a participatory approach and therefore they will not feel they are victims of innovation or technological progress; instead they will feel empowered because they will be part of a solution. Responsible citizens being empowered are willing and capable of involvement and therefore in defining solutions or alternatives to existing situations in order to improve their quality of life and that of their community. This activity can be largely perceived as design according to several authors (Papanek, 1985; Simon, 1996; Levy, from De Coninck, 2005). The action of planning with the intent of improving an existing situation, according to Herbert A. Simon (1996) is considered as design. He defines design as:

> "*Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artifacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state. Design, so construed, is the core of all professional training: it is the principal mark that distinguishes the professions from the sciences. Schools of engineering, as well as schools of architecture, business, education, law, and medicine, are all centrally concerned with the process of design"* (Simon, 1996, p.111).

There are varying definitions of design. Papanek saw design as any planned action with a projected end. According to him, all humans are designers. In *Design for the Real World* (Papanek, 1985) wrote:

> "*All men are designers. All that we do, almost all the time, is design, for design is basic to all human activity. The planning and patterning of any act toward a desired foreseeable end constitutes a design process.*" (p. 3).

Many other prominent authors have proposed their own definition of design. Therefore, before continuing, a definition of design will be presented as a basic framework for this research. The definition that will be used in the context of this research is from Ron Levy (Professeur Titulaire de l'Ecole de Design Industriel de l'Université de Montréal):

> "*Design is the manipulation (by humans) of all things; that is all phenomena (living or non-living), of all objects, all mechanisms, all systems, and all procedures. The finality of this manipulation of things is the creation of new concepts and experiences such that its totality will change the world in a recursive way.*" (liberal translation[56], De Coninck, 2005, pp. 68-69)

Levy refers to the ways in which humans are constantly modifying their relationship to their world through the process of design. In effect designers just like engineers or architects are initiators of change in and of society (De Coninck, 2005). Therefore, the notion of social change is a fundamental and inherent characteristic of design in this context. Since empowerment can be seen as a model for social change, then when designers, consumers, citizens, etc. are empowered, they can therefore contribute to change within society through recommendations of innovative alternatives to existing situations and therefore changing the world in a recursive way.

In seeking to shift into a sustainable development paradigm, which is considered a social change, design can no longer start of at the functionality of the product, but instead starts by fulfilling human needs and searching for innovative alternatives that are possible when 'thinking outside the box' (De Leeuw, 2005). Therefore design responds to the improvement of quality of life by satisfying fundamental human needs. This shift requires as a prerequisite, a sense of empowerment when seeking to improve quality of life.

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[56] "*Le design est la manipulation (par les êtres humains) de tout être; c'est-à-dire de tout phénomène (vivant et non-vivant), de tout objet, tout mécanisme, tout système et toute procédure. La finalité de cette manipulation de ces êtres est la création de concepts nouveaux et d'expériences nouvelles dont la totalité change le monde de manière récursive.*"

This sense of empowerment can help individuals contribute to the identification of problems, the needs to be fulfilled, the possible solutions and those that are acceptable by understanding the causes of the problems and their consequences. The existing design strategies, specifically LCA, help in the optimization of environmental impacts, but there is presupposition that the knowledge of the causes and their effects is available. This is not always possible, in particular in the domain of design, and therefore in the case of innovation. There exist risks, unknowns, and doubts. In this context, what can be done? This is why the precautionary principle is significant for design. Solutions can be found by exploring alternatives early on in the conception process. Therefore it encourages innovation, and so it responds to the definition of design since it does not seek status quo, but is looking for "*new concepts and experiences that will change the world in a recursive way*" (Levy, from De Coninck, 2005, pp. 68-69).

1.4. The Precautionary Principle of Sustainable Development

As was mentioned earlier, during the 1992 United Nations Conference on Environment and Development, five agreements were endorsed by participating nations: *Agenda 21*, *Rio Declaration on Environment and Development*, the *Statement of Forest Principles,* the *United Nations Framework Convention on Climate Change*, and the *Convention on Biological Diversity.* The *Rio Declaration on Environment and Development* (UNCED, 1992) identified 27 principles that sought to define the rights and responsibilities of nations.

In the context of sustainable development (in particular sustainable design), and the search for solutions that can contribute to an improved quality of life by seeking the common-good, a need to move beyond the optimization of products and services is necessary. The precautionary principle can respond to this, since it can help guide decisions where risks, unknowns, and doubts exist, and therefore allow the establishment of a responsible, anticipative action. Therefore the precautionary principle becomes a fundamental principle for sustainable design.

1.4.1. Defining the Precautionary Principle

Principle 15, the precautionary principle defined in the *Rio Declaration on Environment and Development* (1992) was defined as:

> "*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*" (Principle 15).

Uncertainty is a prime motivating factor in the origin and application of the precautionary principle. According to Harremoës *et al.* (2001), precaution has often been used in medicine and public health where the benefit of doubt about a diagnosis is usually given to the patient (err on the side of caution). The applications of the precautionary principle with respect to environmental hazards and their uncertainties only began to surface as a clearly and logically expressed concept within environmental science during the 1970's, with the environmental movement in Germany. The precautionary principle originated from the initial German formulation *Vorsorgeprinzip*, which essentially translates more appropriately to 'forward looking caution principle' or 'foresight principle'.

The main element of the principle was a general rule of public policy action that was to be used in cases of irreversible threats to health or the environment; where potential hazards were to be reduced before there was a strong proof of harm. Since the '70's, the precautionary principle has quickly become a part of political agendas and has been incorporated into many international agreements (Harremoës *et al.*, 2001). The precautionary principle has had many applications: in environmental policy decisions (chemical contamination), socio-economic decisions (fisheries - quotas), technology issues (Y2K bug), health safety decisions (bovine growth hormone), economics (inflation regulation), and physician's patient care (physician's obligation to 'first do no harm') (DeFur & Kaszuba, 2002). The precautionary principle has become, in European regulation of science and technology, a general principle for the protection of the health of human beings, animals, plants, and the environment (Tallachini, 2005).

It is noteworthy to mention that many recent environmental crises have arisen from the failure to act quickly to avoid unintended consequences from seemingly beneficial technologies, and the precaution principle is seen as a way to obtain a justified decision in future situations of uncertainty of harm. Recent social/environmental crisis have revealed, a posteriori, the gaps that exist in preventive policies (e.g. contaminated blood), and have therefore rendered the precautionary principle an imperative in evaluating risks (Kourilsky, 2002). According to Harremoës (2003), the precautionary principle is a way to formulate an approach to situations where uncertainty beyond statistics, ignorance and indeterminacy dominate the cause-effect relationship. The precautionary approach is an integrated attempt to avoid scientific surprises in the future.

Therefore, when environmental or health impacts may occur far into the future and the perceived costs of preventing these hazards are large and immediate, it is difficult to act on the side of safety in the current market based economy. To prevent disaster requires taking action long before there is strong proof of harm, especially if the harm is irreversible; this approach to policy making is part of what is considered the precautionary principle (Harremoës *et al.*, 2001).

Therefore, the precautionary principle responds to a predicament of long-term, invisible dangers that humanity (or the earth in general) has not yet experienced (Harremoës *et al.*, 2001). An example of such a case is the capacity for humans to change the global climate by altering the chemical composition of the atmosphere through emissions which are a result of the way consumer needs have been dealt with in the recent past. This environmental predicament is unprecedented, just as the political structures necessary to govern such situations (Whiteside, 2006). Two main questions arise from this: (1) how can humans take responsibility for the surroundings so that humanity can continue to grow; (2) how much regard should decision makers have in deterministic approaches in policy-making? Often actions to prevent harm are only taken after substantial proof of harm is shown. Usually at which point it is often already too late for the action. The precautionary principle addresses this by modifying the way decisions are made.

By focusing on situations of scientific uncertainty where data are lacking, insufficient, or inconclusive, the principle introduced a shift from a neutral legal attitude towards science to a bias in favor of safety. This also had the effect of a paradigm shift from the certainty and objectiveness of science to awareness that the legal regulation of science involves decisions about values and interests (Tallachini, 2005). According to Lascoumes (1996), the emergence and formalization of the precautionary principle have revealed several shifts in our comprehension of uncertainty and risks. First, decisions cannot be taken only with current knowledge; an attempt must be made to project in the future any long-term effects that may appear to be probabilities of risk. Second, the scientific model of risk assessment is no longer viable; the reality of risk is not limited to an objective rationalization. Preventing known risks is not sufficient, it is necessary now to integrate the notion of an acceptability of risks. Third, the consequences in terms of attribution of responsibility demonstrate another shift. And fourth, a shift is necessary in the management of risks and the forms of cooperation that deal with the assumption of responsibility.

Contemporary scientific knowledge is increasingly characterized by uncertainty because of its intrinsic incompleteness and indeterminacy in particular when making social choices, public policy, and legal decisions (O'Riordan & Cameron, 1994, from Tallachini, 2005). Scientific uncertainty refers to a lack of knowledge in science, the complexity of knowledge, the unpredictability of results, and the random character of predictions. This leads to a condition where regulatory science cannot take a position; therefore science produces partially diverging results. This is not the case of a known risk, where the data associated with the risk is consistent among experts. There is a difference between known risks and uncertainty (Tallachini, 2005):

1. In decisions under the conditions of risk, the main variables are known, and their respective probabilities of different outcomes can be quantified. This type of risk is addressed using a preventive approach.
2. In decisions under the condition of uncertainty, even if the main variables are known, their probabilities are not known. This type of condition is addressed using a precautionary approach.

The precautionary principle is based in an anticipatory, preventive action in the face of uncertainty. There are four components to this principle (Kriebel *et al.*, 2001): (1) taking preventive action in the face of uncertainty; (2) shifting the burden of proof to the proponents of the activity; (3) exploring a wide range of alternatives to possible harmful actions; and (4) increasing public participation in decision making

In essence, the precautionary principle will minimize the ambiguity that is inherent in the management of risks, particularly potential risks. An example of the use of the precautionary principle will illustrate the four components that comprise it. This example is from Kriebel *et al.* (2001). During the takeoff of flight, passengers are asked to not use any electronic devices, and to not use their cell phones at any time during the flight. A study commissioned by the FAA (U.S. Federal Aviation Administration) failed to find any evidence of this interference with electronic devices and cell phones. However, the FAA ruled that the ban of these devices would continue to take place. This illustrates the first component of the precautionary principle; taking preventive action in the face of uncertainty. The second component of the precautionary principle refers to the burden of proof; and here it is clear that those who change the ban will have the responsibility of showing that this change will not cause unreasonable risk. In this particular case, this is why the ban was not removed. The risk of removing the ban, which was the risk of an airplane crash, was too great. This is why in-flight phones were introduced, to satisfy the need of using a phone during a flight. This illustrates the third component of the precautionary principle; exploring a wide range of alternatives to possible harmful actions. A search for an alternative safer solution took place, and the safer solution was found. The precautionary principle therefore provides an encompassing framework that ties environmental sciences and public health.

According to Tallachini (2005), the relationship between science and society has moved into a situation where uncertain knowledge is the rule. A more general framework for a democratic governance of science is necessary. In a democratic society, science may still have an authoritative voice, but it cannot have the ultimate word on decisions that only the broader society may make. Therefore, the current precautionary model of scientific regulation needs to be informed by an extended participatory model of the relationship between science and society. In essence then,

the precautionary principle has revealed several issues that relate to the assessment and management of risk and uncertainty that must be balanced within the scientific and social democratic realms. The precautionary principle elicits fundamental questions about the basic nature of good governance. According to Whiteside (2006):

> "(...) *the precautionary principle encourages individuals and states to think of themselves not only as competitive, self-interest-maximizing consumers (as in the liberal model), but as citizens whose vigilance protects common good*" (p. 87).

1.4.2. Criticisms of the Precautionary Principle

The problem with uncertainty is that it has the capacity to both paralyze and stimulate a situation. When it leads to paralysis, this often is manifested in the form of inaction from the fear that the consequences may be disastrous. However, uncertainty can also stimulate situations, in which case, the stakes are defined and a strategy is conceived (Morin, 2004). It is important then to consider the criticisms of the precautionary principle.

Varying perspectives of the precautionary principle range from the unwarranted veto power of environmental extremists, to the capability for lobby groups to promote trade protectionism. One version of the precautionary principle is extremely prudent (may lead to project paralyses); while another version allows a product on the market that may have negative effects; and there are also multiple moderate versions (versions that lie somewhere in the middle of the other two) (Sunstein, 2005). Opponents of the precautionary principle are concerned that this principle may hinder or completely cripple innovation.

The precautionary principle does not treat the risk, but defines the activity or measures necessary to prevent a possibility of a risk. The precautionary principle rests on a simple concern of the future and this is what critics of this principle use to try to impede this principle from being applied; this concern is far too ambiguous and results in multiple interpretations. Critics feel this principle is too easily manipulated

by public opinion and feel innovation would be constantly paralyzed in research since innovation lies in a universe of risk.

Uncertainty is one of the features that provoke controversy over the issues that are dealt with the precautionary principle. It is highly criticized by the scientific world, saying it is an instrument used to support people's irrational fears (Tallacchini, 2005). Such opponents of this principle claim that scientific certainty does not exist, so scientific uncertainty is prevalent in all decision-making (Resnik, 2003). A zero risk solution would require scientific certainty, and since this cannot exist, non-supporters of the precautionary principle think that this principle would obliterate creativity and innovation. According to Kriebal *et al.* (2001), the most common concerns regarding the precautionary principle are:

1. Current regulatory procedures are already precautionary.
2. The precautionary principle is not scientifically sound because it advocates making decisions without adequate scientific justification.
3. The precautionary principle would stifle innovation if implemented, because it would require proof of safety before being introduced.

According to Godard (2005), early but incomplete information would result in actions that would have to deal with a wide range of potential factors, expected costs and modifications of existing practices to many stakeholders; all this in the absence of having any assurance of arriving at any real benefits based on the incomplete assessment of potential risks. Such actions would be seen as not entirely legitimate by the stakeholders and those responsible for its implementation. Yet, without the precautionary principle, policy measures in cases of uncertainty of harm would be implemented in an ad hoc fashion, which would ultimately lead to confusion and distrust among the people that run the public institutions.

According to Sunstein (2005), the precautionary principle can be criticized in three major areas:

1. This principle would stifle innovation.

2. Causing unintended consequences potentially worse than the reason why the precautionary principle was initially triggered.
3. Creating 'false positives', therefore decisions to stop a technology may be unwarranted.

In response to the criticism that it may stifle innovation, precaution can be a tool to redirect innovation towards safer and cleaner practices to meet human needs in the short and long-term perspective. Also precaution begins by clarifying the intended purposes of the product or service system, therefore questioning its need in the first place. And finally, some technologies and substances probably should be slowed or blocked, after a careful review of their benefits, risks, alternatives, and overall uncertainties. Precaution encourages this review (Whiteside, 2006).

In response to the second criticism, that it may cause unintended harm potentially worse than the reason why the precautionary principle was initially triggered, precaution allows the exploration and implementation of a wide range of preventive options; it also includes a broad range of perspectives in decision-making processes; using both a multi-disciplinary scientific lens and a systems perspective to examine risks before and after interventions take place. A precautionary approach includes the development of methods to monitor interventions for early signals of a problem (Whiteside, 2006).

In response to the last widely held criticism, that it may encourage 'false positives', it has been argued that precaution amounts to increasing the sensitivity of the screening tests for environmental hazards. However, precaution does not mean only more-sensitive tests; it also means linking risk evaluation to alternatives assessments and more democratic discussions of social needs and goals (Whiteside, 2006).

Sunstein (2002) has trouble admitting that there are situations where an incomplete set of data, and therefore uncertainty of harm actually exist. The precautionary principle is for cases where risks are not clearly understood, and therefore a course of action necessitates. Sunstein (2002) suggests that all risks can be calculated using a cost-benefit approach; as if all risks were clear enough to be calculated.

Then what course of action can be taken when the risks are not clearly understood and therefore not deterministic? In his later book, *Laws of Fear* (2005), Sunstein approaches the precautionary principle as a principle in which normative methods of decision making must prevail, therefore he claims this principle becomes inoperable.

A normative method is a prescriptive approach that is impartial. It is based on already knowing what is acceptable and taking actions based on achieving this level of acceptability. Therefore, normative methods of decision making alone cannot prevail with a precautionary principle since the inherent uncertainty in such a situation cannot allow decision makers to envision a situation that may be optimized, but rather it requires the adoption of exploratory methods to solving such situations. This is why a completely normative approach is inconsistent with the precautionary principle. However, having said that, it may still be necessary to adopt normative processes when evaluating alternative solutions. Yet adopt non-normative (or adaptive and flexible) norms as a point of departure.

Sunstein (2005) later introduced a 'reconstruction' of the precautionary principle, calling it the *Anti-Catastrophe principle*. He claims that this new principle can be adopted when citizens face "*catastrophic risks where probabilities cannot be assigned*" (Sunstein, 2005, pp 109). He builds this new principle based on three dimensions of the original precautionary principle which he criticizes. The three dimensions are: *catastrophic risks*, *irreversible harms*, and *margins of safety*. Sunstein (2005) in fact acknowledges that the 1992[57] version in the *Rio Declaration on Environment and Development* (UNCED) of the precautionary principle is unobjectionable since it is a weak definition of this principle; he uses a more rigid definition of this principle in his original critique.

The precautionary principle as defined by law is not a general 'abstaining rule' or a rule imposing a rupture with reasonable foundations of public action (Godard, 2005). It encourages decision makers to acquire an early understanding of potential hazards, but it does not say that abstaining should occur every time a hazard cannot

[57] "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (Principle 15, Rio Declaration on Environment and Development, 1992).

be demonstrated not to exist. Absolute avoidance of risk may be an appropriate attitude in some cases but does not represent a general course of action for the precautionary principle (Godard, 2005). The precautionary principle encourages a scientific comprehension of potential risks, where possible with a democratic decision process (implying a system of governance) to arrive at a precautionary policy. It encourages innovation since when such a situation is identified, a requirement of action ensues, and innovative solutions must be identified, evaluated and finally implemented.

1.4.3. Limitations of a Deterministic Approach

There is no absolute certainty associated with assessing environmental harmfulness because of the way in which experiments are conducted. It is not possible to verify the universality or certainty of a hypothesis in an open space because it is not possible to cover all circumstances; therefore environmental acceptance can only be demonstrated by induction *and* circumstance (Harremoës, 2003).

The current approaches used by scientists to conduct their research make it difficult to set precautionary policy, because traditionally, these approaches emphasise independent effects of chemicals and not the interaction of them (Kriebal *et al.*, 2001). This isolated systems approach is limiting, because the real world does not behave in this way, and therefore will not reflect the complexity of reality. In the real world, for example, a particular suspect toxic element of PVC (Polyvinyl chloride) cannot be isolated during toxicity testing since when a child is using a toy made of such a material the chemical that is suspect will not be isolated, but will be embedded within the material, and within an environment. This is critical in the analysis of the potential risks of any material. Studying interactions of chemicals is far more complex than studying isolated chemicals since there are several variables to understand simultaneously instead of the single one variable.

According to Harremoës (2003), in natural science, the likelihood of false positive (declared harmful when in fact it is not) is small. This is a problem since it is more likely in natural sciences to ignore a threat than to accept an uncertainty. There is a clash in beliefs between natural sciences and the regulation of substances that may

be harmful. In environmental and health regulation, the level of proof or suspicion as a basis for action must depend on the issue; in other words there cannot be a universal threshold; each situation has to be assessed separately. Historically, in natural sciences, it has been axiomatically assumed that there is a unique relationship between action taken and the effects in the environment or human health. However in the last century, a realization that there exist both inherent and practical uncertainties associated with this relationship has emerged. There are various levels of certainty. Table 5 identifies some levels of certainty. This is not an exhaustive list, but illustrates the difficulty involved in such a classification because uncertainty can also be classified using various other characteristics such as coherence, simplicity etc.

Table 5: Classification of levels of certainty (based on Harremoës, 2003).

Level of Certainty	Description
Determinism	Rare but ideal
Risk	A rational approach to describing variation
Uncertainty	This can be expressed statistically and incorporated in risk analysis
Indeterminacy	Chaotic properties make predictions impossible – too many parameters
Ignorance	Do not know essential functional relationship

In a deterministic approach, risks are not distinguished by their level of certainty but by their probability using various stochastic methods (Harremoës, 2003). In fact, in a deterministic approach uncertainty[58] is simply recognized as another type of risk. Therefore a deterministic approach to decision making has rendered decision making in situations where there exists a certainty of uncertainty, problematic. Decisions must still be taken and justified, and as a result, there is incapacity to arrive at a justifiable decision that considers the common-good; which is a fundamental criterion for sustainable development.

A realization that a deterministic approach is inadequate in justifying decisions based on uncertainty of risk is fundamental because in such situations, the data is

[58] Bayesian probabilistic methods are used in a deterministic approach for dealing with uncertainty. This is sometimes referred to as subjective probabilistic methods (Dupuis & Grinbaum, 2005).

diverging; in other words it is incoherent among the experts. When this condition arises, then how are these disjointed expert opinions resolved? Will stochastic methods be sufficient in determining a course of action? Is it better to take a course of action that is precisely wrong based on probability, or one that is approximately right based on a consideration of the common-good? Does this imply a consideration of values in defining a course of action?

These questions are pertinent in seeking to understand how decisions are best taken in cases of precaution. The main problem with the precautionary principle is that issues associated with this principle lie outside the epistemological awareness of the average scientist. There needs not only an appreciation of uncertainty but an appreciation of fundamental values as well, in justifying decisions with respect to this principle.

1.4.4. How can Precaution be used in a Decision Process?

Making decisions based on the precautionary principle cannot be based solely on a risk analysis procedure since the lack of data renders this approach problematic. There are several alternatives to approaching the precautionary principle that will encourage innovation. The two main perspectives for the implementation of the precautionary principle in an effort to support the decision making process are a risk analysis approach and a social heuristic approach. Godard (2005) claims that the analytical tools of the economic risk analysis approach can provide useful insight on key contentious issues that would help in the implementation of the precautionary principle as a social norm.

Table 6 shows some of the differences and similarities between the two approaches based on Godard (2005). This table will also help to understand the fundamental differences between a precautionary approach and a preventive approach to decision making in situations of uncertainty of harm. Godard (2005) uses a risk analysis approach framed in a Bayesian (statistical) framework to estimate the risk of harm; it is a rational method which provides some level of credibility to the argument for precaution. However, he defines this rational approach to precaution as "*more prevention in the short run*" (p. 5). In this approach, Godard does not distinguish

between risk and uncertainty; therefore his definition of the precautionary principle implemented in this manner responds more appropriately to the prevention principle. A precautionary approach is invariably based on ethical considerations because of its lack of quantifiable data, which is closer to the social heuristic approach he describes. A preventive approach is based on measurable and quantifiable data, which is closer to the rational risk analysis approach he proposes.

Table 6: A comparison between a risk analysis and a social heuristic implementation of the precautionary principle (based on Godard, 2005, pp. 2-30).

Risk analysis approach	**Heuristic social approach**
Analytical/rational modes of decision making	Tactic/strategic modes of decision making
Does not distinguish between risk and uncertainty, but recognises a risky context where information necessitates improvement	Distinguishes between risk (preventive approach) and uncertainty (precautionary approach)
Subjective probabilities within a statistical framework informing individual decisions	Defines a public direction for collective decisions regarding collective risks
Decision makers exposed to unique objective expert vision	Decision makers faced with multiple contrasted expert visions
Contributes to the establishment of further scientific developments	Used as a protection against limits from traditional scientific methods – encourages innovation
Further knowledge a requirement for the justification of action – short term solution based on stronger preventive action	Further knowledge not a requirement for the justification of immediate action – action must be taken in spite of uncertainty
Is a provisional means of managing the wait by scientific progress	Is focused on early prevention because of the threats of irreversible an non-substitutable losses
Irreversibility effect is an amplifying factor	Irreversibility effect is a major trigger

Godard (2005) attempts to gain an in-depth understanding of the complexity that the precautionary principle introduces in the decision making process. He does this by finding relationships between the formal approaches of risk analysis with the reasoned social heuristic concepts that are recognized in Europe. Although the economic risk analysis theories are relatively independent on one hand, the social heuristic concepts that are reasoned can be used for interpreting new social norms within a precautionary attitude. There could be great benefits from cross-fertilization

of these two perspectives. The complexity is that the 'language' that each side speaks is different, and therefore a fusing, merging, or mapping of ideas would benefit the implementation of the precautionary principle.

The complementary approaches for the implementation of the precautionary principle based on Godard (2005) can provide a basic level of distinction between a precautionary approach and a preventive approach for situations of uncertainty of risk of harm. These complementary approaches can be similarly mapped onto a solution based approach, such as the 'sufficiency' approach proposed by Princen (2005) for precaution; and problem optimization approach, such as an efficiency approach for prevention. Tickner and Geiser (2004) claim that to achieve more sustainability, the focus needs to be placed on solutions based policy.

Most of the work done in environmental policy focuses on the investigations of the problems and their optimization at the expense of investigations of new or alternate solutions; a shift from problem-based to solution-based is necessary. What this signifies is that the problem-based approach is problematic because in this approach the variables and their values must be known in advance in order to arrive at an optimized solution. However, in the case of precaution, fundamental uncertainties exist and therefore the problem-based approach becomes very difficult, in fact it is not possible to solve in this way. Therefore a solution-based approach to seeking solutions is more appropriate; this means that the problem is a construct, and that it becomes necessary to allow an emergence of the values that characterize the limits of the problem (De Coninck, 1997). This approach redirects environmental science and policy debates from describing problems to identifying solutions; an alternative assessment process.

The role of the precautionary principle in stimulating a search for alternatives to prevent harm has been introduced in relatively few interpretations of the principle. The most appropriate and effective form of implementing precaution is through a conviction for a search of alternatives to avoid potential harm. Options analysis is a central aspect of decision theory (Tickner & Geiser, 2004). A collective and interdisciplinary approach is recommended for a more comprehensive solution. The

following are the general steps involved in an alternative assessment approach; this is an iterative process (Tickner & Geiser, 2004):

- examination/understanding of impacts and purpose of the activity;
- identification of a wide range of alternatives;
- comparative analysis of alternatives;
- alternative selection – including no action.

Assessing alternatives does not eliminate the need to assess risks, because comparisons and sometimes permissible exposures are the best alternative, but this risk assessment will be done through a multi-criteria approach, such as a LCA. In a precautionary context, approaches such as LCA, used to assist decision makers in a decision making process, are inadequate on their own because (1) of the inherent lack of data; and (2) because their scope is too limiting. Therefore in situations of uncertainty of harm, alternative decision making methods are necessary. These new methods will include existing multi-criteria approaches to understand the problem within a particular scope, but must be complemented using public participatory methods (Tickner & Geiser, 2004). A public participation will allow a comprehension of the unresolved issues among participants that is not possible through a risk assessment alone. Tickner and Geiser (2004) propose the following to justify the use of an alternative assessment approach:

- focuses on solutions rather than problems;
- stimulates innovation and prevention;
- multi-risk reduction;
- greater public participation and burden shifting.

Several authors have advocated public participation when searching for a wider range of solutions (Sclove, 1999; Maclagan, 1999; Kriebel *et al.*, 2001; Harremoës, 2003; Tickner & Geiser, 2004; Droz & Lavigne, 2006). The alternative assessment process should be a public process. Therefore a participative approach should encourage the participation of various actors including non-scientific individuals that may be affected by the proposed scenario; and where decisions are made in a participatory democratic forum (Sclove, 1995).

1.4.5. The Need for a Well-Defined Procedure for the Decision Process

In the face of risks, the public wants the assurance that all has been done to minimize a risk. This can be done only if proof of 'valid and efficient' steps or procedures to minimize the risk are available. When the 'reality' of a risk cannot be established, it is the rigor in the procedures that compensates for the uncertainty and becomes the defining parameter in such a situation (Kourilsky, 2002). It is therefore fundamental that the decisions and procedures used to establish potential risks are explicit and well-defined. This will also avoid the situation where there is an indefinite interrogation of the final decision, since the analysis procedure is clear and rigorous in its execution plan; there is no misconception as to how the decision was made.

Several authors have developed checklists that help support the precautionary principle in its task to improve the quality, availability, utilisation, and processing of information in the establishing of public policy on environment and health issues. However, these checklists will not eliminate the dilemma of making the decision – decisions must still be made under circumstances of uncertainty. Kourilsky (2002) has proposed a list of 10 'commandments' which he suggests is used as a basis for the decision and policy making process based on the precautionary principle:

1. Has the risk been defined, analyzed, evaluated and graduated?
2. Have the consequences of different options been compared?
3. Has an economical analysis been carried out in preparation for the decision?
4. Has the risk analysis work been managed independently?
5. Has a research program been planned in the case of uncertainty?
6. Is the considered decision reviewable and is the solution reversible?
7. Is the solution proportional to the potential risk?
8. Are the decision routes and security measures appropriate, coherent, efficient, and reliable?
9. Is transparency assured through traceability and labelling?
10. Is the public well informed?

Harremoës *et al.* (2001, p.193) have established a list of 12 items that may be used to help in the policy making process that is based on the precautionary principle. This

list is referred to as 'late lessons' from case studies that have been reviewed from the past century:

1. Acknowledge and respond to ignorance, as well as uncertainty and risk, in technology appraisal and public policy making.
2. Provide adequate long-term environmental and health monitoring and research into early warnings.
3. Identify and work to reduce 'blind spots' and gaps in scientific knowledge.
4. Identify and reduce interdisciplinary obstacles to learning.
5. Ensure that real world conditions are adequately accounted for in regulatory appraisal.
6. Systematically scrutinise the claimed justifications and benefits alongside the potential risks.
7. Evaluate a range of alternative options for meeting needs alongside the option under appraisal, and promote more robust, diverse and adaptable technologies so as to minimise costs of surprises and maximise the benefits of innovation.
8. Ensure use of 'lay' and local knowledge, as well as relevant specialist expertise in the appraisal.
9. Take full account of the assumptions and values of different social groups.
10. Maintain the regulatory independence of interested parties while retaining an inclusive approach to information and opinion gathering.
11. Identify and reduce institutional obstacles to learning and action.
12. Avoid 'paralysis by analysis' by acting to reduce potential harm when there are reasonable grounds for concern.

These checklists illustrate the importance of rigour in the procedure of decision making to help minimize costs related to unpleasant future surprises, and to achieve a better balance between technological innovations and possible hazards to people and their environments.

1.4.6. Main Elements to Consider with the Precautionary Principle

The main purpose of this principle is to support decisions in situations of potential catastrophic harm. Yet many questions arise as a result of attempting to formulate

such decisions. It is important to note that there are varying levels of the precautionary principle: meaning that some definitions of this principle are very strict and some are very loose. According to several authors, to arrive at a decision that is just and considers the common good, the four following considerations are indispensable (Lascoumes, 1996; Ewald, 1996; Raffensperger & Tickner, 1999; Kourilsky, 2000, 2002; Harremoës *et al.*, 2001; Kriebel *et al.*, 2001; Tickner & Raffensperger, 2002; Harremoës, 2003; Tickner & Geiser, 2004; Godard, 2005; Sunstein, 2005; Whiteside, 2006).

1. What is the *level of the certainty of knowledge*? How plausible is the perceived danger?
    - Is the knowledge determinist, a known risk with an available probability, a case of uncertainty where the probability is unknown, indeterminate, or simply a case of ignorance?
    - Is the available knowledge on the perceived harm coherent among experts? Is the knowledge precise?
2. What is the *level of perceived danger* or harm?
    - What is the probability of the perceived harm, if available?
    - Is the perceived harm catastrophic, irreversible, non-substitutable, socially unacceptable, irreparable, or in fact, what are the rights of future generations, etc?
    - If there are several elements that describe the perceived danger (for example, socially unacceptable and irreparable) how can these elements be prioritized? Does a weighting system need to be defined? If yes, how?
3. What is the *measure taken*?
    - Should the measure taken be based on strict laws, should it be based on norms, will the measure be a simple follow-up, etc?
4. Are the proposed solutions (actions) *proportional* to the perceived harm?
    - Will this evaluation be based on economic criteria? Will it be based on social criteria? What does proportional mean in this context, in particular if the level of knowledge is very low? Is it acceptable to suspend the precautionary measure? Etc.

However, in defining each of these elements for arriving at a decision, it is essential to begin the deliberation by defining *how strict a definition of precaution is acceptable to use* for the given situation. In defining these elements of the precautionary principle, then the level of severity of the precautionary principle will have to be specified otherwise some of the above considerations may be difficult to resolve.

It can be seen from the above considerations that the task of defining each of these elements is non-trivial. In fact, it is an immense task of reflection. In order to arrive at an action or decision, a definition of the precautionary principle and the reflection of each of these elements is essential. This is why a public participation in such cases is fundamental. Without public participation, it may not be possible to arrive at a decision because the 'validity' of the measure taken for the particular context cannot be easily assessed in isolation. This is one reason why the establishment of a system of governance for such decision making is significant.

A precautionary approach requires a complex judgment that is quite different from a risk assessment. This is because a precautionary approach does not profess to be able to quantify risks, since it cannot. Instead it seeks to search for alternatives; it does not seek to define an acceptable level of risk as in the case of a preventive approach. However, when alternatives are assessed, they must be evaluated to ensure that they do not cause more harm than the perceived harm of the original precautionary situation. This is why the levels of certainty of knowledge and the levels of perceived risk must be established. It is not for the purposes of defining levels of acceptability (as in a normative approach), more as a way to establish order in the thought process; to uncover what stakeholders perceive as acceptable would be established in a process of deliberation.

1.5. The Precautionary Principle for Design

A definition of design adopted by this research is that of Ron Levy (De Coninck, 2005, pp. 68-69), because it defines the designer as a type of *social actor*. This is a very appropriate definition because through the solutions that designers make available to the world, they have the capacity to modify the way in which humans

conduct their day-to-day lives. In fact, what would design represent if it is not an activity that can contribute to the improvement of quality of life?

A hypothesis that is prevalent throughout this research is that if designers can redefine the rapport that individuals have with the world (based on Levy), then design, through the exploration of alternative solutions to everyday design problems, can contribute to sustainable development. One way that this may be achieved is through the way that decisions are made. When decisions are based on the notion of precaution, so that the uncertainty of harm to society or the environment can be avoided, then such solutions are more likely to contribute to sustainability than if decisions were made in, at best, using only a preventive approach, or at worst, in an ad hoc manner. This research explores how design can contribute to the development of an improved rapport with the world, through the creation of ethical solutions based on the precautionary principle.

1.5.1. Defining the Precautionary Principle for Design

The definition of the precautionary principle identified by the Rio Declaration on Environment and Development (1992) is a general widely accepted version. The definition of the precautionary principle in a general context can be defined as: a principle that tries to guide development in the absence of certitude and in the presence of potential risks, and therefore allows the establishment of a responsible, anticipative action.

In this section a definition of this principle specifically for design practice will be introduced. Philippe Schiesser (Vigneron, Patingre & Schiesser, 2003), has identified four sustainable principles specifically for design practice: responsibility, solidarity, precaution, and participation. These four interrelated principles are fundamental for the implementation of sustainable development. According to Schiesser (Vigneron, Patingre & Schiesser, 2003, pp. 178-179), these principles are defined as the following (liberal translation):

Precaution

> "*This principle was first introduced in Germany, and can be used in parallel to several other eco-conception tools that employ a preventative approach. This mode of action goes beyond a life cycle analysis thinking; an approach that evaluates the environmental impacts of the inputs and outputs of a product system during the course of its life cycle. A precautionary approach requires an approach that is reflective, exploratory, and prudent. The identification of a real or potential risk does not arise as a result of a life cycle analysis, and therefore eco-conception norms recommend that the precautionary principle is applied when justifying the choice of impacts.*"

Solidarity

> "*This principle seeks to achieve a common good. It asserts that achieving eco-efficiency at an international level, as well as an equitable exchange among economic actors is fundamental to achieving sustainability through design practice.*"

Participation

> "*This principle seeks to achieve sustainability in design practice by encouraging dialogue within a stakeholder engagement process. This will allow the emergence of various solutions as a result of debates or deliberations regarding contentious issues. This principle also encourages the access to documentation for public consumption so that information is made available within society.*"

Responsibility

> "*This principle seeks to ensure a shared responsibility towards sustainability through the use of tools such as traceability (for transparency) or Life Cycle Assessment (to understand the impacts of products). This principle also advocates a preventive approach to design using available tools.*"

The definition of the precautionary principle based on Schiesser (from Vigneron Patingre & Schiesser, 2003) is pertinent for design because in conjunction with the other three principles he has defined for design practice, it becomes significantly

more operational when compared with the definition provided by the Rio Declaration on Environment and Development; it provides a basis for a preliminary implementation of this principle for design practice. His definition of the precautionary principle requires a reflection on possible solutions in an exploratory way, when faced with situations of potential danger. Therefore questions emerging from this are: What will guide stakeholders (designers, producers, consumers, citizens, decision makers) in defining actions for situations that present potential dangers? How will reflective and exploratory methods be manifested so that proposed solutions are just and consider the common-good?

Figure 4, illustrates the four interrelated principles that Schiesser (from Vigneron, Patingre & Schiesser, 2003) has defined for design practice. These four principles cannot be separated or used in isolation in a context of sustainable design. Any one of them in isolation will not allow a sustainable design mode to emerge from the current mode of design. They are inter-related because the Principle of Precaution (reflection, exploration, and prudence) requires some level of dialogue and public knowledge (which is defined in the Principle of Participation) and this can only be done with the knowledge acquired by measurable tools such as an environmental impact assessment tool and traceability measures (which is defined in the Principle of Responsibility). In addition, none of this is possible without an equitable (fair and just) exchange among actors (defined within the Principle of Solidarity).

Therefore, these principles, outlining the foundation of sustainable design are closely related; they make up a system of principles for sustainable design practice. Each one of these principles is dependant on the other to achieve a mode of design that is sustainable. Philippe Scheisser identifies LCA as a core responsibility for the designer, however recommends that precautionary methods are used to justify decisions in situations of potential harm, since these cannot be identified as a result of an LCA (Scheisser, from Vigneron Patingre & Schiesser, 2003).

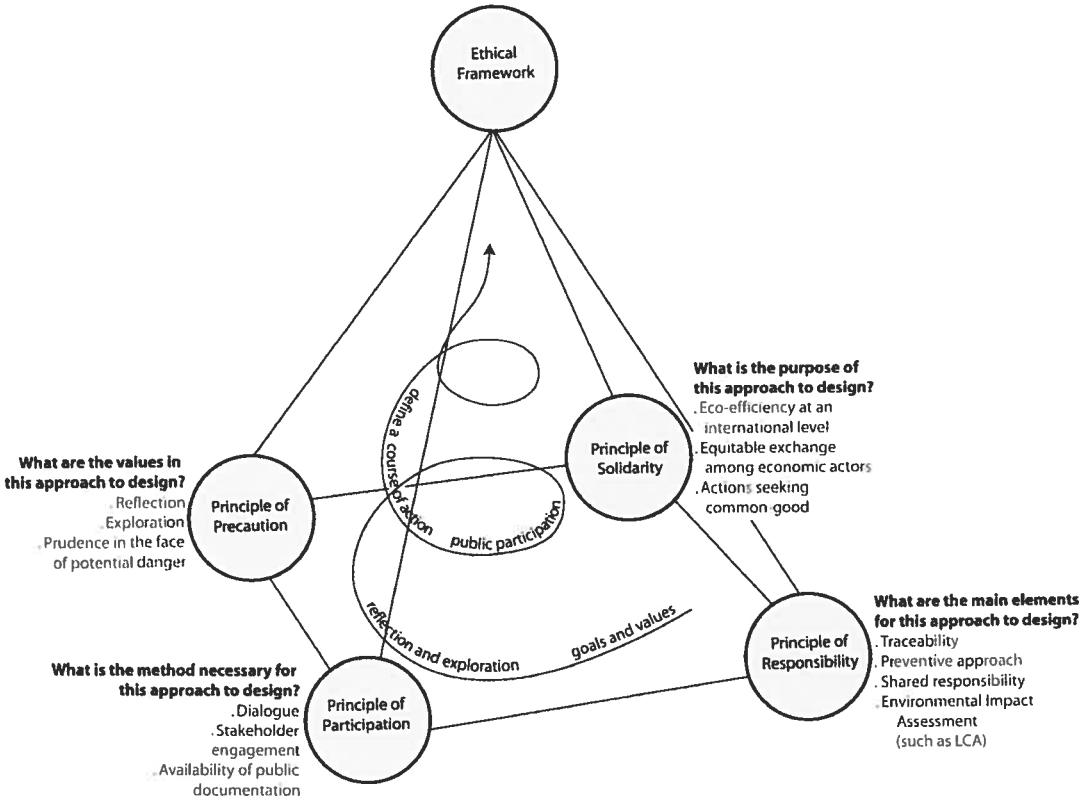

Figure 4: System of sustainable development principles for design practice (based on Schiesser; from Vigneron Patingre & Schiesser, 2003). © Cucuzzella, C., 2007

When using the precautionary principle for design, as defined by Scheisser, a prudent approach towards the search for innovative solutions is adopted. A precautionary approach does not seek to prescribe a solution through optimization, but instead seeks to reveal the risks of the situation in order to search for alternatives. This is done by considering new approaches for improving the quality of life of individuals and their societies. In a precautionary attitude the solutions are sought by conceptualizing new lifestyles, and not by only designing a more eco-efficient product or service. This is because it is at this early phase of conceptualization that the questioning of current potentially harmful consumption habits may be questioned. As a result, the idea of social acceptability of both, the potential dangers imposed and of the alternative scenarios proposed, becomes a major factor in the success for finding resolutions. So a system of governance that can provide the infrastructure for such deliberation is imperative for sustainable design.

1.5.2. Benefits of a Precautionary Approach for Design

Existing eco-design tools, although very useful in assessing and helping to reduce environmental impacts for a product or service system, are no longer sufficient on their own, because they limit the point of view of the problem to the product or service in question and therefore evade the more global perspective of the impacts. This is because the long-term, global, invisible effects of technological innovations on society and the environment require global consideration and cooperation. Therefore, nature and society cannot be analyzed only through a cause-effect perspective because of the existence of emerging phenomenon in technological, social, political, or environmental innovations (which means that uncertainties in discoveries can no longer be ignored). In fact, in the context of sustainable development, an acceptance of uncertainty and diversity of values is inescapable. Deterministic, rational methods (such as LCA) are often advantageous in economic and risk analysis and provide justifications for final decisions. However, this is where the logic geared towards the benefit of the common good is not considered.

Therefore, this research is seeking to adopt a more global perspective to environmental and social impacts using a precautionary approach, when compared to a preventive approach. In fact, UNEP (United Nations Environmental Program) and SETAC (the Society of Environmental Toxicology and Chemistry), under their LCI (Life Cycle Initiative), have created in 2004, a Social Life Cycle Analysis task force with the aim to improve social conditions. The mission of this Task Force is to construct a set of social indicators. This work is done in a primarily socio-economic perspective. It is a fundamental approach in defining social indicators since socio-economic conditions provide a fundamental perspective of quality of life.

However, with the aim of moving beyond an economic (medium term) perspective in defining social indicators, this research is seeking to use a more global, long-term and very long-term perspective in defining social indicators. Because such indicators are seeking to comprehend and assess quality of life, then their establishment cannot be made solely through a cooperation of experts, but would in fact require the collaboration and deliberation of non-experts as well. This is because these indicators will no longer be based only on an economic perspective but also on an ethical framework using a precautionary approach with the aim to help establish and

assess possible solutions to existing lifestyle problems. Table 7 represents fundamental human needs proposed by Max-Neef (1991) which can be used as a basis for developing such indicators. These indicators can help evaluate the values and visions that need to be addressed when establishing and assessing solutions. The author has highlighted the axiological and existential elements from this table that may be pertinent for such a reflection.

Table 7: Fundamental human needs proposed by Max-Neef (1991) and their pertinence for developing social indicators based on quality of life.

Existential Categories / Axiological Categories	**Being (qualities)**	**Having (things)**	**Doing (actions)**	*Interacting (settings)*
subsistence	***physical and mental health***	food, shelter work	feed, clothe, rest, work	***living environment, social setting***
protection	care, ***adaptability autonomy***	social security, **health systems,** work	**co-operate, plan, take care of, help**	***social environment, dwelling***
affection	respect, sense of humour, ***generosity,*** sensuality	friendships, family, ***relationships with nature***	***share, take care of,*** make love, express emotions	privacy, intimate spaces of togetherness
understanding	***critical capacity, curiosity, intuition***	literature, teachers, ***policies, educational***	***analyse, study, meditate investigate,***	***schools, families universities, communities,***
participation	***receptiveness, dedication,*** sense of humour	***responsibilities, duties, work, rights***	***cooperate,*** dissent, ***express opinion***	***associations,*** parties, churches, neighbourhoods
leisure	imagination, tranquillity spontaneity	games, parties, ***peace of mind***	day-dream, remember, relax, have fun	***landscapes,*** intimate spaces, places to be alone
creation	imagination, ***boldness, inventiveness,*** curiosity	***abilities, skills, work, techniques***	***invent,*** build, ***design,*** work, compose, interpret	spaces for expression, workshops, audiences
identity	***sense of belonging, self-esteem, consistency***	language, religions, ***work, customs, values, norms***	get to know oneself, ***grow, commit oneself***	***places one belongs to,*** everyday settings
freedom	***autonomy,*** passion, ***self-esteem, open-mindedness***	***equal rights***	dissent, ***choose,*** run risks, ***develop awareness***	anywhere

Therefore the reflection and comprehension in a sustainable design approach entails a social change, one where the goal is to transform current consumption habits into

more sustainable modes of consumption. This requires a perspective based on human lifestyles (a broader scale than product); therefore a need for assessing impacts on a global scale emerges in a precautionary approach, where *innovative* alternatives are based on the *creation of new lifestyles.*

As a preliminary measure of instantiating change within societies, initiatives can be generated by governments, education systems, or media; where regulations, incentives, courses, or information can contribute to awareness of the crisis. When designers, producers or innovators are sensitized, they have the power to change the way in which individuals relate to their environment. They can do this by using a participative approach to design in an effort to search for innovative solutions. When individuals have the information and motivation necessary to generate change, they are empowered. A responsible citizen being empowered can help contribute to significant social changes intended to improve quality of life. In essence then, designers can contribute to the move towards sustainability by changing the relationship that individuals have to their environment and society.

An approach of sufficiency (Princen, 2003) towards conception is required to move towards sustainability since it will allow a perspective that is beyond one of efficiency. This new perspective is necessary because beyond the optimization of products and services (efficiency), an attitude of sufficiency will allow the emergence of solutions that seek to satisfy the most fundamental human needs by using the least amount of resources. Such solutions will imply a transformation of current lifestyles towards more sustainable lifestyles; in other words, sufficiency seeks to change the relationship that humans have with their world.

Therefore a precautionary approach will entail social innovation since it will encourage public participation in design practice. As many authors have indicated (Sclove, 1995; Tickner & Geiser, 2004; Whiteside, 2006; Droz & Lavigne, 2006), public participation is essential when seeking innovative solutions to problems that have inherent unknowns, potential risks, and doubt. However, public participation necessitates a system of governance so that a concrete public decision can be reached given the various values and visions of the participants. Figure 5 demonstrates the infrastructure necessary for the shift towards sustainable design.

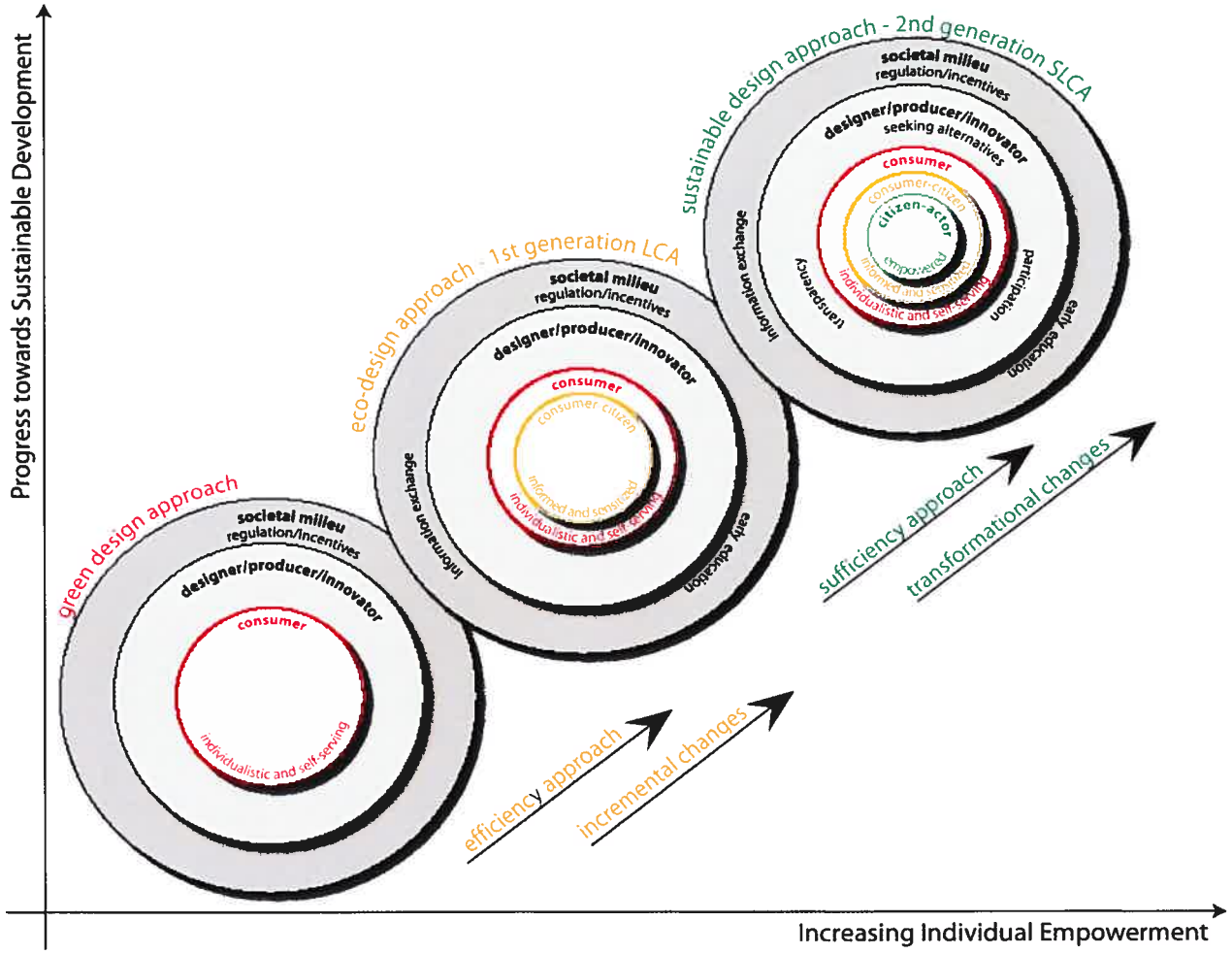

Figure 5: Emergence of the responsible citizen in a perspective of sustainable design. © Cucuzzella, C., 2007

In essence then, a precautionary approach encourages innovation, and so it responds to the *prerogative of design* and in particular contributes to the *improvement of the well-being* of individuals and society, by proposing new concepts and experiences that will ultimately change the world in a *recursive way*. This in fact, relates directly to the definition of design used in the context of this research, defined by Levy. The precautionary principle will therefore drive innovation; this is where design intervention can contribute to sustainability using the precautionary principle. In essence then, the main benefits of adopting a precautionary attitude for design is that: (1) allows an upstream approach to the conceptualizing of products and services based on new lifestyles and not focused solely on new products; (2) the involvement of non-experts in the development of alternative solutions renders them more responsible as they can contribute to the improvement of the quality of their lives and that of their communities; (3) the emergence of the responsible citizen can have an impact on a local, regional, national, and international scale; a global citizen; (4) responds to the notion of design according to Levy, since this will change the world in a recursive way; and (5) it will then allow a shift from eco-design to sustainable design because of the way in which solutions are sought.

1.5.3. Precaution as a Complement to Prevention for Design

Precaution is similar to prevention since both seek to define actions that ultimately seek to reduce harm in situations of potential danger. Therefore, both can be considered as frameworks in a decision making process where risks are immanent; whether they may be potential or known. The main difference between the prevention principle and the precautionary principle is that the prevention principle is value-neutral, where the precaution principle requires defining an action when data is lacking, and therefore cannot be value-neutral. So it seems that these two principles differ significantly in their epistemological perspective[59].

By understanding the differences and similarities between a preventive and a precautionary approach, the pertinence of a precautionary approach to design as a complement to an already existing preventive approach, may emerge. A preventive

[59] This refers to the way in which the researcher perceives the world; this will be further elaborated in section 2.1 of this paper.

approach focuses on environmental and social impacts on a product or service system. This is often based in an economic perspective so as to minimize costs associated with the reduction of impacts. In addition, the scope of the problem is defined by the product (albeit in a cradle-to-grave perspective). However, when evaluating environmental or social impacts in the current global context where impacts are experienced worldwide in a non-immediate temporality, then the concerns and assessments can no longer be limited to a product and service system scale, even if these are in a cradle-to-grave perspective.

In cases of risk of harm to humans or the environment, the current approach is more reactive than proactive; in other words more preventive that precautionary. There is no current method for arriving at decisions in cases of uncertainty of harm for designers. Therefore limits imposed by using solely a preventive approach result in a gap with respect to the impacts that may occur far into the future and cannot be easily understood with existing evaluative tools. Preventive measures are pertinent for sustainable design because they allow evaluative measures for assessing negative impacts of product and service systems. These approaches are often cost-effective measures and therefore are necessary for product and service system optimization. Through its multi-criteria approach, LCA aims to develop as much of a global vision as is possible. However, because the perspective remains at the product level and therefore short to medium term, it cannot be considered a global approach.

In fact, even the introduction of social aspects within the LCA framework at this point is limited in scope. Most methods that have sought to integrate social aspects remain within a preventive approach; for example, among others, the method developed by researchers from the University of Stuttgart, called GaBi[60]. This method is a quantitative based method that uses databases as its main source of information. Assessments are made using models that are used to compute the social impacts. In this approach, all decisions are made by LCA experts, and therefore, there is no involvement by the community in considering what an acceptable solution to the existing social problems may be.

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[60] This approach was presented at the 1st International Conference on Society and Materials in Sevilla, March 2007. Barthel, L., and Pflieger J., from the University of Stuttgart presented a conference called *Assessing Sustainability - social aspects along the life cycle.*

The qualitative approach to establishing or assessing indicators is often not well developed. There are many reasons for this, but the most common is that qualitative measurements and assessments are very difficult to acquire and compare, and therefore currently difficult to use in existing methodologies. In essence however, most assessments whether quantitative or qualitative are a result of a subjective perspective because the level of acceptability of the quantification of a phenomenon is a matter of a subjective interpretation (Droz and Lavigne, 2006). Besides, there exist situations where the data necessary to quantify a phenomenon is not available. In such cases, there is currently no systematic way to arrive at a convincing interpretation or assessment. This as a result, will have implications on the ways in which decisions have to be made.

As mentioned previously, there is some research in developing social indicators based on a qualitative approach; the UNEP/SETAC Task Force[61] is currently conducting research on social aspects based on a qualitative approach. This research is a result of concerns based on the predominant use of a quantitative approach for assessing social impacts, since this group has come to the realization that a quantitative approach alone will result in outcomes that may not reflect the actual problem. This is because anomalies exist in terms of the ways in which the data can be collected for many social indicators; therefore adopting an approach that ignores such irregularities is problematic. Also, in using a qualitative approach, a more in-depth understanding and assessment of the social problem becomes viable. However, even in this approach, the indicators are based on a socio-economic perspective, which essentially remains within the expert realm.

The main reason that many indicators (social and environmental) are based on a predominantly quantitative approach, and therefore remain within risk-analysis or cost-benefit analysis is because this is a paradigm that many are comfortable with. Understanding situations using concrete data is much simpler than the alternative – a qualitative approach; since this requires human intervention for assessing the impacts; the work is not left to the computer. These modes of analysis remain in a short to medium term perspective because the consideration is limited to the impacts

[61] This task force was initially mentioned in section 1.5.2 of this paper.

based on the production of the product (cradle-to-grave), and therefore have not considered a more global perspective.

A global perspective refers to a viewpoint that considers human consumption habits and seeks to improve quality of life by searching for innovative ways where such habits can be transformed to become more sustainable. Citizen participation can greatly nourish such a process because of their views of well-being and their creative insights based on the unacceptable conditions of existing situations. This moves the reflection out of the hands of experts alone and therefore can include the values and visions of the community in the search for solutions. By including the non-expert perspectives, a sense of empowerment is required so that individuals feel the competence, autonomy and need to participate with the intent of improving the quality of life for individuals and their communities on a local, regional and international level.

Therefore, in a precautionary approach, solutions are no longer limited to the product level (process, material and form), but system based solutions are conceptualized that embed the complexity of a global vision. In a precautionary approach there is an attempt to deconstruct the issues and values and use this in a participatory environment. This principle invites a reflection on the limits of the use of all living systems and natural resources, and an exploration of alternative solutions. This principle encourages innovation in a more upstream perspective when compared to a preventive approach. Therefore, innovative solutions using a broader range of criteria and knowledge are identified very early on in a conception process. Because this principle contributes to this type of reflection, the deliberation of existing situations and proposed scenarios for possible resolutions cannot be done in isolation among experts alone since their knowledge cannot pretend to encapsulate the values and visions of society at large. This is why an infrastructure that can encourage a constructive system of alternative assessment is imperative, implying that the fourth pillar of sustainable development – governance, is indispensable.

This combined approach can become very fertile for decision making in a perspective of product and service development. This is because a precautionary approach pulls the reflection and exploration at the beginning of a conception

process (and therefore allows a broader vision of scope) and a prevention approach enables a risk or life cycle analysis once a product or service system has been developed. Therefore, the two approaches can be more closely coupled to achieve a sustainable designed product or service system. The reasons for this coupling of eco-design using a global approach are: (1) most LCA tools focus on the impact of energy consumption and material usage of the product or service system (Madge, 1997), limiting the scope of the problem; (2) most current LCA tools assess a product system's impact using a cause-effect deterministic approach and is therefore unclear how decisions are made in conditions of fundamental uncertainty; and (3) in adopting a precautionary approach, the visions and values of the community would be included in the final solution, widening the scope of knowledge (Sclove, 1995).

Using a precautionary approach that encourages a search for alternatives in cases of uncertainty of harm will still require an evaluation of proposed solutions. Therefore this approach does not eliminate the need to assess risks or impacts of proposed alternatives (if possible) because in some situations, allowable exposures are the most viable alternative. In essence then, a precautionary approach becomes a viable complement to existing approaches for evaluating impacts, such as LCA. In this approach the need for assigning and evaluating product and service system impacts will still be necessary, but this will be done at a later phase in the design process.

An important realization is that the precautionary approach cannot be assumed in all situations; this approach is necessary primarily when current situations impose a potential threat to humanity. In these cases, collective solutions become a way of shifting the attitudes away from the potentially harmful situation to more sane solutions that reflect harmony with the environment and respect for others.

1.5.4. Objective and Significance for Adopting such an Approach

A detailed problematic framing the precautionary principle for design has been constructed in the preceding sections. This construction is meant to lay the groundwork to illustrate the justification of this research. The following sections will propose the core idea of this research based on its theoretical framework and methodology in an attempt to defend its pertinence for design practice. This

research explores how design can contribute to the development of an improved rapport with the world, through the creation of solutions based on the precautionary principle. The precautionary principle has not yet been extensively used within the perspective of design and therefore will be explored with the intent of acquiring an understanding for its applicability in design. This principle implies a participative approach to decision making in design practice and includes not only experts in the deliberation, but non-experts as well. This will allow an emergence of the various value systems, encourage innovative solutions that will promote new modes of consumption, and therefore individuals will acquire an improved relationship with the world. In this approach a sense of empowerment is fundamental, so that non-experts can feel a sense of competence where their perspectives are revealed in searching for innovative solutions. Therefore both experts and non-experts will comprise the set of stakeholders[62] necessary for such a deliberation.

The main reason to use the lens of the precautionary principle for design is because it is intended to help make decisions in cases of uncertainty of catastrophic harm, yet there is no guideline available in which to base such a decision. The critical issues with the precautionary principle are (1) it's diverging interpretations result in confusion with regards to its implementation, (2) the limitations that science based analysis imposes on decision making renders it difficult to arrive at a just decision (3) the inability to arrive at a decision because of a lack of ethical knowledge base, and (4) the antagonisms, contradictions, and uncertainties that exist between intent, action/decision, and outcome of action, all make it an imperative for the justification of decisions in cases of uncertainty, in particular in a context of design.

Methods for assessing progress towards sustainability are essential for its successful operationalization. Indicators enable such an assessment allowing a comprehension of impacts, whether such impacts are negative based (such as damage categories in LCA – a preventive approach) or positive based (such as the satisfaction of fundamental human needs based on the proposed scenario – a precautionary approach). Research towards the development of social indicators is an emerging and promising area for the assessment of social impacts. Various approaches to developing such indicators are under way; using both qualitative and quantitative

[62] Section 2.2.2 of this paper provides further details on this topic.

approaches to data collection. The UNEP/SETAC task force (within LCI) has created a Social Life Cycle Analysis task force with the aim of improving social conditions. Since 2004, CIRAIG (Interuniversity Research Center for the Life Cycle of Products, Processes and Services) is invested within the work-group on the social aspects in life cycle analysis of UNEP-SETAC. This task force attempts to offer a socio-economic perspective for developing social indicators based on a combined qualitative and quantitative approach to data collection. This is a predominantly preventive approach, where the establishment and assessment of impacts (mainly negative based) remains within the expert realm.

This research is seeking a precautionary approach towards the development and evaluation of social indicators that can complement existing methodologies (such as LCA and SLCA) used for assessing impacts. These indicators will be developed in a further research; however an attempt to understand how they can be developed and evaluated will be presented in this paper. As a preliminary step, this research will seek to justify the use of the precautionary principle as an alternate way to develop and assess social indicators, which have become a major concern at an international level. This new approach will be based on the 4th pillar of sustainable development – governance. This will represent the methodological framework of this principle, and ultimately this approach. The theoretical framework of this principle (and approach) will be based on fundamental human needs for an improved quality of life for all generations – present and future. In other words, the values and visions of society become an important contribution to their establishment and assessment. The intent of developing such indicators is to enable a shift from an eco to a sustainable mode of conception. The goal of this paper is to provide the groundwork for further research towards the establishment and assessment of social indicators based on such an ethical framework.

In the next section, the theoretical framework for this research will be established. This framework will be based on the fact that the object of study (a precautionary approach for decision making in design practice) for this research is inherently a social problem, and therefore an appropriate framework that can focus on social aspects in a general context and not solely within an economic context will be identified and justified.

2. The Theoretical Framework

2.1. General Introduction of Epistemology

For the purposes of positioning this research within a suitable epistemological framework, it seems appropriate to provide a brief description of the framework adopted. This will allow a comprehension of the reasons why this research has assumed this specific approach in terms of how it perceives the world. An epistemological framework is an approach (either an orientation or a tendency) of the way in which an author or researcher perceives their reality. They may also be referred to as a philosophy or doctrine (De Coninck, 1993). In this research, this will be referred to as an epistemological framework. An epistemological paradigm on the other hand, signifies a techno-scientific epistemological perspective (De Coninck, 1993).

2.1.1. Complex Framework

This is a way of looking at the world where the phenomena in question is perceived as a system by the observer (Le Moigne, 1995). There is no attempt to discover universal laws or deduce generalizations in this perspective. Instead, this is an approach to comprehending reality based on a construction of reality rather than an approach based on discovery and justification. Logic of recursion[63] is used in this framework (Morin, 2005).

2.1.2. Systemic Paradigm

The systemic approach could be explained as a method that allows a diversity of scientific fields to view problems through a holistic and heuristic perspective (Pirotton, 2005). Systemism is fundamentally pluralist and relativist (De Coninck, 2006). One of the reasons for the emergence of this paradigm is because traditional scientific methods of research are faced with limitations when viewing problems

[63] This is a type of logic that is based on a (auto-eco-re) organization framework. Auto refers to the transformation of the object itself. Eco refers to the transformation of its environment as a result of transforming itself. In this sense it is a recursive organizational logic because the object changes itself, as a result its environment changes, which will then result in a change in the object (Morin, 2005).

through an analytical perspective. This method is no longer sufficient for comprehending dynamic and emerging phenomena; this knowledge can only become enriched through a study of the interactions among elements within the system (Pirotton, 2005; Donnadieu *et al.*, 2003). For example, trying to understand a living organism by studying each part separately will not provide a comprehension of the system as a whole; however, it will provide a disjointed, in depth, knowledge of each of the elements within the system. Therefore, the interactions among the various parts, the organization of these parts, and the exchanges among them, enrich the comprehension of the organism.

Systems

If a system is made of a set of elements linked together, the interactions among the various elements constitute a totality that cannot be reduced to a sum of its parts (Morin, 1982; Pirotton, 2005). A system is dynamic in the sense that the set of processes are in continual interaction (De Rosnay, 1975). The interactions of the processes are ordered, yet not pre-determined or immutable. Each system has at least one goal and is oriented by a project (Le Moigne, 1977). A system is autonomous, meaning that it is only recognizable by its environment. The modification of one element of the system may affect the entire system (Von Bertalanffy, 1968). A 'simple sum' would ignore the new totality that is born from the fact that the elements are not simply juxtaposed within the system, but maintain organized and structured relations; are inter-dependant. Therefore, a system cannot be reduced to a sum of its parts (Morin, 2005).

When studying a system, an observer is required to define the limits of the system and its environment. This is not predefined; it is up to the observer to define the limits. A system essentially corresponds to the observer's hypothesis who notices that the system is partially autonomous with respect to its environment (Pirotton, 2005). In fact, the environment is itself a system composed of subsystems. The environment of a system can be defined as a collection of elements, outside the system in question, and where exchanges take place with the system (Pirotton, 2005).

The system and its environment are interdependent (Donnadieu *et al.*, 2003; Pirotton, 2005). This refers to a co-presence and co-organization between the system and its environment (Morin, 2005); also referred to as their mutual dependence; each requires the other to remain in equilibrium; to maintain a state of stability of the components within the defined environment (in spite of the variations of its environment). This stability should not be confused with an immobilized or static system; this is a dynamic process and refers to the idea of homeostasis (Checkland, 1999).

Systemic Vision - Modeling

Models are useful in understanding complex phenomena, since they help in the comprehension and construction of the system using a graphical tool. The representation of a phenomenon that is perceived as complex is based on a hypothesis that is explicit (ontological), defines a purpose (teleological), and is recursive (Le Moigne, 1999). In modeling complex systems, the main idea is to model actions. In other words, to model a system is to model a system of actions. A question that is often asked to help in the modeling exercise is "*What does this (system) do?*" (liberal translation, Le Moigne, 1999, p.46).

A model of a system can be defined as a description, a representation that contains the elements, its relations and its functionality as perceived by the observer. The purpose of a model is to help in the comprehension of the system. Therefore modeling is an operational methodology that supports a heuristic epistemology; it helps to construct a hypothesis (Donnadieu *et al.*, 2003; De Coninck, 2006). A model cannot however contain all the information since there are often areas where the information is not known. In this case, the user is not concerned with the internal functioning or structure of such an area of the model; this is considered a black box. Black boxes are important to the system's functioning, but are not part of the observer's concern (De Coninck, 1993). A model cannot aim to be complete or perfect; it does not strive for the truth, but instead it seeks pertinence; this is a constructivist approach. Therefore a model cannot be considered right or wrong because it is based on a perspective of the observer and is evaluated based on its pertinence for the comprehension and construction of the system.

The way in which a system is typically constructed is by noting that its behavior/functionality has an orientation, a purpose. There are two aspects when describing systems: functional and structural (Pirotton, 2005). A structural aspect refers to an inventory of elements and their relations; this can be thought of as a conceptual map. In describing a system using a structural approach, the finality of the system must be established. This finality delimits the system (De Rosnay, 1975). A conceptual map or structural aspect is delimited by the observer's definition of the system and its purpose (finality). This map consists of (De Rosnay, 1975, pp. 96-97, from Pirotton, 2005): (1) its limits and frontiers; (2) the elements; (3) the storage areas (reservoirs); and (4) the communication network.

The functional aspect contains: (1) flux; (2) decision center; (3) delays; and (4) feedback loops (Pirotton, 2005). The functional aspect helps understand the processing of the system; there is a sense of temporality in such a descriptive aspect (Checkland, 1999). A functional description of the system may help to understand the control, regularity/irregularity of the flux (Checkland, 1999). This can be thought of as a process map.

In essence then, a systemic vision allows an observer to comprehend an object (phenomenon), represent its functionality, and model its structure through elements, all of which is based on the observer's hypothesis and perspective. It is up to the observer (subject) to define what elements, relations, limits, functionality make up the system (De Coninck, 1993). A system is then organized using four levels of analysis: the elements; the interactions among the elements; the organization of the interactions, and the interaction with the environment (De Coninck, 2006).

Schools of Thought – Complexity and Reductionism

Many authors insist that there exists an opposition between the theory of systems and the traditional scientific (Cartesian) approach; specifically that the experimental (traditional scientific) approach fails (or is limited) with respect to real world problems. Social problems, which are real world problems are often, studied using a complex view of the world. A primary reason for this is that by reducing a social problem into

isolated elements and studying each of these elements in isolation will not provide a comprehension of the social problem (Morin, 1982). Social problems must be looked at through the relationships among the elements within it for a comprehension of the social problem to emerge. When looking at the world in a complex way, "*the whole is greater than the sum of the parts*"[64].

Social problems are approached using a complex view of the world because they are characterized as incomplete problems often having contradictory elements. A traditional linear or reductionist approach to solving such problems is not effective because each attempt to solve the problem in fact modifies the comprehension of the problem. In such problems, there are no simple cause-effect phenomena, but instead a circular or recursive process. In many cases, such problems contain counter-intuitive or perverse properties that cannot be seen when looking at any of the elements in isolation. Such situations often reveal several problems, and each of these problems cannot be easily separated from the system; and therefore must be looked at as a complex system. In such cases, several solutions may likely satisfy the problem, of which the observer has the freedom to select. There is no unique or direct or linear solution to such complex problems in contrast to problems that are dealt with in a scientific traditional approach (Morin, 1982).

2.2. Epistemology of Research

A systemic vision for this research would provide an epistemological paradigm that is coherent with the researcher's perception of the project. The object of study is the decision making process in situations where there is an absence of certainty, and a presence of potential risk (a precautionary approach to decision making). There are several reasons for adopting a complex framework: (1) the decision making process in such a context cannot adopt a traditional Cartesian approach because of the inherent uncertainty in situations of potential harm; (2) the various value systems necessary to take into account when seeking to resolve such situations of fundamental uncertainty; and (3) the antagonisms, doubt and unknowns require a collective approach when searching for innovative solutions because of the

[64] This is one of eight other concepts based on this principle. Please refer to Morin (1982, pp. 175-177).

increased insights among the various actors. In this context, the comprehension of how the precautionary principle can emerge as a foundational principle for decision making in a context of uncertainty becomes pertinent.

In seeking to operationalize the precautionary principle in a sustainable development perspective, a comprehension of ethics in general, and then a re-evaluation of ethics in our contemporary society is a start. By comprehending and articulating the ethical framework of this principle and by applying this knowledge in a decision making process, then this principle becomes operational. It therefore becomes useful as a guide for decision making in a context of potential catastrophic consequences. The ethical framework of the precautionary principle could be perceived as a meta-moral. This means that in establishing an ethical framework, a complex understanding of the laws that govern human action will result. The goal is not to build a deterministic tool to help guide decisions in a logical manner, but a guide or framework that can assist decision makers through their deliberation. Responsibility and open discourse for an equal justice among actors are a basis of such an ethic.

In the following sections, a proposal will be presented that will expose both a theoretical and methodological perspective for an implementation of the precautionary principle for design. This proposal is an outcome of the literature analysis. The aim of this proposal is to be able to construct a set of criteria that can be used as part of an analysis grid for the field work.

2.2.1. An Ethical Framework

Why then an ethical framework? Primarily because value systems – whether explicit or implicit form an ethos, and these have a profound influence on social practices and in part, constitute to social change (Droz & Lavigne, 2006). Therefore, an ethical approach, which constitutes a comprehension of the multiple value systems, will provide a sense of direction regarding social change. Social change requires humans to take a stand; get involved in order to find solutions that will improve situations that are unacceptable. Therefore humans must act when faced with the consequences of current technological and social developments. This encourages a reflection based on the recognition of different value systems. However, very often

the values of the dominant occidental culture are imposed without the participating actors' awareness (Droz & Lavigne, 2006). This is where a sense of empowerment and the need for participation towards the contribution of sustainable solutions becomes part of the solution.

Basic Ethical Theory

Why is it important to understand the various ethical theories in an attempt to define an ethical framework for the precautionary principle? For one, it provides a point of departure from which the controversial problems can be discussed. Ideas such as duty, responsibility, utility, consequence are important, yet vast concepts and therefore it becomes increasingly important to start from a common definition of such terms. Secondly, one of the functions of ethical theories is to provide guidance and allow an evaluation of a controversial situation (Des Jardins, 1995). And finally, it may actually be that the adherence to such ethical theories, the habits of the mind, and the way individuals choose to live because of normative limits, may be a reason why we face such environmental problems today (Des Jardins, 1995).

Before elaborating on a proposal for an ethical framework, it is important to distinguish among *moral, ethical,* and *ethic. Ethic* is the study of morals, or a meta-moral (Feiser, 2006). *Moral* and *ethical* refer to the same concept; both are normative and refer to the set of principles that govern acceptable human conduct (Feiser, 2006). The main difference between moral and ethical is their origin; *moral* is a word of Latin origin, whereas *ethical* is a word of Greek origin (Weinstock, 2006). Therefore when an action is considered ethical (or moral) it is considered this way because of normative thinking. Normative ethics is the study of ethics concerned with classifying actions as right and wrong without bias. Normative ethics regards ethics as a set of norms related to actions. Descriptive ethics deals with what the population *believes to be right and wrong,* while normative ethics deals with what the population *should believe to be right and wrong* (Feiser, 2006). For example, *killing one's children is wrong*, is a normative ethical claim. Normative ethics examines standards for the rightness and wrongness of actions.

If moral (or ethical) is normative that defines the ideas of good and bad, then ethic is different, not because it is not in some way normative, but because it is *adaptive*. Ethic is normative in the context that it offers markers in the form of fundamental shared values that guide the ethical reflection, without being imposed. Ethic can be thought of an analysis of the deconstruction of morals. The place of ethics is in the process of interrogation. Morals are closed; ethics are open and resist closure (Massé, 2003, from Droz & Lavigne, 2006).

The precautionary principle is based on a sense of responsibility, which implies responsibility, duty, and therefore societal norms, so the ethical foundation can be assumed to be deontological. It is not as simple as that. A brief presentation of various ethical theories will serve as an introduction for the comprehension of the ethical framework of the precautionary principle.

Deontological Ethics

This theory believes that there are certain ethical principles that are universal and that impose an absolute duty on a person. Kant referred to such duties as 'categorical imperatives' because they allow for no exception. This theory maintains that whether an action is right or wrong is for the most part independent of whether its consequences are good or bad. From the deontological perspective, there are several distinct moral rules or duties (e.g., not to kill, not to lie, respect the right of others, to keep promises), the observation or violation of these is intrinsically right or wrong (Brennan & Lo, 2002). This type of ethical theory is used in fairness and justice; a common law ethic.

Utilitarian Ethics

This theory requires the ethical person to evaluate the likely consequences of contemplated conduct and weigh the good the act may produce against the harm it may cause. This refers to 'the greatest good for the greatest number.' This is the claim that an act is morally right if and only if that act maximizes the good, that is, if and only if the total amount of good for all, minus the total amount of bad for all, is greater. Classic utilitarianism denies that the moral rightness depends directly on

anything other than consequences (Sinnot-Armstrong, 2006). A common utilitarian ethical view is cost-benefit and cost-risk analysis; the end justifies the means; a common business ethic.

Virtue Ethics

This is an Aristotelian approach, recommending the virtuous way of life by its relation to happiness. He ties happiness to excellent activity of the soul, which is tied to moral virtues and the virtue of practical wisdom. This is excellence in thinking and deciding about how to behave (Parry, 2004).

Contractarianism (Social Contract Theory – SCT)

Social Contract Theory begins with the observation that the existence of an enforced moral code is to our mutual benefit. The purpose of a SCT is to facilitate social living. SCT does not assume that there is one correct conception of the good, unlike utilitarianism. People can agree to a social contract theory because it is rational to do so given that the contract will help them pursue the good as they see it. A SCT is not an explicit contract, but implicit because someone chooses to enter in this contract when they want to participate in society and enjoy its benefits. This theory assumes people to be self-interested in order to justify rules of morality or justice. Persons are presumed to want the benefits of social interactions if they can be had without sacrifice of individual self-interest. Justice, and so a social contract, is only possible where there is some possibility of benefit to each individual from cooperation. Social contract theories take individuals to be the best judges of their interests and the means to satisfy their desires. For this reason, there is a close connection between liberalism and contractarianism. A social contract theory is basically a moral contract and lies within the moral theory of contractarianism (Cudd, 2003).

Utilitarian, deontological and contractarianism are examples of normative ethics. They are based on an understanding of what is considered right or wrong, and are therefore prescriptive. The above definitions help to clarify some basic ideas so that it becomes increasingly clear on how to proceed with an ethic of sustainable development for design practice.

An entirely utilitarian approach is not adequate in an ethic of design since the process of getting to the good solution is as important as the solution. The greatest difficulty of utilitarian ethics is to choose the approach by which to optimize the common good. The utilitarian ideal is a persuasive one and has been very influential in individual morality and public policy in the U.S. in the twentieth century. It is an essential perspective in engineering ethics, where technological decisions are often made in terms of cost/benefit or risk/benefit analysis. These types of analysis are simply applications of utilitarianism. However, there are two major drawbacks to the utilitarian perspective on morality. The first requires extensive knowledge of facts, and sometimes this knowledge is not available. The second is that it may lead to injustice for certain individuals. A mining operation that is unsafe and leads to black lung disease for some of the miners may produce more utility than harm, from an overall standpoint, but it may be unjust to the miners themselves. Table 8 summarizes the various ethical theories.

The most important difference between deontological and utilitarian ethics is that in deontological ethics, basic rights to individuals may not be sacrificed for the greater overall utility. One individual's rights may be overridden to protect another individual's (or group's) rights that are considered to be more basic, but not merely to provide greater utility for the other individual. The difficulty with a deontological approach is that it may be difficult to apply in a way that leads to a clear conclusion. Therefore, this as well may not be sufficient, since the outcomes of a good process may cover a wide spectrum, of which some outcomes may be less than what is considered good. So it seems an impossible dilemma as to which ethical theory to abide by in the realization of an ethic of design; a utilitarian approach disregards the means used to arrive at the end; a deontological approach is primarily concerned with the means often at the expense of a clear achievable goal.

Table 8: Ethical Theories: Various ways to help define a good action (based on Brennan & Lo, 2002; Cudd, 2003; Feiser, 2006; Jonas, 1985; Ladriere, 1997; Parry, 2004; Russ, 1995; Sinnot-Armstrong, 2006).

	Deontological	**Utilitarian**	**Virtue**	**Contractarianism**
How to define what is good and just?	Set of universal laws imposed on individuals.	Action must result in the greatest good (benefit the majority of individuals).	Individual will use the particular situation to decide what is good.	Enforced moral code used to make a good decision. If individual wants to benefit from society then must enter social contract.
Limits to theory	Consequences of actions are often unknown; therefore the action may result in a consequence that is not good.	Consequences of actions are often unknown; therefore it is not known if the decision will result in the greatest good.	Every moral dilemma must be re-evaluated for every situation; and consequences of decisions are often unknown.	When decisions are made outside the moral code, then decision is considered bad by society, even if it may not be.
Benefits of theory	The action or decision taken will be universally good; since consequences are often uncertain, the action is the only certainty of being good.	When the consequences are near certain, then this decision will benefit a greater number of people.	Allows individuals to grow through the personal experience of resolving moral dilemmas.	Facilitates social living when making decisions within moral code.
Basic assumptions of theory	Reciprocity; individuals are humane; individuals have a sense of duty to others and self	Greatest good	Individual growth; individuals seek excellence, are prudent, and have practical knowledge	Individuals are self-interested; similar to liberalism

Since normative thinking refers to duty and obligation based on acceptable norms, it may be too limiting in situations of uncertainty and controversy because it is unbiased and therefore discourages resolutions and deliberation; would be too prescriptive and therefore not flexible enough to allow the plurality of knowledge to emerge. Therefore for an operational precautionary approach, it is best to detach from such an entirely normative approach. In contrast, descriptive ethics seeks to, above all, widen the vision, change the point of view, and go beyond the inherent limits of current thinking (Des Jardins, 1995). However, an entirely descriptive

approach to ethics may also not be appropriate, since it may be too flexible therefore will be very difficult to arrive at a concrete decision.

It may be suitable to use a set of flexible and adaptable norms as a point of departure for deliberation, yet use a normative process of deliberation. A deliberative process to decision making is pertinent in this approach because it requires a conceptual openness, and therefore the bias of the various stakeholders is actually encouraged. In this approach, a normative process that is based on a set of norms that are adaptive and flexible, would be beneficial, since it allows for a common ground without the imposition that a common set of beliefs must be adhered to.

Technological/Social Crisis and the Precautionary Principle

Technological progress is occurring at a rate in which humans have come into a position where they are no longer capable of controlling the consequences of their actions. As progress in technological innovations increases, it seems that human capacity to understand the consequences of these innovations decreases (Ellul, 1954, 1987; Arendt, 1958; Jonas, 1985). How can humans make justified and fair decisions on design and innovation when the current paradigm used to assist them in such decisions has become inadequate? Traditional scientific methods cannot deal with situations of uncertainty, since the information that is necessary to make informed decisions is not available. This paradox is a difficult situation to resolve. Decisions made in the process of design can no longer simply be a result based on the economic benefit that they provide. Because of the uncertainty that exists with new technology, decisions need to embrace a larger scope of considerations. Considerations of social, cultural, environmental, and political dimensions are necessary in the current global situation. Globalization implies that the decisions that are made will more than likely have a global impact and therefore must be considered using a global and complex approach.

In the following sections, a brief description of the various perspectives from authors is provided on concepts such as uncertainty, defining actions in a contemporary context, and contemporary ethics. This will provide a basis for establishing ideas and therefore seeking to identify an ethical framework for the precautionary principle.

Various Perspectives of the Technological/Social Crisis

In this section, the perspectives of the technological/social crisis from selected authors will be presented. This will provide an understanding of how such authors have proposed to deal with this as well as an understanding of how the precautionary principle, which is a fundamental principle with respect to this crisis, can be used to contribute to its resolution. As a way to emphasize the key concepts emerging from this section, the author of this paper has underlined what can be considered as essential dimensions for this principle.

Hans Jonas

According to Jonas (1985), the precautionary principle opens up the question of ethics. What Jonas asserts is the sense of *responsibility* that humans must develop with respect to technological progress. In many technological innovations, the complexity of the societal and biospheric effects is immense and defies all calculation (Jonas, 1985); in other words, the effects of technological innovation surpass the capabilities to react to their effects. He argues that this condition is new to our contemporary industrial society and therefore presents a need for ethical innovation on many levels. The ethics that is needed in this technological age is an *ethics of the future*; the future must become the major object of our concern and this concern must start from a philosophical perspective. Jonas claims that the greatest moral duty in the technological age is that humankind cannot put its survival at risk for the sole purpose of the continued growth of technological progress. According to Jonas, this power that humans and their artifacts have over nature and the planet should result in fear. This fear lies in a sense of responsibility; a *sense of duty* by humans to provide a *viable world to future generations*. Fear is a heuristic tool used in the perception of risk and danger. Fear does not provoke terror, but an anticipatory reaction. Fear is transformed into an engagement of action.

Humans have the capacity to destroy the existence of life, and are conscious of this capacity (Jonas, 1985; Ewald, 1996). This consciousness is embedded in distress because such situations are unprecedented. To add to this distress, man is faced

with the need to find moral rules to limit his powers – an ethic of responsibility (Jonas, 1985; Ewald, 1996). Jonas (1985) proposes an important rupture with respect to the sense of responsibility: traditionally responsibility was linked to past actions, but now *responsibility carries with it the future.*

Jonas' view of ethics for the future is predominantly a utilitarian ethics because the main goal is the survival of humanity. However, Jonas can also be considered to have adopted a deontological ethics because it deals with responsibility and therefore a sense of duty. This implies that humans are responsible for their actions. Therefore the new theme to consider in the ethics of such decisions of uncertainty rests on the duty of responsibility. Ethics can no longer be limited on the actions of the immediate reach and close proximity of time and space (as been historically done), but has expanded to match the scope of human influence in both time and space. The *irreversibility of actions* based on technological innovations is a question raised for consideration, and therefore places responsibility at the center of the ethics concern.

Edgar Morin

Ethics is faced with the difficulty that not all good intentions result in good actions, and that not all good actions are a result of good intentions. This is what Morin refers to as the principle of uncertainty in the relation of intention/action. There is therefore a *complementary* and *antagonistic* relationship when you consider an intention and the result of a moral action. This pair is complementary since a moral intention does not have a meaning except in the resulting act. This pair is antagonistic from the perspective of the eventual immoral consequences from a moral act; or the eventual moral consequences from an immoral act (Morin, 2004).

To understand the problem of the effects of human action, which include moral action, an understanding of 'the ecology of action' is necessary. It means that all action risks not only failure, but also a diversion of its original intent (Arendt, 1958; Morin, 2004). Therefore it is not absolutely certain that the purity of means will result in a desirable outcome; or that the impurity of means will result in an undesirable outcome.

The first principle of the ecology of action is that the effects of action depend not only on the intentions of the actor, but also on the conditions in which the actions take place. Also, in the context of the act, the ecology of action introduces uncertainty and contradiction.

The second principle of the ecology of action is that of the *unpredictability* of long-term effects. Short term effects of an action can be envisioned or calculated in many cases, but long-term effects are unpredictable. Therefore *uncertainty becomes an essential characteristic of human action*. He therefore claims that there are two main ethical problems (Morin, 2004):

- Ethical contradiction – examples of these are abortion, euthanasia, any problems that are dealt within an ethical committee. Morin claims that ethical contradiction cannot be eliminated; it is part of most ethical decisions.
- Ethical uncertainties – in this case, even if the intent is to act for the collective good, the consequences of action are often uncertain and may not always manifest in the collective good. As Morin claims, 'our actions do not obey our intentions'.

An ethical problem is not one in which an individual must follow a rule to fulfill a simple or obvious duty. An ethical problem exists when antagonistic duties are imposed. Therefore a non-complex morality cannot be used in such cases. A non-complex morality is one in which a binary code is used; good/bad, just/unjust. A complex ethic is instead necessary in resolving ethical problems. A complex ethic is one in which the good can contain bad, the bad can contain the good, the just can contain the unjust, and that the unjust can also contain the just (Morin, 2004). Therefore since *duty is in itself complex*, there is not only uncertainty and contradiction in ethics, but also an intrinsic complexity in ethics. Therefore, in each human act, the ethic is subjected to uncertainty, opacity, and confrontation (Morin, 2004).

According to Morin, all decisions correspond to a risk, and therefore strategies must be put in place to be able to modify one's action. This can be referred to as the

reversibility of action. An important point is that it is important to articulate between the ends and the means (consequences and duties), and to situate oneself in a framework of complex thinking. This is linked to the idea of the ethics of comprehension. A comprehension requires sympathy as a minimum human characteristic. However, a major problem in our society is the *valorization of self*, an *under-estimation of others*, and therefore a natural tendency to deceive oneself. This results in the *inability to comprehend* or sympathize with one another.

In essence then, a good intention is a good thing; however, it is not sufficient in producing desired results, and often undesirable outcomes result from many good intentions. Therefore a necessity to think in a complex way, to understand the conditions of the action, the action itself, to contextualize before and during the action are all necessary conditions for an increased probability of a positive outcome of an action. Complex thinking can drive an ethic of *interdependence* and *non-coercion*. This implies a principle of action that organizes, not orders; *communicates*, not manipulates; and animates, not directs. Complex thinking nourishes ethics by orienting itself on the interdependence and comprehension of humans (Morin, 2004).

Hannah Arendt

In her 1958 publication, Arendt had realized the weakness of human action, and the *paradox that exists*; as *humans become more powerful* through an increase in technological progress, the ability for humans to be able to *control the consequences* based on the technological advances *decreases*. The following is a quote pertinent within the context of the precautionary principle (Arendt, 1958):

> "*..the attempt to eliminate action because of its uncertainty and to save human affairs from their frailty by dealing with them as though they were or could become the planned products of human making has first of all resulted in channeling the human capacity for action, for beginning new and spontaneous processes which without men never would come into existence, into an attitude toward nature which up to the latest stage of the modern age had been one of exploring natural laws and fabricating objects out of natural material. To what extent we have begun to act into nature, in the literal sense*

> *of the word, is perhaps best illustrated by a recent casual remark of a scientist who quite seriously suggested that 'basic research is when I am doing what I don't know what I am doing.'* " (pp 230-231).

J.-P. Dupuy and A. Grinbaum

These authors suggest that traditional ethical theories are inadequate in dealing with the problems that we face and continue to face as a result of the introduction of new technology, and therefore alternative modes of responsible decision making become a necessity in the current developmental crisis. They propose an *ongoing normative assessment methodology*, which uses existing norms for judging facts. Updating norms or creating new norms will be done by evaluating new facts. They propose that the assessment process is normative and that the norms themselves are continually adapted. As Dupuy and Grinbaum (2005) state,

> "*Virtue ethics is manifestly insufficient since the problems ahead have very little to do with the fact that scientists or engineers are beyond moral reproach or not. Deontological doctrines do not fare much better since they evaluate the rightness of an action in terms of its conformity to a norm or a rule, for example to the Kantian categorical imperative: we are now well acquainted with the possibility that 'good' (e.g. democratic) procedures lead one into an abyss. As for consequentialism—i.e. the set of doctrines that evaluate an action based on its consequences for all agents concerned—it treats uncertainty as does the theory of expected utility, namely by ascribing probabilities to uncertain outcomes. Hans Jonas argues that doing so has become morally irresponsible.*" (p. 6).

Barbara Adam

The combination of science and economics has been a powerful combination in controlling situations by justifying decisions based on the certainty of facts. However, at some point the certainty of facts could no longer be assured because of the consequences of unintended negative effects. There is a large gap between the *production of long-term effects* and the *inability to understand the outcomes* of these

actions. Many major scientific successes are linked to unforeseen problems which societies seem unequipped to deal with. This is what Adam (2004) refers to as the success-problem axis. This success-problem axis is a source of intense debate concerning the future of humanity.

There are two sides to this debate concerning the future of humanity. There are the proponents of progress through scientific and economic advancement. There are also the opponents who are concerned with the uncertainties and risks that are both actual and potential as a result of the scientific and economic progress. The proponents' utopian enthusiasm counteracts with the opponents' prophecies of doom and gloom. Even though both of these groups seem irreconcilable, they are both rooted in a history of ethics (Adam, 2004).

In the moral code of Greek Antiquity, humans did not have the power to change nature in a significant way, and therefore nature was beyond their ethical concern. However, this no longer applies. New ethical challenges face humanity because of the changed socio-technical conditions of contemporary industrial societies (Adam, 2004). These new ethical challenges are a result of the gap between the power to act and the capacity to know. Jonas (1985) argues that this condition is new to contemporary industrial society and therefore presents a need for ethical innovation on many levels.

The dominant conceptual tools of the industrial way of life arise from the combination of science, economics, and liberal democracy. These three tools have now become a way of life that is taken for granted (Adam, 2004). The assumptions from these conceptual tools need to be resurfaced and renewed together with moral traditions identified by Jonas (1985, from Adam, 2004) as preconditions to an ethics of responsibility.

The first part of this combination is the scientific sphere. There seems to be a structural irresponsibility at the very core of science. The scientific future perceived from the science community lies in technological innovations, however, without the capacity to know the consequences of this innovation. There is an inverse

proportion between the capacities to know the consequences to the complexity of the scientific innovation (Adam, 2004).

The second part is the economics sphere. An economic future is equated with money; risks become part of the balance sheet. Future is considered an economic resource and traded like any other resource; the future is commodified. Neither, classical science (based on measurable and quantifiable observations), nor the idea of borrowing from the future for the benefit of the present, is conducive to defining an action that is based on an ethic of responsibility. In fact, using these two approaches will neither provide the knowledge of an action's potential impacts, since it is not possible to predict that far into the future using such approaches. Neither discipline has an approach of a responsibility for the future (Adam, 2004).

The third element of the combination is the liberal democratic sphere. Policies made within any time period are not only experienced during that time period, but are open-ended and are experienced by future generations who did not contribute to the decision process of that democratic sphere. This is similar to the economic process, where the future is being borrowed for the benefits of the present. Therefore there is an inappropriate knowledge base for approaching futures in a more responsible manner (Adam, 2004).

Based on the above perspectives on contemporary scientific-economic conditions and their effect on the way in which humans define their actions, nature is therefore no longer just a backdrop to human activity; it has now gained ethical significance, and therefore is no longer ethically neutral. Anthropocentric values alone are no longer valid. In this traditional idea of ethics, science and economics continue to practice for the benefit of the present, without considering the effects that their decisions may have for future generations. A radical change in the moral perspective is necessary to bridge the gap between techno-power, uncertainty to known consequences, and responsibility for actions taken (Adam, 2004).

A *temporal dimension* must be added to the moral equation that has been absent from traditional ethical concerns. This temporality of moral behavior falls *outside the traditional scope of reciprocity*. Reciprocity refers to 'The Golden Rule' in ethics. This

is a basic way of judging behavior affecting others by putting oneself in the position of those affected. However it is much too simple a rule to apply in complex situations where there are many conflicting areas of interest. In the current ethics of responsibility, inaction and preservation of the status quo are the outcomes of uncertainty (Adam, 2004).

One of the main barriers to understanding uncertainty is the limitation from traditional scientific practice. Traditional science use *causal modes of thinking*. Causal modes of thinking (looking at the past to understand the present, and make predictions about the future) are a central pillar in contemporary western understanding of how the world works. The impact of materialism (refers to all things real in the perspective of science – objects, matter…) can be a moral imperative of responsibility to and for the future (Adam, 2004). Therefore from a materialistic perspective, the *future cannot be felt* and is therefore *perceived as unreal*. The traditional definition of the material real and its ability to be quantified is no longer appropriate. The idea of a material real is now transformed (computer viruses, financial markets…) while the conceptual tools necessary for understanding them are trapped in a previous period. This inconsistency between the conceptual tools and contemporary materiality has had as a result, that society now wants to have or find proof of things that cannot be seen, or even felt (Adam, 2004). To take account of the future is to embrace the unknown and therefore uncertainty; where this uncertainty is not quantifiable. Yet, this tradition of quantification is taken for granted. In the contemporary situation where the scientific-economic effects are distant from current/local time/space, quantification and causal analysis lose their relevance. Instead, quantification and causal analysis only demonstrate the uncertainty of the future for societies that continue the industrial way of life.

Poul Harremoës

Causal analysis is a primary mode of assessment of risk for environmental engineers. Many scientists and engineers do not appreciate the context in which they work. Precautionary principle is one source of *confusion* – there is a fundamental difference between *deontological principles* and *consequentialism* (utilitarian) principles; the traditional scientist/engineer is *not aware* of these principles. Also

there is a current development *away from anthropocentric* values *towards eco-centric value*; moving away from the idea that humans are all important and moving towards the idea that all of nature, animals and humans are equally important. An understanding of the most fundamental aspects of philosophy, ethics in particular, is essential (Harremoës, 2003).

A key question within the context of sustainable development is the basic ethical considerations of uncertainty associated with the identification of the potential harmful effects. What was acceptable 40 years ago is probably not acceptable today. The public is less willing to accept risks, and risks may actually be rising (Harremoës, 2003). There has been an *evolution in the ethics behind the type of solutions* that are perceived as acceptable for environmental problems during the last 40 years:

- dispersion (spreading in air, water and soil)
- containment (landfills, deposits in salt mines)
- conversion (water treatment, purification of flue gas, end-of-pipe solutions)
- reuse, recycle
- no-use (cleaner production, cleaner products, control of demand and control of driving forces)

  (Harremoës, 2003)

In the '60s, dispersion and containment were ethically viable solutions. In the '70s these became unethical. Conversion was an ethical solution in the '70s, but in the '80s, this was no longer ethical. Currently, reuse, recycle, and no-use are ethically viable solutions to the environmental problems. During the evolution of the ethics of these solutions, a realization was that a substance cannot be used in society without leaving traces in the environment. This realization has rendered dispersion, containment, and conversion as unethical solutions. There is a need for integrated environmental assessment (incorporating all options/values in the analysis of the assessment) (Harremoës, 2003). In most cases, there is no certitude in environmental harmfulness; there will always be some degree of uncertainty. This is because of the uncertainties as a result of practical experiments, and in the *inherent uncertainties in cause-effect relationships*. The reality that most scientists see as a

result of their cause-effect analysis is usually an ideal truth and not reality (Harremoës, 2003).

Kerry H. Whiteside

According to Whiteside (2006, pp. 30-37), an ethical justification for the precautionary principle arises from the following reasoning:

- Traditionally environmental problems have had a temporal immediacy; in contrast to current environmental problems which *have an undefined (often long-term) temporality*.
- The uncertainties that exist in scientific observation, and the often *long-term invisible effects* from technological innovations, result in the need for a new relationship between popular participation, scientific advice and political decision making.
- There are problems that require global consideration and cooperation, therefore a need to *serve the interests of citizens* at the international level.
- The global (social and environmental) degradation that is occurring is often a result of multiple factors, and it is *not clear who is responsible.* So such concerns necessitate a new ethical approach that considers this complex condition of responsibility.
- Traditionally, the idea that nature was an immutable force external to humans was common. However, the idea that nature is a constant and that humans cannot fundamentally change it has been challenged in the past century. In fact, scientists have also had to admit that there exist uncertainties in their discoveries, and that *nature cannot only be looked at in an objective way*.

In summing up the above ethical perspectives with regard to fundamental uncertain outcomes of technological progress, the reciprocity rule of ethics seems insufficient in the perspective of sustainable development. An *ethic of the future* requires an attitude that goes *beyond that of reciprocity;* it requires generosity, an ethic of donation, an ethic that is *concerned about others.* Without this, the future is not assured; however, this in itself does not ensure a future. Therefore every generation

needs to find more *involvement* towards this ethic that concerns the survival of others, and requires a confidence in humanity and in the future (Droz & Lavigne, 2006). In the context of sustainable development then, social resources must be developed (interpersonal and social relations and shared values), and human resources must also be developed (education and health). Inter generational interdependence requires that such interests and resources are passed onto future generations, as much as environmental resources (natural resources and landscapes) (Droz & Lavigne, 2006).

Therefore, there exists a need for a new ethical framework because of the *current problems that face humanity* as a *result of scientific-economic* effects. One of the common concerns among the above authors is that forging ahead blindly with technological innovation presents humanity with controversial situations that can no longer be addressed using *traditional methods* of decision making. These methods not only *limit the scope of the problem* to a level where the breadth of the problem is not available, but these methods in themselves cannot be used in isolation because they lack the flexibility necessary for situations that are controversial, antagonistic, and are burdened with a lack of knowledge. Current environmental and social problems require an *enlarged perspective* if they are to be addressed in a way that can offer solutions that will have a short, medium and long and *very long-term* positive impact. The lack of knowledge based on the outcomes of decisions is a serious consideration, and this is where the precautionary principle is pertinent in a decision making process. This lack of knowledge has caused a *shift in the way in which decisions* are taken. The question is: How are decisions then taken if they can no longer rely solely on traditional scientific-economic quantifiable methods?

In an attempt to converge to an ethical framework for the precautionary principle, a clearer understanding of precaution and how it relates to prevention is essential. In fact, the idea of precaution is *based on an attitude of prudence.* Prudence refers to how humans deal with situations when they are faced with an uncertainty of harm. Decisions based on this attitude can be manifested on an individual or collective level, through an expert or non-expert forum, using a rational or a more global approach.

Analysis of Prudent Attitudes for dealing with Uncertainty

To help clarify the differences in the approaches towards decision making in situations of uncertainty of harm, it is important to understand the various attitudes towards situations of uncertainty. Overlaps exist between precaution and prevention. The preventive element is present in precaution. According to Ewald (1996), the attitude of prudence defines the actions of humans when confronted with uncertainty. Historically there have been three concepts based in uncertainty: *foresight*[65], *prevention*, and *precaution*.

Foresight is a liability plan that is based in fault (Ewald, 1996). It was based in an ethics of virtue; linked to chance or fate. Foresight encouraged the integration of the future with the present on an individual level. It was not aware of future risks; action was initiated by seeking to avoid random future events. Foresight can be considered as proactive because it sought to control situations by acting in advance rather than waiting to respond to a situation after it happens.

Prevention is a solidarity plan based on known risks (Ewald, 1996). Prevention developed from a certainty of risk through scientific analysis. Prevention speaks the language of science; it is the concern of scientific experts. It is a rational behavior that science could objectify and quantify in the face of a risk. The main reason why prevention is a reactive tool is because it acts only after a situation has occurred. For example in the case of pollution prevention, it only comes into effect after the pollution is manifested; the approach is to clean up pollution in soil, air, and water. Therefore it does not act in advance; remaining reactive. Also, it is a tactical tool and not a strategic tool, because it seeks to solve micro or at best meso level problems. This means that the approach seeks to solve problems primarily within a limited phase of a wider problem. For example, pollution prevention can be used to clean up the toxicity levels at a certain site; this is only a tactic because it really belongs to the wider problem of environmental degradation. Prevention is mainly a problem optimization approach.

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[65] Ewald (1996) uses the French word 'prévoyance' in describing one of the three prudent attitudes related to uncertainty. We have used the word foresight as the translation for the word 'prévoyance', which in this context, is defined as 'providence by virtue of planning prudently for the future' (Fellbaum, 1998).

Precaution is a safety process based in the notion of potential risks. The current global situation has resulted in a profound transformation and reformulation of the problematic of responsibility (Ewald, 1996). Precaution, as it is emerging currently, deals with another type of uncertainty; it is the uncertainty of science itself (Ewald, 1996). Precaution deals with the more global idea of human and environmental safety in contrast to prevention which deals with known risks which are measurable. Therefore, precaution refers to conditions that have not been used in the idea of foresight, nor by prevention (Ewald, 1996). Precaution is not based in an individual ontology as is foresight. The potential dangers that it deals with are collective; not only regional, but international. Precaution does not either participate in the realm of prevention because the threats that are dealt with by precaution cannot be proven or quantified. According to Ewald (1996), societies are threatened with risks that can be of a catastrophic nature; introduced in an act that itself tries to reduce such risks (science based activities). The act of precaution starts when a decision must be made in the context of scientific uncertainty; not in a context of scientific certainty, but in a context of doubt, suspicion, defiance, concern, fear, mistrust. Precaution is therefore caught in a kind of suspension and shift between the requirements of action and the certainty of knowledge (Ewald, 1996). Table 9 illustrates the differences among foresight, precaution and prevention, all based within the attitude of prudence.

Table 9: A comparison of foresight, prevention and precaution with respect to the 4 poles of knowledge (based on Adam, 2004; Ewald, 1996; Jonas, 1985). © Cucuzzella, C., 2007

	Foresight *(prévoyance)*	**Prevention**	**Precaution**
Ontological	Individual concern	Collective (expert) concern	Collective (stakeholders) concern
What is the form of the perceived world?	Based in ethics of virtue, integrates the future with present actions	Based on quantifiable, objective data, (deterministic)	Based in ethics of responsibility of the future and on the uncertainty of science (non-deterministic)
(what)	Based on the randomness of future events that have local and finite consequences	Known risks having harmful consequences vary in time and space	Potential risks may have global and infinite harmful consequences
Epistemological	Consideration for the reversibility of action	Reversibility of action is not a consideration	Consideration for the reversibility of action
What is the relation between the person that is constructing the knowledge and the perceived world?	Cautionary, decision based on an imaginable fate	Objective, rational, measurable decision	Anticipative, subjective decision
(values)		Based on single truth	Based on multiple visions of the truth
	Virtuous attitude (Axiological)	Prescriptive attitude (Deontological)	Heuristic attitude (Axiological)
	Based on randomness of events in the future	Based on a cause-effect chain of events (deterministic)	Based on a complex vision of the world
	Valorization of future needs for individual	Valorization of needs for current generations	Valorization of needs for future generations
Methodological	Adaptive approach	Normative	Adaptive approach, but requires basic statistical norms
What methods are used to obtain the knowledge?	Need based approach	Problem based approach, notion of efficiency	Solution (result) based approach, notion of sufficiency
(operational)	Projection tool	Tactic tool	Strategic tool
	Proactive	Reactive	Proactive
	Future necessity is defined by individual condition	Risk defined by experts collectively	Levels of acceptability defined by stakeholders collectively in a ongoing basis as new facts become available.
	Decision made in situations without potential or known risks	Decisions made in situations of known risks	Decision made in situation of potential risks
Teleological	No real requirement of action; probability of random future events initiates course of action	Requirement of action based on known danger	Requirement of action based on potential danger
What is the intention of the researcher?	Private decision	Expert decision	Public decision
(purpose)	Liability plan (providing a better future for individual)	Solidarity plan (reduce or avoid consequences of known risks)	Safety process (reduce or avoid potential harm from uncertain situations)
	Individual plan for an inevitable imagined fate	Collective is involved in the implementation of preventive measures	Collective is involved in the definition of the levels of acceptability to be used as markers to help reveal potential problems

In this section, a deconstruction of three basic attitudes of prudence was conducted which exposed their limits and benefits, demonstrating the gaps that exist among the three attitudes. This deconstruction was necessary because it allowed a comprehension of the implications of each of the approaches for resolving current technological-social problems. This table also exposes the emergence of criteria necessary when establishing and assessing solutions based on a prudent attitude. These criteria go beyond a socio-economic perspective since they are based on values and visions based in prudence. These criteria can be used as a point of departure for a decision process that is based in uncertainty.

The main reason for adopting a stakeholder process in cases of precaution is because experts disagree on the available data; which is contradictory or divergent. Therefore in order to arrive at a just and fair decision that considers the common good, the scope of the stakeholders can no longer be limited to experts alone. Stakeholders now will include experts and non-experts. A question that arises is: How will this stakeholder approach benefit the situation?

2.2.2. A Stakeholder Approach

To help clarify the various concepts used in this section, a brief explanation of key terms will be introduced. A participative process is a process where individuals' values and concerns are expressed. It is meant to respect individuals' or groups' right to an opinion, while at the same time claiming to be ethical and responsible (Maclagan, 1999). A consensus is a process where agreements are achieved by a group as a whole (WorldNet, 2006). A consensus implies that debate has taken place and could result in an agreement where no accord has been reached. Unanimous consensus is seldom reached. A *discursive process* is a process that allows reaching a conclusion by reason or argument rather than intuition (WordNet, 2006). Arbitration has been defined as "*the hearing and determination of a dispute by an impartial referee agreed to by both parties (often used to settle disputes between labor and management)*" (WordNet, 2006).

In a context of sustainable development, an ethical framework refers to the comprehension and articulation of the values necessary for a strategy of development. This process seeks awareness of the multiple values and practices, and in doing so, the participants become knowledgeable about their position and choice of action. The ethical process is therefore a form of active learning, attentive observation; discourses that justify choice, choice of options, values, norms, and the practices that will result (Droz & Lavigne, 2006).

A sense of responsibility towards others (current and future) is at the core of this framework. Even with this basic value, it is not evident what the best course of action is, since what may seem a responsible action to someone, may be considered irresponsible to someone else. A collective discourse process that seeks consensus on sustainability issues is one ethical approach. In such a collective forum, the various stakeholders reveal their ethos and seek to comprehend the ethos of other stakeholders within the discourse. It is this sense of comprehension that may allow a decision to be made that will ultimately be based on a common good.

A participative process is therefore recommended to allow a decision process that will include the ethics of all the stakeholders involved. Although an expert ethic could in essence make a decision in a precautionary situation, he/she will only provide one perspective of the global vision necessary to make a fair and just decision. Every stakeholder in a situation of uncertainty has an ethical foundation that contributes to the complexity of the situation. Without this collective approach, the plurality of the situation may be compromised. The following sections will seek to justify a stakeholder approach for cases where a precautionary approach is called for.

Defining the Stakeholders in a Perspective of Sustainability

The interests of all stakeholders are of concern to an organization. A common definition of stakeholders by Freeman (1984, p. 46) is "*(…) any group or individual who can affect or is affected by the organization's objectives.*" Two assessments of stakeholders are important in a stakeholder approach, namely: (1) how to identify the key stakeholders and determine their relative power; (2) how to map the

stakeholder's relative power to other groups. Figure 6 is a typical model of stakeholder groups for an organization.

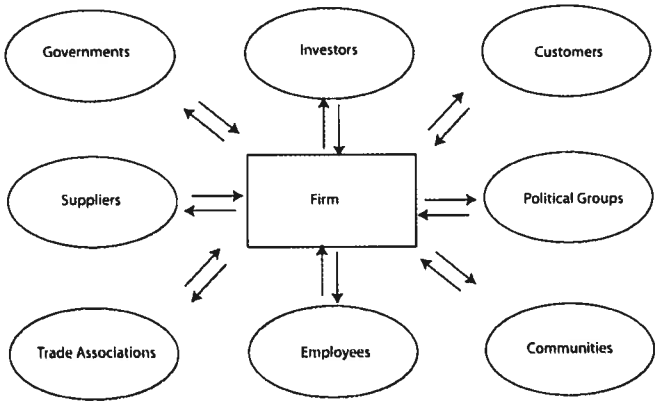


Figure 6: The stakeholder model (based on Donaldson & Preston, 1995).

In a sustainable context, some typical examples of stakeholders groups are: associations, customers, employees, suppliers, investors, future generations, social actors or institutions, and groups that operate at all levels (domestic, local, regional, national, international, private, and public). There are many actors each with a specific and significant interest for a set of given resources and their management. The stakeholder approach allows organizations at all levels to contribute to the process by dictating good practices and norms.

Groups at the domestic and local level are often the citizens or enterprises within a community that seek the good of the citizens within the community. Even if these groups act on a local level, they have a global perspective because of their involvement. Stakeholder groups at the regional or national levels seek to endorse the societal common-good. International organizations have a perspective from the community of nations and attempt to achieve a planetary global good (Droz & Lavigne, 2006). The function of each of these stakeholder groups in a sustainable development context becomes one of openness for a common cause – a survival of the earth through a perspective of improving the quality of life for all generations, present and future. Sustainable development can then be realized through constructive relations among economical, ecological, social, political and cultural systems. The idea is not to preserve or save such systems, but to valorize, in a precautionary way, and adapt to existing conditions (Droz & Lavigne, 2006).

Defining a Stakeholder Approach in a Perspective of Sustainability

Stakeholder theory has been useful in a range of situations to assist in strategy development and implementation. One of the main purposes of stakeholder theory is to help organizations improve the outcomes of their actions, and minimize harm to stakeholders. A stakeholder approach can be described by the various theories and concepts from stakeholder theory. According to Donaldson and Preston (1995) four central ideas are related to stakeholder theory.

- it is descriptive – offers a model of the corporation;
- it is instrumental – offers a framework for investigating the links between conventional firm performance and the practice of stakeholder management;
- even if stakeholder theory is descriptive and instrumental, it is in fact, essentially normative. This requires an acceptance of two values:
    - stakeholders are identified by their interests and;
    - all stakeholder interests are considered to be intrinsically valuable.
- it is managerial in a broad sense of the term; it recommends attitudes, structures, and practices and requires that simultaneous consideration be given to the interests of all rightful stakeholders.

A collective approach that seeks consensus needs to be adopted in the attempt to arrive at a decision that considers an inter/intra-generational common-good. There is a need to address conflict resolution with respect to the various stakeholders involved in the decision making process. Conflict is often at the core of discourses that involve various stakeholders because of the diverging opinions among them. The following are some principles of conflict management for a better sense of collaboration (Droz & Lavigne, 2006, p.75):

- Conflict is not a negative thing but is part of all society where different visions co-exist. This implies a possible confrontation of perspectives, interests, and needs.
- To arrive at applicable and sustainable decisions, the decision making

process must be participative and keep into account all the affected parties (stakeholders).

- The applicability of decisions is that the stakeholders arrive at voluntary decisions through a process of negotiation.

There exist various methods for a stakeholder approach in order to reach consensus. The ways in which decisions are reached may differ significantly based on which approach is adopted. In essence, the two poles in a stakeholder approach are (Droz & Lavigne, 2006):

1. *General*: which includes all the stakeholders; this implies a decision from all the participants of change. It is clear that not all situations can use such an approach where everyone has a say in the final decision.

2. *Limited*: It is based in the exchange of information and considers the relationships of power among the actors. But this approach avoids the actors that may be too far from the problem or where the interests are simply incompatible. This strategy may give too much decision ability to the most powerful groups. There is an exchange of information, but the ability to contribute to the final decision rests on one or a few stakeholders.

These two poles, being on the opposite ends of a continuum of approaches, define the two extremes of a stakeholder process; in essence, it can fall anywhere within the two extremes. The stakeholder approach is an invitation to examine the relationships of power among groups and individuals and their respective interests with respect to a resource or situation (Chevalier, 2001, from Droz & Lavigne, 2006). This approach promotes the systematic implication of the actors and an orderly way to resolve problems. It is a participative approach that is oriented towards both the actors and the structure of power that form the foundation for situations of change.

A disclosure of different perspectives of humanity is needed for the pursuit of sustainability, in particular, within a precautionary attitude. Responsible decision making requires consideration of the effects on all stakeholders. A large part of the diffusion of this approach is the realization that technical methods alone are not

adequate in searching for solutions. This approach is flexible since it adapts to specific contexts.

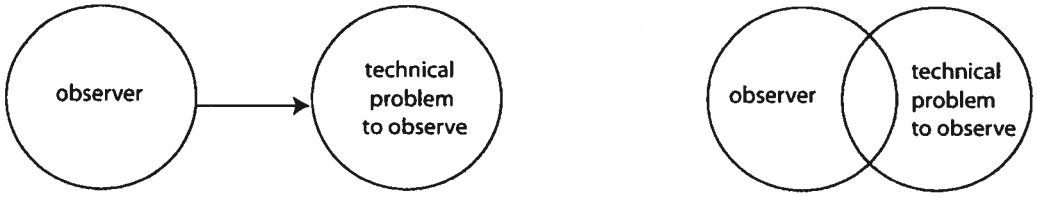
Justification of a Stakeholder Approach for the Precautionary Principle

Problems that have fundamental technological uncertainties (as distinct from risks with known probabilities) can often be considered social problems that are intrinsically related with technological problems, because they affect society or the relationship between society and the uncertain consequences of the technology. Such problems are distinct from technical problems on their own since the latter can adopt a deterministic approach to finding a solution. This is because technical problems have defined variables with *known* uncertainties and therefore the problems are linearly solvable. However, when dealing with problems that require a precautionary approach, this is not the case; such problems become inherently social problems based of the fact that society can be affected in catastrophic ways as a result of the technological outcomes. When this is the case, the problem becomes complex since a solution to this dilemma must involve society, and their diverse points of view.

In fact, according to Dupuy and Grinbaum (2005) uncertainties as a result of technological innovations do not respond well to deterministic approaches, not only because of a temporary lack of knowledge, but mostly because of the type of situations that these problems become. They become primarily social problems and therefore complex. The inherent complexity within societies is a direct result of its diversity; each stakeholder of the situation has their own set of concerns and commitments. In addition, there are very often too many unknowns in a social problem to adopt a linear approach for solving the problem. These types of problems that are contradictory and incomplete often occur in a social context because of the fact that there exists diversity among society and therefore involve complex judgements in searching for solutions.

Figure 7 illustrates the difference of the approaches to these two types of problems. In the technical problem, the approach is that the observer lies outside the problem, and therefore the problem can be solved in a deterministic, objective way. In this

case, the observer does not become part of the solution, since the solution is obtainable on its own by observing the problem in a deterministic manner. However, this is in contrast to the technological problem with a social context. In this case, the observer (or society) is related to the technical problem and therefore the problem will involve society. In this case, the problem can no longer be solved in a deterministic manner since problems in a social context are complex.



Technical problem that could be solved in a linear manner. The observer lies outside the scope of the problem.

Technical problem that could only be solved through a participation of the observer (in this case society). The observer is intrinsically related to the problem.

Figure 7: Comparison of approaches to dealing with technical problems and techno-social problems.

In addition, social problems cannot be *simplified* so that linear approaches are adopted for problem solving. The main reason being that in the process of manipulation of real world complex conditions into simplifications (in order to satisfy deterministic models for calculations), the problem is no longer complex. It has become a complicated problem that can be solved using a linear approach. In this case then, the solution obtained is not a solution to the original social problem, but a solution to a problem that can be resolved using a linear approach; this is not to say that the simplified problem is simple, it may still be hyper-complicated, yet completely predictable and solvable (De Coninck, 1993). However, it remains that the solution obtained from this simplified problem statement will not be a solution to the original social problem, but to the simplified problem. A precautionary approach, which is inherently a social problem, does not seek to simplify the situation in order to satisfy a decision algorithm, but instead encourages an emergence of the social complexity of the situation.

In cases of technological uncertainty, another major problem is that threshold of damage is not known, and in addition, the outcomes as a result from reaching this

threshold are not known. This is because the outcomes of such situations, when they pass their thresholds will change the states of the situation in a completely unpredictable manner, becoming a social problem (Dupuy & Grinbaum, 2005). Solving social problems requires alternate methods of decision making; a shared comprehension of the problem is necessary because of the inherent diversity within society. In fact the problem cannot be solved unless there is also a shared commitment in searching for a solution. This implies that to solve such problems some type of participation method will be necessary.

A stakeholder approach is therefore particularly attentive to 'neighbors' and to the effects they experience from decisions they may have not been part of. This requires that the stakeholders are willing to participate and have obtained a basic knowledge to contribute to the debate. This process encourages a sense of inter-dependence among the stakeholders in an effort to allow a comprehension of the various values systems when seeking consensus. Therefore a sense of empowerment responds to a system of interrelated needs that improve the quality of life of individuals and their communities.

That is why this approach is pertinent for sustainable development, since the stakeholders become part of the solution, except for those stakeholders not yet born. In sustainable development, future generations are also stakeholders, and their needs or aspirations are not yet known. Any generation cannot consider themselves 'owners' of the planet. Therefore this approach operates on a double geographic displacement; spatial and temporal. This approach, more than traditional approaches, respects an ethical process, by inserting others in the reflection. This is a radical rupture since it associates others in a personal future. Therefore a stakeholder approach for precaution is justified; and as a result the development of a system of governance, which represents the fourth pillar of sustainable development, becomes essential.

Benefits of a Stakeholder Approach for the Precautionary Principle

Tradeoffs often exist among choices; between short, medium, and long-term solutions, and in finding a compromise between conflicting objectives like

conservation, preservation, development, equity and peace. There is a pluralist, and constructivist tendency in this approach, which places an emphasis on the processes of social development much more effectively than the previous positivist approach to sustainability.

According to Sclove (1995), there are several reasons for a greater public participation in research, development and design (RD&D):

- a larger number and more diverse range of participants increase the chance that someone will come up with a creative insight;
- a more diverse range of social needs and concerns are reflected in the design process;
- can provide enhanced opportunities for rich cross-fertilization of ideas;
- a broadened participation will allow an improved response from markets to the needs of everyone; not only the wealthy, but also the economically deprived.

According to Tickner and Geiser (2004), the benefits for public participation in assessing alternative solutions are:

- those who may be adversely affected can provide potentially better solutions;
- will draw on a wide set of 'experts' and sources of experience;
- public becomes aware that environmental impacts are not inevitable, but that there are choices.

According to Droz and Lavigne (2006), the benefits to stakeholder engagement are:

- generates negative outcomes;
- reveals under represented stakeholders;
- reveals lack of clarity or certitude;
- generates disputes and a more diverse range of knowledge and therefore becomes pertinent for social change.

Based on the above authors' arguments, there are various common threads among the range of benefits or usefulness of a participatory approach for the precautionary principle. By basing their commonalities on three main axes, the following basic ideas emerge:

Justification axis

The justification of a decision in a context of uncertainty, cannot be done in isolation because of the lack of data, and therefore as a result will also shift the burden of proof to the stakeholders; satisfies the justification of the decision process. What may seem responsible to one person may not be to someone else.

Social Co-Learning axis

A public participative approach allows the public to become aware; empowered to make choices with respect to social or environmental impacts from products or service systems, and in the process each one benefits from the knowledge and values of the other.

Generating Alternatives axis

A broadened range of possible insights as a result of the various perspectives of the stakeholders nourishes the creative process.

In using a participatory approach, the selection of stakeholders is an important question to consider (De Coninck, 2005). A public participation will allow a comprehension of the unresolved issues among participants that is not possible through a risk assessment or life cycle assessment alone. Because of the greater public participation, the burden is now in fact shifted to the public (Tickner & Geiser, 2004). When Tickner and Geiser's reasoning for greater public participation are compared to Sclove's (1995), and to Droz and Lavigne's (2006), similarities exist with respect to the emergence of the various points of view. This may have as a result the widening of a society's moral scope, and therefore a better capacity to comprehend the knowledge that materializes through such participation. From this perspective, public participation becomes a way to expose and deliberate the different ethical positions of each stakeholder (De Coninck, 1997, 2000, 2005).

A public participatory approach to help in the decision making process of a situation based in lack of knowledge, will have several benefits, as specified above. Public participatory approaches to decision making are ways of sharing knowledge, and not

of being lectured. In a public participatory forum, the participants must be willing to listen and engage themselves in the discussion (De Koning & Martin, 1996). This process of public participation allows the participants to regain control of situations[66] that they may have previously believed to be out of their control; and therefore it provides the participants a way to rebuild their belief in a democratic system that is constructed to satisfy the common-good. Therefore a sense of empowerment becomes a fundamental characteristic for stakeholders.

2.2.3. Precaution: A Collective, Normative, Adaptive Approach

Typically, organizations use a deontological ethical framework to help ensure that processes are adhered to. It is not that simple in a perspective of precaution. If designers try to use a traditional ethical theory to guide them in defining their course of action; either a deontological approach or a utilitarian approach; they will find each of them insufficient in some way. The following is a proposal for a precautionary approach for decision making using a stakeholder approach that is based on the emergence of values and visions of the various stakeholders.

This ethic of sustainable development touches economic elements (revenue, consumerable goods), qualitative elements (environment, quality of life), and social elements (family, politics), considering these useful for the flourishing of human life (Droz & Lavigne, 2006). By considering elements that constitute a 'good' life, a dialog among stakeholders that is based on an ethical framework becomes essential.

The ethics that is being proposed relies on an ethic of consensus; not a dogmatic (imposed) form of ethic. Principles, which can be used as hypothesis, can be included during discourse. Arbitration is not recommended for several reasons. According to Massé (2003, from Droz & Lavigne, 2006), an ethical approach that is based in arbitration through a list of principles, has largely been condemned in the last two decades for its excessive normative tendency and its rigidity towards an analysis of ethical issues. The main criticisms were (Massé, 2003, from Droz & Lavigne, 2006 p. 90):

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[66] Section 1.3.3 of this paper provides further elaboration of this concept.

- Absence of sensitivity to specific contexts especially in the context of health issues
- The mechanist character of the ethical analysis process
- An absence of a fundamental ethical theory

Therefore a consensual approach to deliberation is recommended. The idea of principles used in a consensual approach can bring many contributions on a methodological perspective. An applied ethic to govern the environment would benefit from the following methodological contributions (Massé, 2003, from Droz & Lavigne, 2006 p. 90):

- None of the norms would have an absolute value because they would be in a context of pluralist societies
- Ethical analysis implies a continual assessment of norms which are all legitimate and defendable. Therefore an applied ethic can be seen as the deliberation of conflicting views for new norms.
- The implementation and choice of these norms must pass through the fundamental step of their specification; definition and pertinence in a given context using a normative consensual process.

In essence then, the consensual process is normative, but relies on the ongoing assessment of norms to arrive at a consensus for: (1) updating existing norms; or for (2) creating new norms (Dupuy & Grinbaum, 2005). Therefore the existing norms will be used for judging situations (as a point of departure), and in addition, the evaluation of new situations will be used for updating the existing norms and creating new ones (Dupuy & Grinbaum, 2005). The latter step requires an anticipation of the future (Dupuis & Grinbaum, 2005). Therefore there is a shift from a deontological approach to an axiological approach.

The values that influence decisions are based on an axiological perspective of the situation. The reason why these values cannot be normative is because when a consensus is based on values, these values can be considered to be based on what a stakeholder considers *what is right and wrong*, and not what a stakeholder *should consider to be right and wrong*; therefore based on an axiology and not on a

deontology. Such private values will often be in contradiction with public norms, and therefore the difficulty resides in finding a common ground among the stakeholders.

A Framework based on Values

In a stakeholder approach, the process of debate is not limited to a group of experts. The participation of citizens is a fundamental part of this process. Therefore a sense of empowerment among stakeholders is a requirement for such a process to be effective. This signifies that participants are autonomous, competent and are willing to participate in order to improve unacceptable situations.

In such a process, it is a given that each stakeholder has their own set of private values. Amongst the divergent value systems, a democratic and rational debate seeking consensus on norms (their hierarchy, the establishment of new norms, updating existing norms) is the goal. The debate would focus on the search for a common-good and an improved quality of life; a common goal for all stakeholders. The goal is therefore to transform the pluralist and individual values into universal norms that are acceptable by the largest number (Droz & Lavigne, 2006). A debate that expects 'established truths' to be recognized by all is headed towards failure, since this will never be reached. The practical objective is to arrive at a common position on norms that may be used to direct some program of development or governance of the environment (Droz & Lavigne, 2006).

Solidarity signifies that a common set of goals exist when seeking to improve the quality of life for all. According to Des Jardins (1995) beyond the divergent opinions among stakeholders, there is a set of generally accepted conditions, which are based on values. Some examples of such generally accepted conditions are (Droz & Lavigne, 2006, p. 97):

- rejection of an ethic based strictly on cost-benefit;
- rejection of a radical liberal conduct of privatization of ecological enterprises;
- the commodification of pure air;
- the commodification of drinkable water;
- respect for justice towards the polluting of poor countries;

- recognition of the limits of the over-use of natural resources;
- recognition of the limits of the capacity for the environment to metabolize toxic waste and to regenerate itself;
- moral duty with respect to animal species;
- responsibility towards future generations, and others.

Based on this list of common concerns, some fundamental values and goals emerge as a point of departure for such an ethical debate. These may clarify the dimensions that are part of a common ethos for sustainable development in a perspective of precaution, which may eventually lead to a shared ethic; a first step toward consensus. Table 10 seeks to articulate fundamental values within a context of sustainability based on (Jonas, 1985; Morin, 2004; Ewald, 1996; Dupuy & Grinbaum, 2005; Arendt, 1958; Adam, 2004; Harremoës, 2003; Whiteside, 2006; Droz & Lavigne, 2006; Kourilsky, 2002; Tallachini, 2005). This table can also be used as a preliminary analysis grid for understanding whether the precautionary principle is implicitly manifested in decision making. This cannot define with certainty if this principle is used, (unless explicitly stated with specific processes defined), since this would require more criteria to properly evaluate, however, it can indicate if the decision processes are implicitly precautionary. This can be a starting point for an evaluation.

This list of values and goals that can be used in a reflection for a decision based on a precautionary attitude has some semblance to the fundamental human needs and satisfiers proposed by Max-Neef (1991) (Table 7, page 82). For example respect, equality, justice, responsibility, and adaptability are satisfiers according to Max-Neef, and appear on this table as fundamental values for a precautionary attitude. Freedom is considered a fundamental need by Max-Neef and also appears on this list of values. Participation, another fundamental human need according to Max-Neef is directly related to empowerment and solidarity, other values on this table. Therefore, this set of values that can be used as a basis for a precautionary mind-set is directly related to the set of fundamental human needs that constitute a sense of well-being. This is because a precautionary attitude seeks to improve the quality of life for all; reduce potential dangers by being proactive and anticipative; ensure a sense of justice, equality and equal access and capacity for all.

Table 10: Fundamental values and goals in a context of precaution (based on Jonas, 1985; Morin, 2004; Ewald, 1996; Dupuy & Grinbaum, 2005; Arendt, 1958; Adam, 2004; Harremoës, 2003; Whiteside, 2006; Droz & Lavigne, 2006; Kourilsky, 2002; Tallachini, 2005).

Values	Goals
Responsibility	Protection of common good (everyone has the right to a good life)
Fairness	
Respect	
Futurity	Promotion of well-being (improving quality of life)
Equality	
Justice	
Freedom	Avoidance of irreversibility and non-substitutability of actions
Empowerment	
Solidarity	
Dignity	
Transparency	Harmony with nature (preservation and conservation)
Non-maleficence	
Adaptability	

The fundamental values and goals that can be invoked to help in a reflection based in ethics are numerous. Even with a sense of solidarity, it is not evident how to proceed in such a debate. One observation seems evident: if consensus building methods and hierarchy of values are *not* taken into account in a stakeholder approach, then this approach, with its contradictory discourse, may result in the inability to make a decision. Therefore the stakeholder process would be normative (Dupuy & Grinbaum, 2005), but the norms would be flexible and adaptive. An ongoing process of adapting norms to new knowledge would allow the flexibility necessary in a precautionary approach.

2.2.4. Moving Towards a Precautionary Approach for Design

In this section the evolution of design approaches and their concerns will be presented in order to understand where and how the precautionary approach can be integrated into a sustainable design process. Design can contribute significantly to sustainable development by proposing solutions that embed a global understanding

of a situation and that consider the benefits to the environment and society for the short, medium, and long-term. Design can be considered as a means to ensure a future for humanity. Therefore situations of uncertainty can be addressed through various ways; one way is through the understanding of ethics and its application in the decision making process for design. A stakeholder approach for the deliberation of issues addresses this in a contemporary ethical manner. An ethical framework entails a mutual comprehension of an individual as well as a social ethos through open deliberation. A social ethos may not be entirely related in an incremental manner to an individual ethos (Droz & Lavigne, 2006), and this is why the choice of stakeholders involved in a stakeholder approach is an important consideration (De Coninck, 1997, 2000, 2005). This process implies an understanding of values and their applicability to searching for innovative sustainable solutions.

When seeking to shift from a preventive approach towards a precautionary approach, it is not clear how the transition will take place because of the differences in the way these two approaches seek solutions. Eco-design adopts a problem optimization approach (Figure 8). On the other hand, sustainable design is defined as a mode of conception that seeks global, long-term solutions that consider the common-good. In this perspective, sustainable design adopts a precautionary approach (Figure 9). The evolution of design strategies, from green to eco to sustainable, reveals a noticeable evolution towards a systemic approach, which is increasingly global in nature when establishing solutions. There is an attempt, as one strategy evolves to the next, to increasingly integrate complexity – social as well as environmental issues need to be dealt with on a more global scale, to move towards a mode of sustainable design. Sustainable design seeks to find solutions that would improve the quality of life on a global scale.

Figure 8 presents the evolution of design approaches up to the second wave of eco-design. This series of 4 models illustrate the increasing complexity inherent in the decision making process for designers when adopting solutions that seek to abide by a mode of eco-design. They provide a basis for an evolution towards a precautionary approach to design practice by presenting the concerns prevalent in existing approaches to eco-design. In particular, the second wave of eco-design intervention

(Figure 8) provides examples of indicators that can be evaluated using deterministic methods.

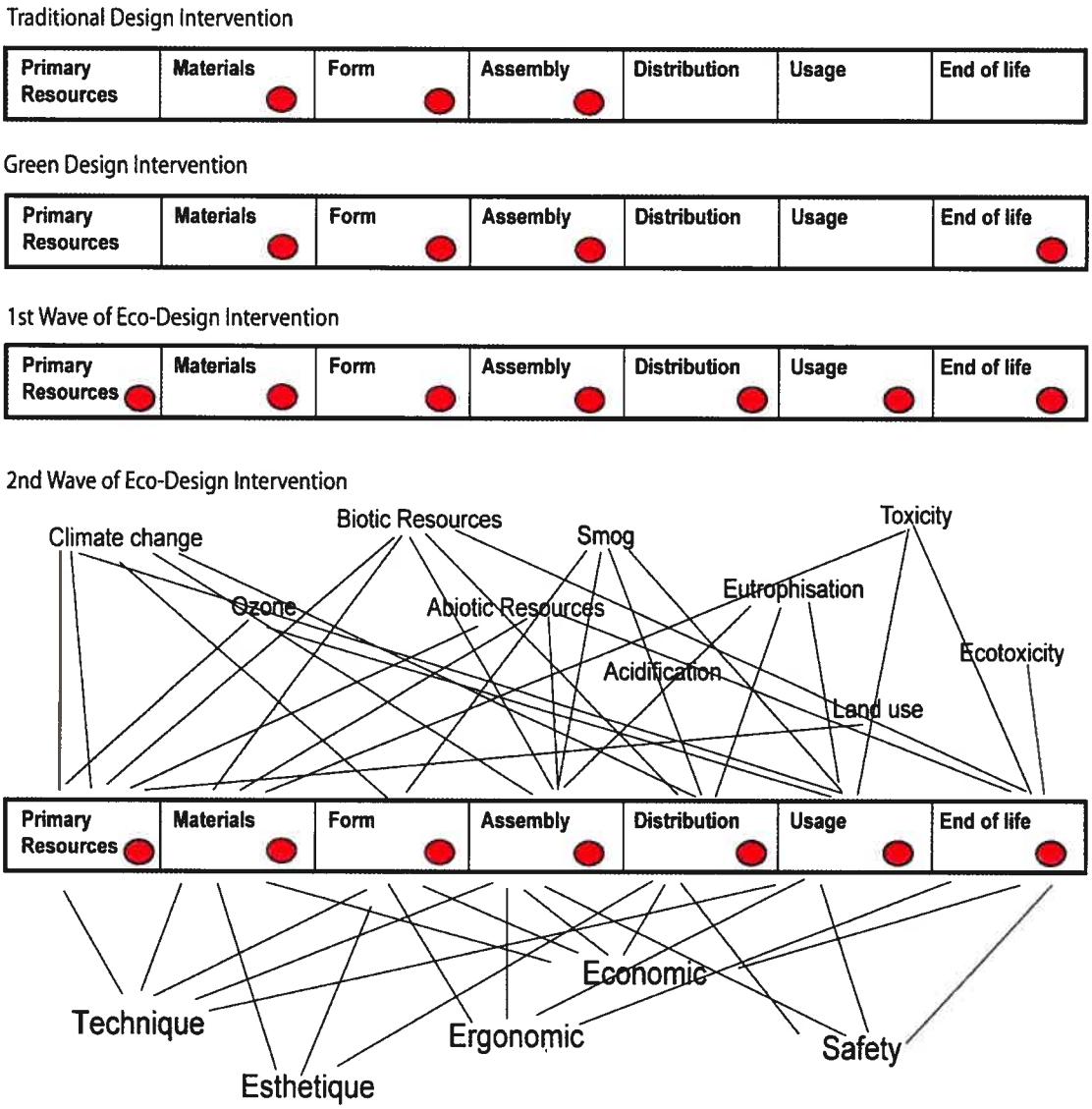

Figure 8: Evolution of design intervention and their main considerations (based on: Plouffe, 2006, slides 3, 6, 12, 15).

Figure 9 presents a sustainable approach to design and proposes how the precautionary principle can be integrated into such an approach. In this figure an attempt is made to delimit the type of criteria (values and visions based on a global, long-term perspective) necessary for such a reflection. In this figure, the criteria such as *fairness, dignity, responsibility, etc.* represent the values coherent with a precautionary attitude (these are presented above the main process). Criteria such

as *protection of common-good, social cohesion, ecological integrity, etc.*, represent the global visions pertinent for a precautionary attitude (these are presented below the main process). For example, if social cohesion can be considered as an indicator category based on a global vision of quality of life, then possible indicators for this category could be justice, fairness, responsibility, respect and freedom. This is just an illustrative example, and further research is needed to properly establish such indicators.

Indicators that are based on the values and visions cannot be assessed using traditional modes of evaluation that are deterministic, and this is why a stakeholder process must be integrated into this process of decision making, which is not present in the traditional approach to decision making. This presents a rupture in the way decisions are made and confirms the requirement for a system of governance necessary for the establishment and assessment of such indicators since they are seeking to satisfy a common-good based on fundamental human needs. It becomes clear in this figure that the precautionary principle can be used as a complement to an already existing preventive approach to design. However, a precautionary approach to design would be used only in particular situations; when current lifestyles impose potential harm to individuals or their societies and therefore a precautionary approach for finding innovative solutions would be warranted.

Therefore when sustainable solutions are sought in a perspective of precaution these solutions will be based on the conception of new lifestyles and therefore the assessment is based on scenarios using values as the main form of criteria. Whereas a preventive approach to design will assess environmental and social impacts on a product or service scale using deterministic methods; this is a value neutral approach. So both preventive and precautionary approaches are necessary for achieving sustainability. As a result a precautionary approach will not only complement a preventive approach, but will also encourage a shift from an eco-design mode to a sustainable design mode.

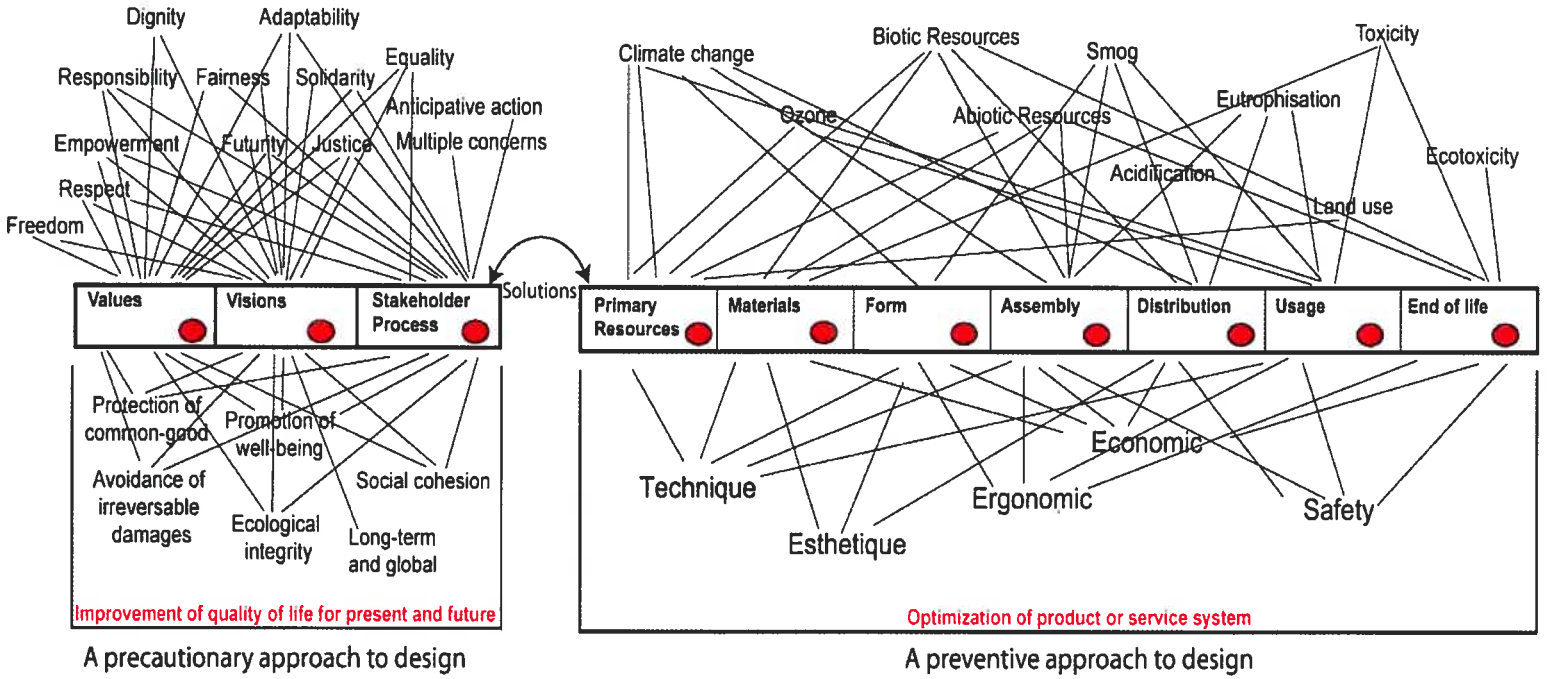

Figure 9: A sustainable design intervention using a precautionary approach (based on Plouffe, 2006). © Cucuzzella, C., 2007

As has been mentioned, the concerns and criteria in a precautionary approach are of a different character, and are based on a different method of establishment, evaluation and assessment from the criteria used within a preventive approach. In the next section, the gap between these two approaches will be elaborated.

Epistemological Gap between Prevention and Precaution

The deterministic approach is a point of view among others (heuristic, social, ethical) of looking at the world. It has its own set of values; an attitude of articulating the truth through objective facts and imposing this value system to others (Morin, 1982). A deterministic approach has power because of its expert knowledge and quantifiable facts that seem indisputable (Morin, 1982). In fact, based on its ability for explanatory power, predictability, and absolute truth, science has the capacity to contest a hypothesis or theory; often referred to as the theory of falsability (Popper, 1965). However this does not mean that scientific discourse cannot be questioned (Droz & Lavigne, 2006).

Complexity is another way of looking at the world; it does not mean complicated. It is important to understand the difference between complexity and complication in order to understand the epistemological gap between prevention and precaution. Popper (1965) suggests that a complexification of natural phenomena is appropriate in cases where it is necessary to go beyond a rational approach; in his perspective, complexity implies that a *recipe* can be used to arrive at a response. In fact, Popper is referring to the framework of hyper-complication; an approach that upholds its predictive powers (De Coninck, 1993), and not a complex framework. According to Morin (1982) a complex framework is less of an approach for problem solving and more of an approach for the emergence of problems (De Coninck, 1993).

The idea of an epistemological obstacle was first introduced by Bachelard (1938). He showed that science has progressed against the notion of common-sense and ordinary knowledge; he claims this to be a source of epistemological obstacles to the advancement of science. According to Bachelard (1938), scientists use the same form of argumentation and explanation they are accustomed to and therefore are caught in a kind of inertia; this he claims is another source of an epistemological

barrier. This refers to the habits of accepting the ways in which things are done, and therefore inhibits new questioning. In some sense, this inhibition of asking questions in innovative ways can be seen as a working within a paradigm (Kuhn, 1970).

The distinction in epistemological stances represents the core discrepancy when describing the differences between prevention and precaution approaches. The epistemological position of sustainable design is coincident with the precautionary principle; just as the epistemology of green and eco-design is similar to that of the prevention principle (Figure 10). An awareness of the inequalities of the 'knowledge producing world' (or expert knowledge providers) is a point of departure for a precautionary approach. In this approach, a participative forum for decision making allows a pluralistic, non-neutral position (Droz & Lavigne, 2006); this is in contrast to a preventive approach, which adopts a universal and neutral position of knowledge. A precautionary approach will allow an emergence of various points of view; a way to construct solutions from the diversity of knowledge, values, and concerns. To embrace the complexity of situations from the perspective of precaution requires: (1) a commitment to justice and fairness; (2) a participative method to allow the emergence of the issues of each stakeholder; (3) a commitment to comprehending the value systems of each stakeholder; and (4) a commitment to search for alternative solutions that will not shift the negative impacts, but seek to avoid them altogether.

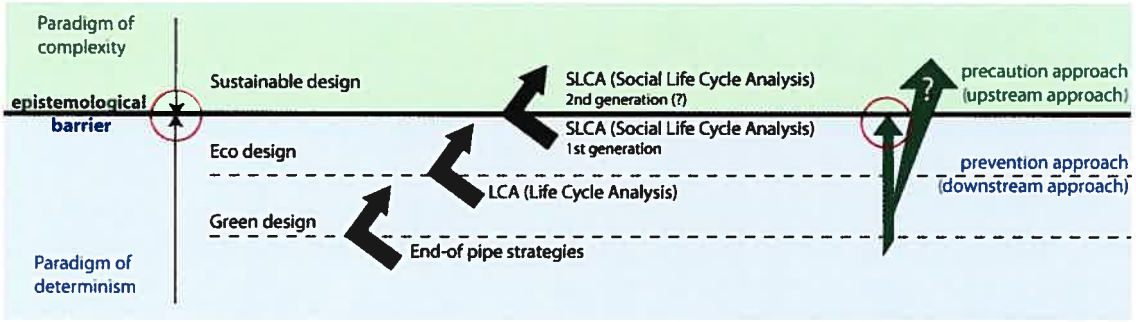

Figure 10: Towards a global and systemic approach in the establishment of social indicators: a theoretical result of adopting a precautionary approach to decision making. © Cucuzzella, C., De Coninck, P., 2007

Assessment tools such as SLCA, that address social impacts and therefore social problems, can aptly be embedded within the systemic paradigm. However, very little

research is currently done on SLCA within this paradigm; most research in SLCA is firmly embedded within a deterministic paradigm using quantitative methods[67]. The main problem with using only quantitative methods for assessing social impacts is that much of the data available is not measurable and therefore very difficult to fit into such an approach. In addition in cases of fundamental uncertainties, it becomes very problematic to use such approaches.

However, the attraction of using deterministic quantitative methods is that they have predictive powers where decisions based on computable data are simpler to rationalize; humans are very comfortable with this type of support for decision making (Dupuy & Grinbaum, 2005). There is a difficulty in moving beyond a deterministic approach; instead there is a greater tendency to rely on statistical probabilities to support decision making in cases of uncertainty (Dupuy & Grinbaum, 2005).

Some current research on social impacts is being done using a qualitative (in addition to quantitative) approach[68]. This is an immense improvement from approaches that seek to measure social impacts using quantitative methods alone because of the greater depth of information in regards to world conditions; however, even these approaches remain in the preventive paradigm. This is because these indicators are measuring impacts based on the production of products and service systems; primarily a socio-economic perspective. How to move beyond a preventive approach so that decisions made in a precautionary context consider the common-good? In order to adopt a precautionary approach, the assessment should be made on lifestyles, not on the products and services; and on finding creative solutions to existing lifestyles that would improve quality of life for individuals and communities (Marchand, De Coninck & Walker, 2005).

Therefore a fundamental emerging concept for design in a perspective of precaution is that this approach would seek solutions to improve the quality of life over and above assessing the impacts of the proposed solutions. Both approaches,

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[67] For example GaBi developed by L. Barthel, and J. Pflieger from the University of Stuttgart. This approach was presented at the international conference Society and Materials in Seville, May, 2007.

[68] For example the UNEP/SETAC task force within the Life Cycle Initiative has adopted a qualitative perspective for establishing and assessing social impacts.

prevention and precaution, therefore become pertinent in this process of sustainable design. This is because designing new lifestyles in a precautionary approach would seek to satisfy fundamental human needs on both inter and intra-generational levels; an attitude of sufficiency becomes the core of this thought process. And by improving the quality of life, this process is essentially precautionary since it:

- is anticipative;
- considers reversibility of actions;
- is based on multiple value systems (collective approach);
- valorizes future generations;
- is proactive in the solutions it seeks;
- considers safety and health issues;
- adopts a global perspective (temporal and spatial).

These criteria are based on Table 9 from page 117; by elaborating on the dimensions of prudence the criteria for a precautionary approach emerged. All of these considerations are pertinent to precaution and therefore equally essential for a sustainable mode of design. Therefore because this approach requires collaboration among stakeholders to contribute to decisions based on innovative solutions that seek to improve quality of life, then a sense of empowerment among the stakeholders (employees, citizens, suppliers, among others) is fundamental since without this, a collective approach to decision making would not be feasible. Figure 11 presents a conceptual map of the major elements of this study; the highlighted elements indicate the specific areas of interest.

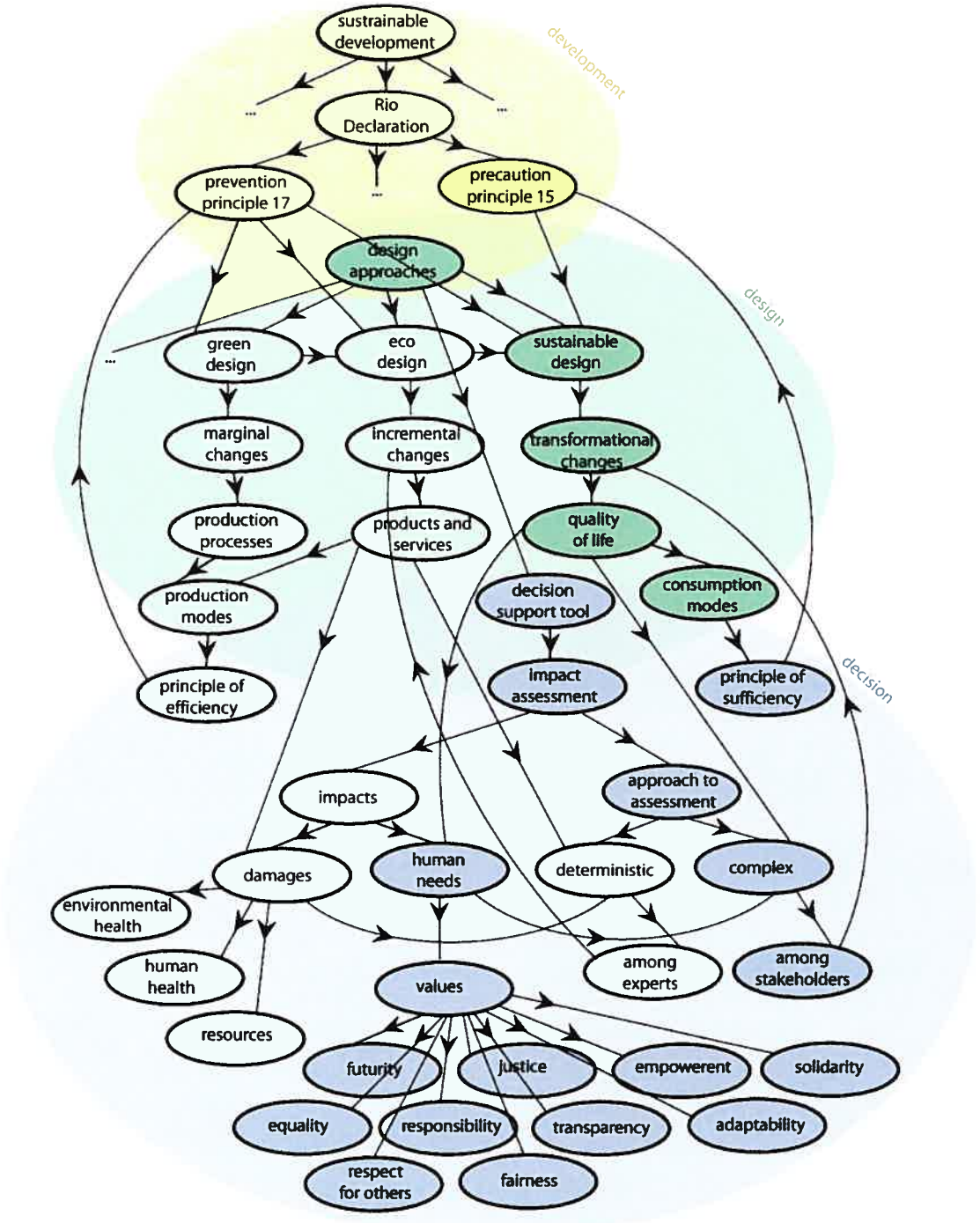

Figure 11: Conceptual map comprising of: the development paradigm; the design approach; and the decision support necessary. © Cucuzzella, C., 2007

2.2.5. General Description of Data Requirements

As stated earlier, LCA methodologies are fundamental for assessing a product's adherence to eco-conception; however, they are limited because (1) of the ways in which impacts are established and assessed in cases of fundamental uncertainty; remain within a deterministic paradigm (2) their lack of a spatial (global) and temporal (long-term) perspective (limited to product and service system impacts), and; (3) their lack of embedding the multiple values and visions of stakeholders. These are all necessary in a context of precaution. On the other hand, sustainable assessment methodologies at an organizational level may be better equipped to deal with precautionary concerns, in particular if they adopt a stakeholder approach. However, a stakeholder approach needs some guidance in making decisions, otherwise, decisions can never be reached. Are these guidelines in the form of an ethical framework, guiding principles, codes of conduct or all three? In a context of searching for and assessing sustainable solutions, the involvement of non-experts as well as experts is essential. Therefore, the emergence of an empowered consumer citizen would be a fundamental necessity for such a process of decision making to be effective. How do organizations deal with the nature of such decisions? In essence then, the intent is to understand how organizations assess situations and make decisions that are based in fundamental uncertainties.

The nature of the data to be collected in this research will be textual. The unit of data for this research is the organization, and in particular their sustainable development assessment methodologies. An understanding of these methodologies will provide a better picture on how organizations make decisions when seeking sustainable solutions. While some of these methodologies are used directly for product and service development, others are used at a corporate level for assessing the level of sustainability for organizations. In understanding these methodologies, then the way in which organizations make decisions in cases of uncertainty of catastrophic harm will emerge, either on a product and service level or on an organizational level. In fact, in understanding each of these two levels of assessment (product and service or organizational), then an understanding of which level of assessment is more adaptable for a precaution approach may emerge.

One question that will arise is: Can an understanding of situations of uncertainty of catastrophic harm at a product and service system level help stakeholders in their deliberation? Is this scope too limiting? Is the corporation a better unit (as opposed to product and service) for grasping the issues in situations of uncertainty? How is the commitment to sustainable development being supported by company values, principles and codes of conduct? The basic assumptions that underlie my epistemological approach are that in order to operationalize the precautionary principle for product and service development, two main requirements are necessary:

- An ethical framework that can be used to guide deliberation;
- A stakeholder approach for the decision making process.

If organizations seek sustainability, in particular to reduce potential harm from uncertainties in technologies, what do they use to guide them in their decision processes? Do they have such frameworks available for decision making? Are stakeholder approaches in place within their organizations to address these types of decisions? Such questions will be addressed in the field work of this research. In the next section, details of the methods for conducting this work will be presented.

3. The Methodological Framework

3.1. General Introduction of Methodology

Before detailing the methods that will be used in conducting the field work, it is important to introduce some methods and tools available for this type of research. The questions that this research is addressing are very open-ended questions; a comprehension of existing sustainable development assessment methodologies and their inclusion (or exclusion) of the precautionary principle in their decision processes. In essence, these questions seek to understand some aspect of human behaviour within a specific context. Therefore it seems that a qualitative approach for the research will be most appropriate. After the introduction of the various qualitative methods and tools, a justification for such an approach will be further elaborated.

3.1.1. Research Methods

Social sciences are interested in human action and therefore the object of study is the human being within a particular context. Knowledge – whether it is layman or scientific, has been a controversial area. Human sciences run the risk of having traditional science confuse the interpretations that the observers have of reality with reality itself (Poupart *et al.*, 1997).

Qualitative research seeks to understand phenomena in context specific settings. Quantitative research uses methods that are experimental to test hypothesis generalizations, through quantitative measures with precise laboratory settings. Each of these methods is used for very different types of research questions, and therefore, the activity that the researcher engages in is founded on the basic assumptions of each methodology (Hoepfl, 1997).

Qualitative and quantitative methodologies are not mutually exclusive. Qualitative research tends to describe the unfolding of social processes, rather than describing the social structures which are done using a quantitative methodology (Van Maanen, 1979). In a qualitative methodology a description of the phenomena within a specific

context will be constructed from the perspective of the researcher. This requires an empathetic understanding that is often achieved by direct or firsthand knowledge of a research setting. This is a basis for most qualitative research (Denzin & Lincoln, 2005).

The basis for a qualitative research is dictated by the type and field of research. If the research question is open-ended, this often signifies a need for a qualitative approach to be able to properly contribute to the discovery that often results from such a research question (Hoepfl, 1997). Another consideration in selecting to adopt a qualitative approach is that the phenomena can be more fully described using such an approach in contrast to a quantitative research approach (Van Maanen, 1979). Quantitative research can often result in generalizations that are 'simplifying' and therefore cannot properly satisfy a research question that requires the richness that often results from of a qualitative interpretation.

Both qualitative and quantitative research is an interpretation of the observed or studied phenomena through the perspective of the researcher. Qualitative research has an emergent nature, and therefore it is neither possible nor appropriate to finalize research strategies before data collection has begun. In a qualitative research, the researcher seeks to observe and interpret meanings in context (Poupart *et al.*, 1997).

This is unlike quantitative research, which has a predetermined strategy, right from the beginning of the research. For both quantitative and qualitative research methods, the primary questions and the plans for data collections strategies are specified before data collection has begun (Hoepfl, 1997). In both cases, the researcher presents a bias on the object of study by the choices made throughout the research process.

Typically the product of a qualitative research is the generation of theory and not theory validation or testing (Hoepfl, 1997). Since it is theory generation, the result will not be a finished product, but instead a product that is in constant evolution or development. In addition, the results are usually not generalized theories, since

qualitative research is usually framed within a specific context and therefore generalizations are difficult to conclude. According to Weiss:

> "*Qualitative data are apt to be superior to quantitative data in density of information, vividness, and clarity of meaning – characteristics more important in holistic work, than precision and reproducibility*" (from Van Maanen, 1979, pp.344-345).

There are various tools available for a qualitative research. The next section will present the tools that will be used during the field work.

3.1.2. Research Tools

There are three main forms of data collection for a qualitative research: literature analysis, interviews, and observation. This research will focus on literature analysis and the interview process (in particular, semi-structured interviews).

Document Analysis

This often provides a complementary form of data collection (Lessard-Hébert, Goyette & Boutin, 1990). In other words, collecting data from documentation (such as charts, journals, correspondence, web sites, organizational reports) as a complementary step in a qualitative research will provide a researcher the insight to formulate ideas and/or questions for either of the other two qualitative techniques: interviews and observation.

Interviews

The possibility of interrogating social actors and using them as resources for the comprehension of social realities is a great advantage that the social sciences have over the physical sciences; since in physical science the objects of study are inanimate or cannot speak. The interview process is the method used for interrogating actors. The interview has advantages and disadvantages. On the one side, interviews are an effective means to comprehend social realities through a dialog and an understanding of the social actors. On the other hand, social realities are not easily grasped; the knowledge that is sought is transmitted through the

interview process and may be difficult to comprehend because of the multiple interpretations (Poupart *et al.*, 1997).

According to Lessard-Hébert, Goyette, and Boutin, (1990), interviews are an effective way to collect information about beliefs, knowledge, and ideas from subjects. This information is pertinent since it comes directly from the subjects. Interviews could be used as a primary source of information or in conjunction with other forms of data collection. According to Patton (1990) there are three main types of qualitative interviewing:

Informal Interviews

These are conversational interviews. These often follow either an observation that involves participation, or direct observation. It is a beneficial method when the observer wants maximum flexibility to follow through on ideas as they emerge in the conversation. As the conversation opens up, the observer then starts to formulate the questions in a spontaneous way and asks these questions in an informal manner. One problem with this approach is that the collected data may be difficult to classify and analyze because the data was generated in a less orderly way.

Semi-structured Interviews

These interviews use a pre-determined set of questions as well as a pre-determined interviewee from a setting or group. Because the questions are predetermined, which is considered an interview guide, each interviewee will answer the same set of questions. The questions are open-ended, and therefore can capture as much detail as the interviewee is capable and willing to divulge. Also, the interviewer can follow through on ideas as they emerge in the interview (follow-up questions). One disadvantage of this method is that it is not as flexible as an informal interview. However, the big advantage is that all interviewees will answer the same set of questions and therefore classification and analysis is simpler than using an informal approach.

Standardized Interviews

These are open-ended interviews, similar to a survey. The questions are standardized. This means that they are carefully scripted and written down so that each interviewee will get the same set of questions in the exact same order. This is

particularly good for comparing across interviewees. However, does not provide any flexibility to follow up on ideas as they emerge in the interview.

Forms of Communication for Interviews

In addition, to the above categorization of interview process, there is also several ways to conduct any of the above interviews: face-to-face interviews[69]; phone interviews[70]; email interviews[71]; and chat/messaging interviews[72]. Each of these formats have benefits and limitations based on the specific situation.

Besides selecting the format of observation, the researcher must also select the way in which the interviewees will be selected. This is called sampling. In many ways, for a qualitative research, the process of selecting who to interview is a recursive process because the choice often depends on what was found in the current iteration to be able to make a decision on who to interview next.

Sample Selection

The way in which the subjects are selected depends on the type of information that the researcher seeks. The subjects may be selected from (Patton, 1980; Lessard-Hébert, Goyette, and Boutin, 1990):

- a random sampling strategy;
- a purposeful sampling strategy;
- from key informants

A *random sampling* is effective for: (1) avoiding a systematic bias; (2) tries to achieve a representative sample set, and; (3) increases confidence when making generalization to particular areas or groups (Patton, 1980). In random sampling strategies, the cases may be selected either in a simple random manner, a stratified random manner, or a cluster random manner.

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[69] This type of interview is beneficial when a necessity to adopt questions to the answers of interviewee.

[70] This type of interview is beneficial when interviewee is geographically far away, or is too busy to talk and does not want to use internet technology.

[71] These are less personal that face-to-face or phone, but very convenient because the results are already in digital format. However, the interviewer may not get as much information because it is less feasible to ask follow-up questions in this format.

[72] This format is beneficial when talking to people who are geographically far away, and also have the benefit of asking follow-up questions. A disadvantage is that the answers may be too concise.

A *purposeful sampling* has other advantages, such as: (1) it increases the use of the information collected; (2) provides information about special cases; (3) avoids a study where results would be dismissed because the object of study is considered 'unusual'; (4) allows for maximum application of information towards other cases, based on the special cases; and (5) it may save time and money (Patton, 1980). In purposeful sampling strategies, the observer may choose subjects that are: typical of the phenomena; atypical of the phenomena; politically oriented cases; or subjects selected as a matter of convenience.

When selecting subjects that are *key informants*, the subjects are typically very competent in the phenomena of study. This is an effective way of collecting data, especially when the phenomenon in question requires specific competencies. In such cases, neither random sampling nor purposeful sampling will provide the observer with subjects that can provide responses that are significant enough to enlighten (Poupart *et al.*, 1997). This strategy of sampling is pertinent when the competency in question is not widespread, and the observer must be sure to select a subject that can provide the responses for the observer's questions.

Having reviewed the various tools available for a qualitative research, the following section will seek to (1) justify this approach; and (2) present the protocol that will be followed in conducting the field work.

3.2. Research Protocol

The main objective of this research is to justify the establishment of an ethical framework for an eventual operationalization of the precautionary principle for design using a stakeholder approach. This principle is a principle meant to guide decision makers in a context of uncertainty of harm. In seeking to understand how decisions are made in a context of sustainable development, and in particular in situations where the precautionary principle is required, an understanding of assessment methodologies will be conducted during this research. In carrying out an analysis of existing sustainable assessment methodologies, the expectation is that a

comprehension of how decisions are made within organizations in situations of lack of knowledge will emerge. This is pertinent, since by understanding the current modes of operation in situations where a lack of knowledge (or conflicting data) exists, then the gaps in the decision making process may surface. These gaps will enrich the comprehension of (1) the pertinence of this principle for the decision making process; (2) if pertinent, when can it be applied; and (3) how can it be implemented.

Therefore a qualitative approach seems appropriate since the questions that are being considered can be more fully described using such an approach. Also, it is the comprehension of the process of decision making that is of interest and therefore a quantitative approach would be too limiting. In addition, the studies will be done within a specific context, and the comprehension of these phenomena will be constructed from the perspective of the author. For these reasons, a qualitative approach for the field work is justified.

There are three main steps in the research protocol. The *first step* entails the document analysis of assessment methodologies. At least one of the methodologies will be for product and service development; in other words, a narrow scope of assessment. In addition at least one assessment methodology will be at an organizational level; a broader scope of assessment. The *second step* will entail semi-structured interviews. These interviews will be conducted either through emails, telephone or face-to-face using key informants from selected organizations. The format will depend on the geographical location of the interviewee. In addition the questions for the interview will need to be set. The *last step* will be the establishment of the analytical grid for the collected data. This will require that the collected data be classified in an appropriate manner so that it can be properly analyzed using the proposed grid. In the next sections each of these steps will be further elaborated.

3.2.1. Document Analysis

The first step will involve a review of existing documentation of selected methodologies. This will provide a basic understanding of how these methodologies are used by stakeholders; the purpose is to understand how the methodology

operates or guides stakeholders in making decisions. Four organizations were selected for document analysis: *Eco-indicator 99, SustainAbility, FIDD* (Fonds d'investissement en développement durable), and *Ethibel.*

Eco-indicator 99[73] was selected because it is a widely used tool for eco-designers. It is based on an endpoint approach (damage oriented); endpoint refers to secondary effects (such as CO2 emissions). This organization has developed a life cycle analysis methodology specifically oriented for SMEs (Small and Medium Enterprises). It is fundamental for designers in their practise as it guides their decision making process.

SustainAbility[74], established in 1987, is the first private consulting organization with triple bottom line goals (economic, environmental, and social performance). This organization was selected for analysis because much of their documents are publicly available; the use of this material will allow a better comprehension of the mission and methods of the organization. Also, this organization seems well connected to fundamental international organizations that research sustainable development reporting frameworks and sustainable development impact definitions.

Another example of an organization that has adopted a corporate level perspective for the assessment of sustainability is FIDD[75]. This is a Quebec based organization whose mission is to finance corporations that have an objective of developing and commercializing product systems that favor sustainable development. It invests in corporations that are proactive, and environmentally and socially responsible. The details of their methodology for assessing sustainability are not publicly available. However, enough documentation is made publicly available to conduct an analysis of their philosophy in evaluating and selecting SME's for funding. Their concept of financing organizations that adopt a sustainable approach to development is fundamental for the ongoing objective of sustainable development; in particular their concern for social impacts. They are different as a venture capitalist fund in this perspective. Also, their focus is the funding of SMEs, which is different from

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[73] More information on this organization is found on URL=<http://www.pre.nl/methodology.htm>.
[74] More information on this organization is found on URL=<www.sustainability.com>.
[75] More information on this organization is found on URL=<www.fidd.qc.ca>.

SustainAbility, which provides consultancy primarily to multi-national organizations. Although SustainAbility is not a venture capitalist funding organization, it provides similar consultancy services as FIDD but on a different organizational perspective.

The last organization selected is Ethibel[76]; it is a Belgium based organization. This organization was selected for several reasons, but the primary being that it recommends organizations for funding based on their level of corporate social responsibility. Its main purpose is to advise banks and brokers that offer ethical savings accounts and investment funds as to which organizations are considered socially responsible. The way in which Ethibel guarantees the quality of their assessments, is through a European label for socially responsible investment funds (Ethibel, 2003). The criteria for selecting companies (which are attributed the Ethibel label) cover many aspects of social corporate responsibility. Ethibel also has direct access to companies and their stakeholders, and therefore plays an important role in stimulating sustainable entrepreneurship. The methodology that Ethibel uses for assessing corporations is publicly available on their web site[77], and is a primary reason why this company was selected.

3.2.2. Semi-structured Interviews

The second step will involve conducting semi-structured interviews of a subset of the selected organizations from the document analysis step (step 1). The organizations that were selected for the semi-structured interview process were *Sustainability* and *FIDD*. The reason why each of these was selected is because they will provide both a European and a North American perspective; the perspective of the precautionary principle differs greatly on each continent[78]. This will be useful for understanding the current use, the potential, and the pertinence of the precautionary principle for decision making.

The intent of the semi-structured interviews is to complement the comprehension of the precautionary principle, and its ethical framework, based on the analysis of existing sustainable assessment methodologies. These interviews will be based on a

[76] More information on this organization is found on URL=<http://www.ethibel.org/subs_e/1_info/main.html>.
[77] URL=<http://www.ethibel.org/subs_e/1_info/main.html>.
[78] Whiteside (2006) provides a comparison of this principle based on continental perspectives.

set of open-ended questions with the intent of obtaining an in-depth understanding of the views of stakeholders. It is not sufficient to analyse and critique the assessment methodologies based on documentation alone, since a great deal of non-documented contemplation went into their development. It is fundamental to be able to comprehend the views of such key subjects through an interaction that will allow the flow of such non-documented information.

One of the objectives of the interview process is to confirm the knowledge obtained from the literature review and the document analysis; that an ethical approach of the precautionary principle can be used by stakeholders in the establishment of sustainable development initiatives. This type of knowledge can allow further insight into the development of methodologies, since this ethical framework can assist in the construction of strategies for additional improvements, as well as in the process of assessment. The intent is to use this ethical framework to facilitate the operationalization of sustainable development.

Therefore semi-structured interviews are indispensable for obtaining information from the inside of such organizations, in contrast to the publicly available information. Although this information is essential in the comprehension of these methodologies, a clearer or deeper perception of the ways in which such methodologies are constructed can be acquired through interviews with key people of such organizations. Such a process is an efficient way to obtain a perspective from the inside and of the issues that face stakeholders. An interview could reveal discriminatory or unethical business practises, as well as innovative and socially responsible business practices (Denzin & Lincoln, 2005).

In addition, the interview process can provide an in-depth examination of the issues surrounding the implementation of the precautionary principle, in particular: (1) what basis do stakeholders use to help guide them in making decisions in a context of uncertainty of harm? (2) how is the precautionary principle interpreted by organizations that already have adopted a sustainable approach to development or decision making?

Therefore the main objective from the interview process is to obtain a comprehension of the knowledge by stakeholders of the precautionary principle. In particular, how this principle is applied to the decision making process in situations where data is lacking or divergent and where such situations may present a threat of harm. The interviews will therefore help to enrich my comprehension over and above the document analysis.

Questions for Semi-structured Interviews

The following questions are intended to help explore the decision making process based on the precautionary principle of sustainable development; if possible what ethical framework is used by stakeholders when using this principle in decision making. These questions are attempting to understand: *How do organizations make decisions in a context of sustainable development, in situations where data is divergent or lacking and there exists a threat of harm; in essence, how do organizations incorporate the precautionary principle in their decision making process?*

By using the precautionary principle in their decision processes, stakeholders are required to explore a wide range of alternatives to products or services that may have harmful effects, and seek innovative sustainable solutions that: (1) have a higher certainty of knowledge, (2) have a lower potential of harm, and (3) is somewhat proportional to the original problem. The intent of the interviews is to comprehend the level of knowledge of this principle within organizations: How much of this knowledge is used in their decision making processes? How useful they perceive this principle in decision making processes in a context of sustainability? At what point in the decision making process would this principle be most effective? How will decisions be made using this principle? The open-ended questions for the interview process are separated into various topics that go from a general knowledge of sustainability to a very specific knowledge of the precautionary principle.

General Schema for Semi-structured Interviews

1. Sustainable Development
    i. What is their interpretation of sustainable development?
    ii. What are the main principles of sustainable development?

2. Precautionary Principle
    i. What is their interpretation of the precautionary principle?
    ii. How useful is this principle in a decision making process?
    iii. When do you recommend the use of the precautionary principle?
    iv. How can the precautionary principle be practically applied?
    v. Because of the lack of data, how are decisions made in the case of uncertainty?
    vi. What ethical framework is necessary in a perspective of precaution?
3. Obstacles
    i. What barriers exist for stakeholders in making decisions based on precaution?
    ii. How can these barriers be removed?
4. Incentives
    i. What must be done so that stakeholders take on a more precautionary approach towards decision making?

3.2.3. Classification of Data and Analytical Grid

The third step will entail the classification and analysis of the collected data. This will be done through the lens of the precautionary principle: *How do these methodologies guide decision makers in a decision making process in situations where data is divergent or lacking and there exists a threat of harm; in essence, how do these methodologies guide decision making processes in situations where a precautionary approach is required?*

The expectation from these critiques and analysis is that gaps in the methodologies will emerge due to the fact that existing methodologies are incapable (or not very capable) of dealing with uncertainty; which is at the core of the precautionary principle. This fundamental uncertainty is a major concern when assessments must be made and scientific data is not yet available to make an assessment. How are existing methodologies currently addressing these uncertainties?

The analysis can provide an in-depth examination of the issues surrounding an implementation of the precautionary principle. This would help in the comprehension of what type of reflection is necessary for its operationalization. The analysis will achieve *three major objectives.* The *first one* is that it will reveal how decisions are made when the precautionary principle is incorporated in the decision making process. However, a high probability exists that this knowledge is not available, since it may be that this principle has not yet been used by organizations in their decision making processes. In this case then the second objective will be achieved. The *second objective* is that gaps in decision processes will emerge, due to the incapacity to make decisions in cases of inherent uncertainty. And *finally*, the last objective is to complement my understanding of the literature available on the precautionary principle. As a result, a global comprehension of the operational perspective of the decision making in an organizational environment within a perspective of precaution will be achieved.

The classification of data will be done during the preliminary qualitative analysis of each of the organizations studied. From this analysis an interpretation will be done using the analytical grid presented in Table 11. This grid will permit the data from the preliminary analysis to be classified. This will then be used to construct an interpretation of the results. For each of the organizations studied, each of these areas will be looked at to obtain a clearer understanding about how their methodologies incorporate this principle in their decision making process.

This analytical grid provides five main sections of criteria. As the criteria moves from left to right, it becomes more specific for the precautionary principle. The criteria in the first two columns are not specific only to the precautionary principle; they are in fact criteria necessary for sustainable development, but a necessary requirement for a precautionary attitude. The last three columns are criteria related directly to the precautionary principle. The general hypothesis is that most of the organizations studied will pass much of the criteria in the first two columns, but most of the organizations will not pass much of the criteria in the last three columns.

Table 11: Analytical grid for classification of data and data analysis.

General Attributes of SD ----------→----------→---------→ Specific Knowledge of PP				
1. Basic Values	**2. Basic Goals**	**3. Decision Making Strategy**	**4. Precautionary Attributes**	**5. General Knowledge of the Precautionary Principle**
Responsibility	Social cohesion - Protection of common good	Temporal perspective (long-term or very long-term)	Collective process in decision making	Aware of the Precautionary Principle
Fairness	Promotion of well-being	Scope of problem (global spatial perspective of assessment)	Comprehension of multiple value systems	Clear Definition of the Precautionary Principle
Respect	Ensure Reversibility of actions	Impacts Criteria upstream of production considerations	Consideration of temporal and spatial consequences (global, long-term solutions)	Differentiation between risks and uncertainties
Futurity	Ensure Non-substitutable damage is avoided	Epistemological approach towards methodology	Based on values and knowledge	Different treatment between risk and uncertainty
Equality	Harmony with nature – Ecological integrity	Uncertainty/Risk Process Adopted	Anticipative decision	Differentiation between prevention and precaution
Justice	Major transformation of consumer habits	Solution type in cases of uncertainty	Sense of solidarity towards common sustainable goals	How are decisions taken in cases of uncertainty
Freedom		What measure is most often taken in cases of uncertainty	Complex vision of world (inter-dependence of elements)	Tools or Framework used for supporting decisions of uncertainty
Empowerment		What type of stakeholder approach is adopted	Adaptive approach to defining norms	What measure is most often taken in cases of uncertainty
Solidarity		How are the multiple values systems comprehended?	Normative stakeholder approach	Is the measure taken proportional to the perceived danger
Dignity			Looking for global solutions and not problem optimization	
Transparency			Proactive solution	
Non-maleficence			Considers health and safety beyond satisfaction of norms	
Adaptability			Solution entails a reversibility of action	

The next chapter presents the results of the field work. There are three main parts in the next section: (1) the data collection, which consists of the document analysis and the semi-structured interviews; (2) the preliminary data analysis which will seek to classify and analyse the data; and (3) the interpretation of the results through the use of the analytical grid presented above. An understanding of the analysis of the data collected in the field work will provide some directive as to where the gaps in decision making exist with respect to this principle, and this may reveal areas for further research.

4. Field Work

4.1. Data Collection

In this section, there will be four assessment methodologies that will be studied: Eco-indicator 99, SustainAbility, Ethibel, and FIDD. Eco-indicator 99 is the only methodology at the product level. The other three (SustainAbility, Ethibel, and FIDD) are methodologies at the organizational level. The documents obtained for each of these organizations were publicly available on the web. In most cases the information was thoroughly available. However, in the case of FIDD, although their web site was very informative in terms of the processes adopted for assessment, the details of their methodology were not available. In studying the two levels of assessment (product and organizational), it will become evident where the precautionary principle is currently used or, if not yet used in decision processes by organizations, then where it is best suited for eventual use: organizational or product.

4.1.1. Eco-Indicator 99 Life Cycle Methodology

Life cycle assessment is an effective tool in assessing environmental impacts, however it is costly and time consuming (Consoli *et al.*, 1993). In fact, the result of an LCA does not give the designer a definite answer as to which product is more environmentally sound. The results of LCA have to be interpreted. Since designers have to make many decisions during design, (80% of environmental impacts are decided at the moment of conception), they need a tool that is more accessible with respect to cost and time. Eco-Indicator 95, the predecessor of Eco-Indicator 99 is an LCA weighting tool specifically developed for product design. This tool allows decision makers to accumulate LCA results into comprehensible units called Eco-indicators. Eco-indicator 95, although often used by decision makers lacks some environmental aspects, which are addressed in Eco-Indicator 99 (Goedkoop, Effting & Collignon, 2000).

Eco-Indicator 99 was commissioned by the Dutch Ministry of Environment. It was co-funded by the Swiss National Science Foundation and BUWAL (the Swiss Agency

for the Environment, Forests and Landscapes) (Goedkoop & Spriensma, 2001). PRé Consultants established a collaborative and consultative structure which included environmental and LCA (Life Cycle Assessment) experts.

The result of the Eco-indicator program is a screening LCA procedure that is very useful for design purposes. According to Graedel (1998), methodologies that adopt a simplified approach to LCA are part of a continuum, where the regions that are less detailed, are referred to as scoping or eco-screening regions. These regions are in effect aiming to understand whether additional assessment is necessary. Therefore a screening LCA procedure is a procedure that allows designers to more easily assess their design choices. The idea of the Eco-indicator program is to have a single number for each unit process and material which reflects the cradle to grave impacts. The unit that is used for Eco-indicator 99 can be perceived as dimensionless; however the unit is named Pt[79] (an Eco-indicator point). Therefore 1000 mPt is equivalent to 1 Pt. The effort to conduct an LCA study is therefore simplified considerably.

In Life Cycle Impact Assessment (LCIA), there are basically three fields of scientific knowledge and reasoning. These fields are referred to as spheres (Hofstetter, 1999, from Goedkoop & Spriensma, 2001):

- *Technosphere*: A description of the life cycle as long as it is based on causal relations. This sphere resides mainly in the natural science paradigm, with relatively low uncertainties. Measurements in this sphere can be verified and reproduced.
- *Ecosphere*: This is the modelling of the environmental changes (damages). In this sphere the uncertainty emerges from two main areas. Firstly, the models are often uncertain because they are difficult to verify. Secondly, the data also contains uncertainties of a several orders of magnitude. In this sphere, the models are, in part, based on value choices. This makes them difficult to verify in a reproducible manner.

[79] The absolute value of the point is not relevant; its main purpose is to compare relative differences. The scale is chosen so that the value of 1 Pt represents one thousandth of the yearly environmental load of the average European (Goedkoop and Spriensma, 2001).

- *Valuesphere*: This is the modelling of the perceived seriousness of such changes (damages). This sphere also manages the modelling choices from the other two spheres. This sphere is in a social science paradigm, since the natural science paradigm cannot cope with the term 'seriousness'. Therefore this sphere is the interpretive sphere, where several perceptions exist.

In the LCA community, much emphasis is placed on the Technosphere. The Eco-indicator 95 method, among others, has raised an awareness of the importance of working in the Ecosphere. Only a few authors, namely Hofstetter (1998) and Tukker (1998, from Goedkoop & Spriensma, 2001), have shown that the Valuesphere is of equal importance to the other two spheres. Hofstetter (1998) has proposed an approach called the Cultural Theory, which had been developed by Thompson, Ellis, and Wildavsky (1990). The Cultural Theory is a system proposed to deal with uncertainties that emerge within this process. In the Eco-indicator 99 methodology, there are three main types of uncertainties:

- *(Operational) Data uncertainties*: This refers to a technical problem of measurement or assessment. Often, this refers to the difficulties in measuring or predicting effects. This type of uncertainty is often expressed as a standard deviation, and therefore relatively easy to handle (Goedkoop & Spriensma, 2001).
- *(Fundamental) Model uncertainties*: This refers to the uncertainty of the correctness of a model, such as: the choice of the time horizon in the damage model, or, whether an effect should be included, even if the scientific proof that the effect exists is incomplete. This type of uncertainty is caused by unavoidable ethical based choices. Model uncertainties cannot be expressed using a standard deviation, since it is the correctness of the model that is in question (Goedkoop & Spriensma, 2001).
- *Uncertainty on the completeness*: This cannot be documented at all because, (1) although the impact categories (e.g. acidification, ozone layer depletion, etc.) are relevant, an adequate damage model has not yet been developed, and (2) inside some impact categories, there exist more damage categories that cannot actually be presently described. This results in a known incompleteness. There is ongoing research to improve some of the modelling

in further developments of this tool. Because of the inability to model some effects, it is difficult to understand the importance of these omissions, however, at times; it is possible to get some idea of the relevance of an omission (Goedkoop & Spriensma, 2001).

The basis for making value choices in the latter two categories of uncertainties is a subjective process (Goedkoop & Spriensma, 2001). Such choices can often be problematic if the method to arrive at such choices is not well defined. Since a different version of this methodology cannot exist for every different perspective available, Eco-indicator 99 has proposed three different perspectives based on three different value systems. Therefore in the case of model uncertainties, or uncertainty that arises from a known incompleteness, the system, called Cultural Theory (Thompson, Ellis & Wildavsky, 1990, from Goedkoop & Spriensma, 2001), is used to deal with this type of uncertainty. This theory is important because of the fundamental varying perspectives of the seriousness of environmental effects. The theory is based on a grid-group typology (Figure 12). The grid is essentially the set of externally imposed prescriptions; and group refers to any group that an individual may relate to.

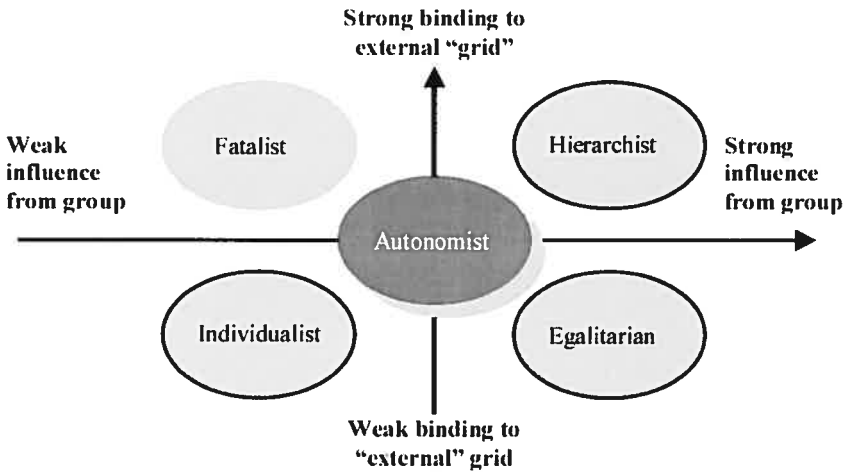

Figure 12: Grid-group dependency of the five archetypes distinguished in Cultural Theory (source: Goedkoop & Spriensma, 2001, p. 16).

This various combinations in this typology and the cultural bias of the individual can be considered as the way of life of a particular individual. This does not imply that

only five types of people exist. In fact, no one really conforms to any one perspective, and in fact, peoples' attitudes often change over time. However, this distinction is valuable as it has been used by several authors in risk perception studies (Goedkoop & Spriensma, 2001). According to Goedkoop and Spriensma (2001), although there are 5 different perspectives, only three will be used because (1) the Fatalist is too easily swayed by others' opinion, and (2) the Autonomist thinks independently therefore is not influenced within a group environment, and is not bound to any grid (externally imposed prescriptions). This perspective was not selected to be included in the Eco-indicator 99 tool, since there was no adherence to prescriptive behavior, or a capacity to shift perspectives. Therefore the three perspectives, which are based on three different sets of values, and are proposed for this method, are (Goedkoop & Spriensma, 2001):

- *Individualists*: In this perspective, all limits are subject to negotiation. This individual is not often controlled by others, but has a tendency in controlling others. In this version of the damage model, only proven cause-effect relations are included, with a short-term perspective of the impacts (if applicable). This is because an individualist will consider each limit as negotiable, but not when there is sufficient proof. Also in this perspective, the perception of time is short term because an individualist tends to believe that long-term effects can be corrected by the progress of technology.
- *Egalitarians*: In this perspective, the relations between group members are often ambiguous, and therefore conflicts arise easily. In this version of the damage model, the precautionary principle is frequently used. This is the most extensive version, yet the version that will contain the largest data uncertainties since it will attempt not to leave anything out, even those elements that are laden in doubt. In fact, data that lacks consensus is sometimes included. In this perspective, there is a long-term perspective of damage, since egalitarians do not believe that future problems can be avoided, but must be dealt with in the present.
- *Hierarchists*: In this perspective, people are both controlling of others and are subject to control. There exists a high level of stability within such a group. In this version of the damage models, facts that are backed up by scientific and political bodies with sufficient recognition are included. This is a common

approach in the scientific community as well as with policy makers.

The value of the Cultural Theory is that it allows predictability based on the basic attitudes of the three different archetypes. Each of the above archetypes is modelled, and therefore three different damage models can be developed (based on each archetype). As a result, there will be three scores depending on the perspective selected. This practise reflects the fact that there is a variety of judgments when it comes to environmental problems. The question of the temporality of damage is a subjective consideration, and therefore methods for assessing damage using models based of various perspectives is fundamental. The model that is often recommended is the hierarchist model since this model works according to consensus building processes. According to Goedkoop and Spriensma (2001), in a hierarchist model there is also a more balanced approach to long and short term perspectives. In fact, Eco-indicator 99 would have been solely based in the heirarchist model if an attempt to distinguish the other perspectives would not have been done. Often the other two perspectives are used as a means of comparison, or as a robustness or sensitivity analysis. Table 12 summarises the basic attitudes of the different value systems that can be used by Eco-Indicator 99.

Table 12: Typical values in the three different perspectives (source: Goedkoop & Spriensma, 2001, p. 17).

Archetypes: ***Predictions:***	**Egalitarian**	**Individualist**	**Hierarchist**
Criteria	Argument	Experience	Evidence
Management style	Preventive	Adaptive	Control
Distribution	Parity	Priority	Proportionality
Perception of time	Long term dominates short term	Short term dominates long term	Balanced distinction between short and long term
Intergeneration responsibility	Present < future	Present > Future	Present = future
View of resources	Depleting	Abundant	Scarce
Perception of needs and resources	Can manage needs, but not resources	Can manage needs and resources	Can manage resources, but not needs
Energy future	Low growth (radical change now)	Business as usual	Middle of the road (technical fix)
Attitude to nature	Attentive	Laissez-faire	Regulatory
Attitude towards humans	Construct Egalitarian society	Channel rather than change	Restrict behaviour
Attitude towards resources	Need reducing strategy	Manage needs and resources	Increase resources
Perception (myth) of nature	Nature ephemeral	Nature benign	Nature perverse/tolerant
Perception of human nature	Born good, malleable	Self-seeking	Sinful
Attitude towards risk	Risk-aversive	Risk-seeking	Risk-accepting

There are three main steps to calculate the Eco-indicator score (Goedkoop & Spriensma, 2001):

1. Inventory of all flows to and from all processes in the life cycle of a product. This is a standard step in LCA. This step is mainly in the Technosphere.
2. Calculation (modelling effect) of damage that these flows have to Human Health, Ecosystem Quality, and Resources. This step is mainly in the Ecosphere.
3. Weighting of the three damage categories. This step is mainly in the Valuesphere.

The social aspects that are considered in the Human Health category are based on a definition by WHO (World Health Organization, 1995, from Geodekoop & Spriensma, 2001):

> "*includes both the direct pathochemical effects of chemicals, radiation and some biological agents, and the effects (often indirect) on health and well-being of the broad physical, psychological, social, and aesthetic environment, which includes housing, urban development, land-use and transport* (p. 41)

EI99 in fact use a more restrictive interpretation because of the limitations in the scope of an LCA. They define the Human Health category by the "*absence of premature death, sickness, or irritations caused by emission from industrial and agricultural processes to air, water and soil*" (Goedkoop & Spriensma, 2001, p.41). So the social aspects (Human Health category) considered in this methodology are limited to toxicological effects of emissions.

The most crucial step in a Life Cycle Impact Assessment is the weighting step (Goedkoop & Spriensma, 2001). Therefore Eco-Indicator 99 has simplified this step by limiting the types of environmental damages that a panel should weigh to three (Figure 13). In the weighting step, a panel is not asked to weigh impact categories, such as, acidification, ozone layer depletion, etc., but instead asked to weigh the

different types of damage as a result of the impact categories. These damage categories are less abstract for the non-expert members of the panel, and therefore more meaningful. Also, instead of asking the panel to weigh a set of ten or more categories (an enormous task), they are asked to weigh only a set of three damage categories. The following are the three damage categories (Goedkoop & Spriensma, 2001):

- *Human health*: This refers to the idea that all human beings should be free of environmentally transmitted diseases, disabilities or premature deaths, present and future.
- *Ecosystem health*: This refers to the idea that non-human species should not suffer from negative changes of their populations or geographical distribution.
- *Resources*: This refers to the idea that the supply of nature's non-living resources, which are necessary to humans, should be available for present and future generations.

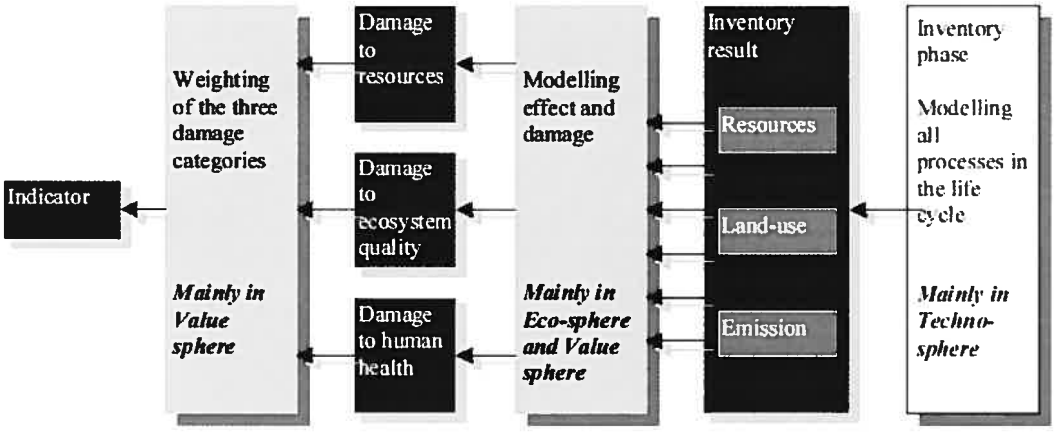

Figure 13: The core concept of the Eco-indicator 99 methodology (source: Goedkoop & Spriensma, 2001, p. 8).

It is possible to choose other damage categories such as equality, safety, happiness, etc. The Eco-indicator method does not include such damage categories mainly because they are too complex to model. Also, in general, products may have both positive and negative (environmental) effects; for example, the use of pesticides may have a positive effect on human welfare, but a negative effect on the environment, and therefore would lead to strange conclusions. What this implies, is that pesticides

allow for a more consistent source of agricultural products to be distributed for human consumption, because pesticides keep plants free from sickness; in turn humans will continue to have this source of food available to them. However, the negative effects of the pesticides on the environment because of the toxins within the pesticides that permeate the soil and water sources will result in odd findings using this tool.

The three spheres: Technosphere, Ecosphere, and Valuesphere are used to construct the basic three step approach of the Eco-Indicator 99 method. The inventory table is a result of the life cycle model constructed in the Technosphere. The three damage categories: Human health, Ecosystem health, and Resources (also referred to as the endpoints) are linked to the inventory table using the Ecosphere modelling. The Valuesphere modelling is used to (1) model the value choices in the Ecosphere, and (2) weighting of the three endpoints to a single indicator (Pt).

Even though the three steps in the Eco-indicator 99 method seem to belong to each of the three spheres, in essence, the distinction is not so clear. Both the Technosphere and the Ecosphere are faced with normative modelling assumptions and simplifications and therefore both use elements of the Valuesphere. It is important to note that the use of the Cultural Theory, discussed earlier, is used throughout the process of Life Cycle Impact Assessment, when uncertainties arise in modeling, or when modeling assumptions must be made. In such cases these uncertainties cannot be dealt with using standard deviations.

The Eco-Indicator 99 methodology can be used without the final weighting step. Instead a 'triangle concept' can be used (Figure 14), which makes it possible to use this methodology in a consensus building process. This process allows multiple views to be expressed instead of using the weighting step which may be perceived as calculating 'simple truths'.

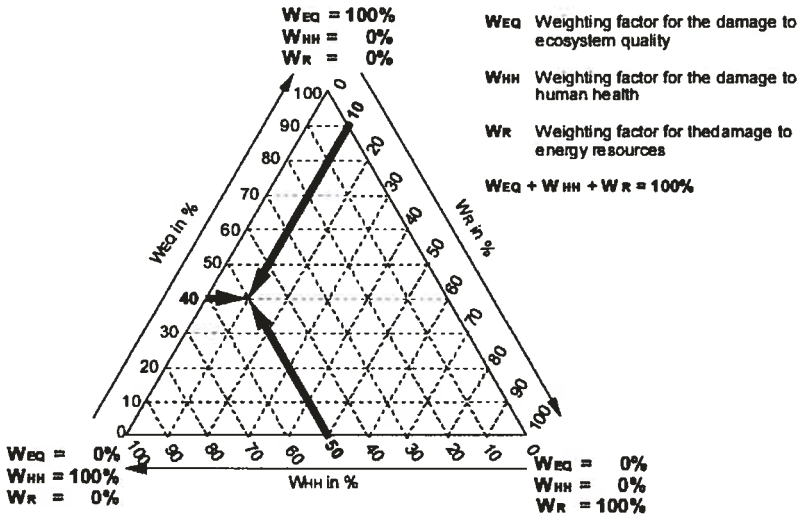

Figure 14: The mixing triangle concept which can be used in a consensus building process (source: Goedkoop & Spriensma, 2001, p. 88).

The factors used for weighting are normative, and therefore they cannot be considered to be true or false. However, a judgment can be made as to the 'true' reflection of these factors to the views of the stakeholder group. Therefore to assess if the weighting factors are an appropriate reflection, two quality criteria for obtaining weighting factors exists (Goedkoop & Spriensma, 2001, p.87):

- "*The stakeholder group is properly defined and represented in the methodology used.*
- *The methodology and procedure is designed, performed and interpreted in a carefully conducted consistent and scientifically valid procedure. The term scientific here refers to the social sciences.*"

Weighting – method used to obtain weights for damage categories

For the Eco-indicator 99 method, when weighting factors had to be determined, a questionnaire was sent out to a number of respondents. In this questionnaire several questions regarding the cultural perspectives of the respondents were used to analyze their views. This was also used to understand how their cultural perspectives coincided with their views (weighting factors to damage categories).

The questionnaire contained five basic parts: (1) brief description and purpose of the methodology, and a description of the damage categories (2) respondents were asked for a ranking of the damage categories (3) respondents were asked to assign weights to damage categories (4) they were asked basic questions so that the respondents can be categorized based on the already established categories of cultural perspectives, and (5) respondents were asked background questions such as age, sex, etc.

This information was used in part to divide the respondents into categories of eco-centric or anthropocentric attitudes. Also, based on the answers in the questionnaire, the respondents were then distinguished by cultural perspectives. This process was not evident, and not all respondents could be distinguished this way. In fact, only 29 out of the 49 respondents who actually assigned weights could be distinguished as adhering to a specific cultural perspective.

Based on the answers to this questionnaire, there was a significant correlation between their attitudes (eco-centric/anthropocentric) and the weights given for Human health or Ecosystem health. There was also not a statistically significant difference between Egalitarians and Hierarchists. However, there was a major difference between Individualists and Egalitarians in the weighting factors they provided for Ecosystem health and Human health, but not a significant difference for Resources. The discrepancy between the Individualists and the Hierarchists were only considerable for the Ecosystem health category (Goedkoop & Spriensma, 2001). Because of the substantial differences between the cultural perspectives, it is important to provide the three different damage models. As a consequence, three different indicator values can be calculated which can be used in a sensitivity analysis to further understand the impact of the product.

4.1.2. SustainAbility Reporting Methodology and Consultancy Services

SustainAbility[80] was established in 1987, a few months before the Brundtland Commission published its report on sustainable development. It is a consulting company that focuses on sustainability issues. It also provides an assessment of sustainability reporting by organizations. This report is typically released every two years and their 2006[81] was released November 9, 2006, as scheduled; it is called Global Reporters 2006. Global Reporters is their flagship research program which surveys and ranks the quality of non-financial reporting (or sustainability reporting). SustainAbility has partnered with the United Nations Environment Programme (UNEP) and Standard & Poor's to produce their fourth international benchmark survey of non-financial reporting: Global Reporters 2006.

The way in which this is done is through their benchmarking assessment methodology which provides guidelines for their analysts. The main purpose of this methodology is to assess the reporting of corporate sustainability. This assessment is used as an accounting to society of the company's commitment, performance, and impact to environmental and societal issues. This methodology is intended to assess an organization's available (disclosed or discussed) reports based on sustainability: environmental, social, community, corporate citizenship, etc. It does not explicitly address whether an organization's efforts in achieving sustainability are good or bad, since their methodology is not intended for this purpose. Such a judgement would require a set of sustainable development indicators that covers social and environmental impacts using a stakeholder approach. Therefore such a judgement is left to the stakeholders.

Mission of Methodology

The fundamental question that this methodology attempts to answer is: "*How well does an organization's disclosure enable such a user to draw comprehensive and accurate conclusions around a company's:*

- *Commitment to contribute to sustainable development in a real and strategic way, in both short and long-term.*

[80] The web site for SustainAbility is URL=<http://www.sustainability.com/>.
[81] This report is called Global Reporters 2006 and can be found on URL=<www.sustainability.com>

- *Operational performance and impacts over the reporting period.*
- *Likely future performance and impact, as judged from the quality of an organization's leadership, structures, systems, and incentives.*
- *Ability to ensure the integrity of the reporting and disclosure process itself?*" (SustainAbility, 2004, pp. 5-6)

SustainAbility does not provide a reporting framework or guideline for developing a sustainability report. However, they have sought to align their methodology with current best practise[82] in sustainability reporting (SustainAbility, 2004). An example of a reporting framework that is used is the Global Reporters Initiative Reporting Framework. This framework provides guidance on how organizations can disclose their sustainability performance. Judy Kuszewski is a member of the core team of SustainaAbility (an associate director) as well as an Associate Director Member of GRI Stakeholder Council. So there is a direct connection between the reporting framework provided by GRI and the benchmark reporting assessment methodology of SustainAbility. GRI is a non-profit organization, and is a collaborating centre of UNEP (United Nations Environment Program). This implies that SustainAbility's benchmarking reporting assessment methodology reflects current best practice reporting frameworks and guidelines.

All sustainability reporting is done from within the organization; since the reporting is done through their perspective, just as financial reporting is done from within. The sustainability issues that organizations feel are pertinent will be the issues that will be reported on. The decision on what is pertinent to report on is not a trivial task. This is what is called 'materiality'; it refers to the issues that have the largest impact for shareholder value. Two key drivers have pushed materiality onto the Corporate Social Responsibility (CSR) agenda: sustainability reporting and Socially Responsible Investment. If a sustainability issue or risk has the potential to improve or threaten shareholder value, then it is worthy of investment consideration: this is called a value-driven investment as opposed to ethically-driven investment.

As the list of sustainability indicators continuously increases, it is difficult to include all the indicators in a report, and it is difficult to see which indicators are the most

[82] The Global Reporting Initiative framework is currently considered best practise for sustainable reporting.

pertinent to report on. Materiality allows a company to manage their significant impacts and issues better. It is not recommended that an organization produces an enormous sustainability report, since it will be difficult to see what the most pertinent issues are. It is highly recommended to understand what the largest impacts and issues for an organization are, and report on these only. It is not up to an outsider to decide what is to be reported, this decision comes from the organization. However, there are often groups of stakeholders selected to assess the quality of the reporting strategy done by an organization. The selection of stakeholders is often done with advisors from SustainAbility, as this is one of the services they provide to their clients.

The Benchmark Sustainability Reporting Assessment Methodlogy

The sustainability reporting assessment for an organization is done by an analyst who is fully versed in the concepts that underlie the specific criteria of this methodology; he produces a preliminary report. Following this, a peer analyst reviews the preliminary report, and discusses the rationale behind the scores given. When the two analysts arrive at an accord, then final scores are given. The scoring is done using a generic scoring device from 0-4 points, where (SustainAbility, 2004): 0 = Nothing; 1 = Sketch; 2 = Systematic; 3 = Extensive; 4 = Integrated. The scores are in order and therefore for a report to deserve a score, indicates that the report has also passed the requirements of the lower scores as well.

The reporting assessment methodology is broken down into various elements (SustainAbility, 2004):

1. *Context and commitments*: This section assesses the organization's intentions with regard to sustainable development. The following are the major areas that it assesses.
    - Context
    - Decision-making
    - Business case
    - Vision

2. *Management quality*: This section is intended to evaluate how well the organization is positioned to implement its sustainable development objectives. The main idea that is used is the idea of alignment through:
    - How has the company aligned its in-house systems to undertake its sustainable development objectives?
    - How is the organization proactively seeking to shape external conditions to help realize its sustainable development targets?

3. *Performance over reporting period*: This section is intended to help the analyst evaluate how well the organization has reported on performance, which includes economic, social and environmental dimensions. There are also multi-dimensional performance criteria which include dimensions that naturally cross the economic, social and environmental dimensions. These include aspects such as:
    - Operational performance that directly affects sustainable development impacts
    - Actual impacts due to an organizations activities (impacts based on the development of products and/or services)
    - Their commitments for improvement

4. *Accessibility and assurance*: This section evaluates how well the organization has reported on its commitment towards sustainability through the quality and frequency of its sustainability reporting. This section provides the following type of assessment of the organization's reporting:
    - Indicate what information can be expected in the future from the organization (will it be on a regular basis and how to obtain the information)
    - To be able to interpret the information in a way that is accessible for a wide range of stakeholders
    - Ensure that the boundaries of what is included (or not included) are clearly specified; geographic, activities, contractors, joint ventures
    - Providing a level of confidence that the report is accurate and reliable.

The Consulting Frameworks

SustainAbility also provides a variety of services to organizations seeking triple bottom line. The spectrum of consultancy services ranges from simple advice to the implementation of a CSR (Corporate Social Responsibility) strategy. They also provide consultation on the reporting of risks as well as assist organizations in developing opportunities. They provide a spectrum of services to organizations that are serious about this endeavour. Some frameworks that SustainAbility has developed for the initiation of sustainability within organizations are (SustainAbility, 2006):

1. Emerging Economies Services:

Their Emerging Economies program focuses on applying their insight to the challenges and opportunities specifically faced by national and multinational companies in the developing world (SustainAbility, 2006).

2. Strategy Development & Business Case:

Through research and internal interviews, they establish the organization's current approach and vision. They compare these internal perceptions against SustainAbility's external research into the views of key stakeholders. Then they begin building a strategy, roadmap and accountability for the organization (SustainAbility, 2006).

3. Corporate Governance:

They seek to understand the current governance approach, limitations, aspirations and insights. This gives SustainAbility the inputs necessary to appraise strengths, weaknesses, opportunities and threats. The intent is to articulate the ambitions of the organization and develop a clear vision and roadmap for the future (SustainAbility, 2006).

4. Operational Effectiveness:

SustainAbility seeks to understand how the current management framework functions, its efficiency and effectiveness in relation to corporate responsibility and the constraints on and opportunities for further progress. Then they benchmark this approach against best practice and where relevant undertake external interviews (e.g. with suppliers) to understand their perceptions, issues and opportunities. This

provides SustainAbility with the inputs to help in establishing a clear vision, robust priorities and a roadmap for the future with the organization (SustainAbility, 2006).

5. Issues and Trends Analysis:

In this analysis, SustainAbility seeks to scope and prioritize corporate responsibility issues for the organization. This is done by first, undertaking research and interviews within the organization to understand perceptions of relevant issues, their current management, and the quality of related stakeholder engagement. Secondly they contextualize their approach by presenting pertinent case studies of comparable issues and how these issues have been managed by other companies. Then SustainAbility maps and prioritizes key stakeholders with respect to the evolution of the issues (SustainAbility, 2006).

6. Non-Financial Risk Management:

SustainAbility will scope and prioritize the set of corporate responsibility-related risks (or a particular risk). First, they conduct research and internal interviews with key executives and managers to understand the organization's perceptions of relevant risks and their likely evolution, as well as views on the robustness of current risk management systems and external stakeholder engagement. This will indicate to SustainAbility the extent that knowledge from the outside informs internal knowledge and action. Then, they benchmark the approach against best practice and provide case-studies of various frameworks and strategies. SustainAbility then interviews external stakeholders who can provide important insight into either a specific issue or on the overall risk management framework (SustainAbility, 2006).

7. Innovation:

SustainAbility will either use an Issue Management appraisal to help the organization understand their current situation, or help them take a more innovation focused approach. The key elements include:

- Understanding the perceptions of the challenges and opportunities by key executives and managers.
- Identifying key stakeholders that can help bring fresh perspectives.
- They will then facilitate a process for creative stakeholder inputs whose output will identify the options for innovation within a clear set of agreed

criteria.

This process will also build trust and credibility with key stakeholders (SustainAbility, 2006).

8. Stakeholder Engagement:

SustainAbility first tries to understand the organization's openness for external engagement. They will map and prioritize stakeholders according to influence/impact and the company's ability/credibility to engage. Then SustainAbility will engage directly with key stakeholders to understand their interest in a way that builds the trust and confidence by the organization as well as the stakeholders (SustainAbility, 2006).

9. Dilemma Resolution:

The most common and fundamental approaches to identifying and managing critical dilemmas in an organization are issue management and stakeholder engagement. A dilemma, its associated alternatives and trade-offs can frequently be discussed through a clear engagement process. This approach will provide a sense of assurance that the understanding of the dilemma and its possible solutions are acceptable to key external stakeholders (SustainAbility, 2006).

10. Corporate Reporting:

Most of their client work involves providing advice and direction on reporting as it relates to best current practice, key trends, corporate governance challenges, issue management and stakeholder engagement (SustainAbility, 2006).

Data Collected from Semi-structured Interviews

This section will interpret the data collected from the semi-structured interviews. There were two telephone interviews and some email exchanges conducted with a representative from SustainAbility. The interview transcription is on the right column; and the author's interpretation of the collected data is on the left column. It is important to note that SustainAbility employees may have differing views from those of SustainAbility Ltd/Inc, so where opinions are given they are not necessarily those of SustainAbility Ltd/Inc.

Name of Interviewee: Jean Philippe Renaut
Organization: SustainAbility
Position within organization: Advisor
Type of interview: Telephone
Date: November 3, 2006

Interpretation	***Question***: *What is SustainAbility's mission?*
Current best practice	"Every two years there is a different methodology for assessing sustainability reporting (...) It evolves with the best practice sustainability reporting methods available (...) SustainAbility is more of a mission driven company than a profit driven company. We get funding from sponsors, international organizations."
Sustainable consulting services provided.	"We provide various consulting services to help organizations solve dilemmas regarding sustainability. We do not do any reporting for organizations, they are responsible for their own sustainability or non-financial reporting, just as they are responsible for their own financial reporting. We only help them how to do this type of reporting using various best practice approaches."
Provide transparency of evaluation methods used.	***Question***: *Why do you provide your assessment methodology online?* "We do this for transparency so that organizations understand how their reporting is being evaluated. It is also done to give organizations a sense of the criteria we use for assessment."
Materiality an important concept when assessing sustainability reporting.	***Question***: *What is the most important aspect when assessing a sustainability report?* "Materiality ... this refers to the issues that the organization has identified as important to them in pursuing sustainability. As an evaluator of these sustainability reports, we may not always agree on the issues that the organizations has deemed important. Our job is not to put a judgment on the relevance of the issues within the sustainability context, but to assess the robustness of the internal process to identify these material issues. (...) The reporting needs to come from the inside; it cannot be done from the outside."
Credibility of sustainability reporting is an important issue to consider.	***Question***: *How do you assess the credibility of a sustainability report?* "There are several criteria we use to evaluate the credibility of a report. There is a formal assurance statement from the organization, we look at the consistency between years ... an organization cannot be expected to achieve an enormous leap in sustainability goals within a year, so when this happens the credibility of the report is questionable ... Their internal audit procedures also give an indication of the credibility of their reporting ... These are valid approaches to assessing credibility."
The criteria for the credibility of a report are completeness, accountability, and consistency.	"If a company does not have any audits done, then this will not reflect credibility... The organization must have a strategy to ensure completeness, accountability and consistency; otherwise this also does not reflect any credibility."
PP is considered as a	***Question***: *Does SustainAbility include the precautionary principle in their sustainability reporting assessment methodology?* "The 2006 methodology of benchmarking sustainability reports

method for organizations to manage their risks, no elaboration however.	(issued on November 9th) does include a small element of the PP, but the use of the precautionary principle is not thoroughly elaborated. In fact it is just mentioned briefly as an element of risk management."

Name of Interviewee: Jean Philippe Renaut
Organization: SustainAbility
Position within organization: Advisor
Type of interview: email[83]
Date: November 6, 2006

After the above conversation with Mr. Renaut, there was a realization that it would be beneficial to send him a list of questions for reflection before the next interview. This would allow Mr. Renaut to understand the context of my concerns. The questions sent to Mr. Renaut from SustainAbility on Nov 6, 2006 in preparation for our telephone interview:

1. How do you interpret sustainable development?
2. What role do designers have in sustainable development?
3. How do you interpret the precautionary principle?
4. In what cases would this principle be useful?
5. Can designers make use of such a principle in their practise? How?
6. What ethical framework do you feel is necessary in a perspective of precaution? How can this ethical framework be used in the course of decision making? Why is this ethical framework necessary?
7. How do you perceive the use of a stakeholder engagement in supporting the precautionary principle? Why is this approach useful for precaution or why is it not useful?
8. To what degree can precautionary thinking be embedded within industrial design?
9. What are the current barriers for designers when making decisions based in precaution?
10. What must be done so that designers take on a more precautionary approach towards design?

In the following section an interpretation of the main elements from the email exchanges are presented. It shows that some of the questions provided to him were

[83] Appendix 6 provides the full transcription of the email exchanges.

too broad and would require a verbal discussion rather than an email exchange to be properly discussed.

Interpretation	***Responses from J.-P. Renaut***
Some of the questions may have been too broad.	***After the 10 questions were sent for review by email...*** I have to say, this is a rather long list. Having just finished my own studies, I understand where they come from. However, if this is important to you, I don't mind spending 20 minutes discussing on the semantics of "Sustainable Development" and the "Precautionary Principle".
Not enough knowledge in this particular area to be able to answer the set of questions that were sent to him.	As for the role of designers, I have to say that this is really not my area of expertise. I understand what you mean by d'designers" (assuming you mean someone like McDonough and Braungart, or even people that shape and "design" business models such as social entrepreuneurs). However, my experience/knowledge is really limited in this area.

After these questions were sent, Mr. Renaut felt this set of questions was very large and he was not in a position to be able to answer them all; he lacks some of the experience or knowledge. So it was suggested that we would discuss and try to understand my main concern which was: Is the precautionary principle used in assessing organization's reporting, or is it recommended through consultation services, and how? This would be discussed on the next telephone interview.

Name of Interviewee: Jean Philippe Renaut
Organization: SustainAbility
Position within organization: Advisor
Type of interview: Telephone
Date: November 14, 2006 (last interview)

Interpretation	***Question**: What is your interpretation of sustainability?*
Addresses the idea of justice and equity as a way to *maximize* well-being.	"(...) a just and equitable way to maximize well-being without jeopardizing future needs... Takes into account inter and intra generational equity. Intra refers to all people that are living at the moment, inter refers to people of future generations."
Clear definition of the principle, but very limited in terms of how to address the potential risks.	***Question**: What is your interpretation of the precautionary principle?* "This is a principle that addresses potential risks with a high degree of uncertainty."

***Question**: When do you recommend the use of the precautionary principle?*

A clear idea of when to use the PP, he suggests within a context of optimization of socio-economic conditions.

"(...) The degree at which to compromise the economy with respect to environmental and social capital is a situation where the precautionary principle can be integrated to come to a more just decision (...) when you do not know what the impacts are, it is necessary to use the precautionary principle."

Organizations ignore fundamental uncertainties.

"Organizations, when faced with uncertainty would rather ignore the situation than confront it (...)The precautionary principle is seldom used by organizations because it results in an action that lacks justification, since they do not have any hard facts to back up such a decision."

Encourages it but does not follow through its use.

"(...) I would encourage the use of the precautionary principle in dilemma resolution situations; however, it is not often used."

***Question**: How would the precautionary principle be practically applied?*

Stakeholder engagement essential for precautionary situations.

"(...) first there would be stakeholder discussions ... the stakeholders involved would not only consist of local community members, but scientists, economists, in general a global stakeholder engagement."

Understands that long-term analysis is not feasible using.

"Economic studies are often not feasible in assessing a situation since they project too far into the future and therefore the analysis is often irrelevant ... same can be said for long-term risk analysis. Therefore these tools are meaningless for long-term projections."

A reciprocity rule is prevalent, and not beyond, which is what is necessary for sustainability.

"Organizations seem to be stuck in a win-win logic.... Respect the community, respect the society, do not deplete resources, all within a perspective of economic benefit, so much is often compromised in terms of the benefits to society or community."

"Social entrepreneurship often entails an enterprise with a mission that deals with some unmet social need. This is their priority, and the economic benefits are thought of as secondary, the enterprises go beyond the win-win logic of conducting business. In this type of entrepreneurship, the economic revenue often follows as the public becomes aware of the purpose."

True social entrepreneurship goes beyond the golden rule of reciprocity.

"(...) These organizations are grass-roots, whose logic goes beyond the traditional win-win logic. In the social entrepreneur, it clearly shows that some organizations are beyond this win-win logic."

***Question**: What is win-win logic?*

An attitude of efficiency is what is dominant.

"(...) respect the environment (waste less) and the society (get sued less and gain better employee) and you will profit."

***Question**: What is beyond win-win logic?*

A gift giving attitude towards society and the environment.

"I mean beyond the logic that being good for the environment and society drives profit in the company. Some entrepreneurs (and perhaps business leaders) may express some altruistic behavior, or want to create value beyond the borders of their company and their generation. This can (and should) still generate value (including financial) but it goes beyond the logic of short-term (or medium-term) profit maximization"

	***Question**: How do organizations deal with uncertainties in their situations?*
Deterministic approach to dealing with uncertainty, and at worst ignoring it.	"For organizations facing issues that are laden with uncertainties, these issues often get ignored... anything that resembles the precautionary principle is not incorporated in decisions (...) most people are taught to deal with hard info when making a decision (...) info is what allows people to make decisions for optimizing processes, reducing costs, improving productivity (...)"
This principle and its application is typically ignored because there is no 'cost-effective' way to deal with it.	"Something as vague as the precautionary principle is extremely tricky and difficult to deal with; it is equally difficult to justify a course of action using this principle."
The dominant ideology is prevalent for supporting decisions.	"In reality most people use data to justify a course of action. Analysis, be it risk or economic, is a tool to help define a course of action. The reality is that there is a habit of using data to take action and when it is missing, then how is an action justified?"
Fundamental uncertainty is only dealt with if the request is imposed by community.	"In cases of uncertainty, situations are often ignored unless there is a critical resistance within the community or pressure groups impose an action that the organization is not ready to commit to. When this happens then the precautionary principle is invoked. No other reason will currently invoke this principle."
A stakeholder approach is one way to be able to justify decisions in these cases.	"Taking a decision with a lack of data is difficult to justify. However, when stakeholders are involved in such situations, the decision can be justified because it represents a 'public' opinion, and ignoring this could prove costly."

4.1.3. Ethibel Methodology for Sustainability Assessment

ETHIBEL asbl[84] was set up in 1991 by NGOs, most of which were operating in the field of alternative and solidarity financing. Since then, ETHIBEL has grown and has adapted to the changing market conditions, and supported and steered the new visions on corporate sustainability, corporate social responsibility and business ethics. In 2000, in order to finance its growth and to make greater investments into research, ETHIBEL set up a public limited company – STOCK at STAKE sa. There was a clear split in responsibilities within the ETHIBEL Group (which now included STOCK at STAKE sa.). STOCK at STAKE sa, a social profit company, was responsible for research and analysis, while ETHIBEL asbl, the non-profit association, was responsible for assessments and selections and for all labeling and certification activities. At the end of 2005, STOCK at STAKE sa merged with the

[84] The web site for Ethibel is URL=<www.ethibel.org>; the source of this document analysis.

French rating agency VIGEO. Both Vigeo and STOCK at STAKE now form the Paris/Brussels entities of the VIGEO GROUP, specialized in Corporate Sustainability and Responsibility Research for customers in the field of Socially Responsible Investment (SRI) and for the auditing of companies to assess their level of Corporate Social Responsibility (CSR) (Ethibel, 2005). Early 2006, ETHIBEL became Forum ETHIBEL. Forum ETHIBEL maintains its responsibilities at the level of ethical assessments in relation to the ETHIBEL labels and the ETHIBEL Sustainability Indices. Gradually Forum ETHIBEL will be focusing on the stakeholder accountability aspects of SRI by linking up with NGOs, consumers, and trade unions.

Mission

Forum ETHIBEL encourages dialogue between companies, NGOs, government, SRI investors and trade unions with the aim of promoting in-depth CSR and SRI. Forum ETHIBEL's main objective is to contribute to a fair balance between economic progress, environmental protection and social justice. Forum ETHIBEL's main contributions are to develop tools and methodologies for achieving SRI and to encourage companies and organizations to meet sustainable development targets (Ethibel, 2005).

Ethibel is a consultancy agency for socially responsible investments. It guarantees the quality of the recommended organization through the use of their proprietary label. It is a European quality label[85]. The criteria used in this label cover many aspects of social corporate responsibility. The Ethibel label is a label for investment funds. When an investor only uses companies that are in the Ethibel register then he can ask for an Ethibel label for the fund. They do not certify companies but investments. They do not work for companies either (Ethibel, 2003).

Research for the Two ETHIBEL Investment Registers

The ETHIBEL research and evaluation model now serves to identify the best companies for both the *ETHIBEL Excellence label* launched in December 2004, as well as the *ETHIBEL Pioneer label.* The same strict research and evaluation

[85] This is a registered collective label for all the countries of the European Union.

methods that have been Forum ETHIBEL's hallmark for the past 14 years continue to be applied to both ETHIBEL labels. An international team of analysts of STOCK at STAKE/VIGEO group evaluates companies against a total of 106 different criteria. Assessments are still verified via consultation with trade unions, environmental and human rights organizations, among others. The final assessment and ranking and the advice to the Board of Directors is made by the Register Committee, which is an international panel of experts (Ethibel, 2005).

The ETHIBEL Evaluation Model

Forum ETHIBEL has developed an evaluation model that serves as the basis for the selection criteria for shares and bonds for the ETHIBEL Investment Register (Ethibel IR) and the ETHIBEL Sustainability Indices (Ethibel SI). These criteria may be expanded or modified depending on the results of research carried out and on the outcome of current social discussions on sustainability (Ethibel, 2005).

This methodology consists of a list of sustainable development criteria that can provide an understanding of the level of social responsibility a company adopts. It is divided into five areas. The first area is intended to provide a general understanding of the enterprise and is not part of the evaluation. The other four parts are called: Internal Social Policy; Environmental Policy; External Social Policy; and Ethical Economic Policy. There is an equal importance given to each of these parts in the methodology. A requirement of openness, transparency and respect is necessary for this evaluation.

Internal Social Policy[86]

The main areas for evaluation are the quality of the working conditions and the level of social contribution by the company. The main criteria in this policy are the working content, the conditions, the environment and the relationships. This includes an analysis of: "*the development of employment and the nature of contracts; training possibilities for employees; equal opportunity policy of the company and its effects on the number of women in higher positions, the attitude of the company towards employees of different cultures, etc.; equal wage structure; safety policy on the work*

[86] Appendix 2 contains the themes covered in this policy.

floor; negotiating structures; participation of employees in company policy." (Ethibel, 2003)

Environmental Policy[87]

This includes an examination of the internal environmental policy of the organization and the management of its production chains. Considerations such as external certifications are considered here. ETHIBEL studies the way in which the company establishes its environmental policies, such as: use of raw materials and energy; emissions and waste and; the environmental impact of the finished product.

External Social Policy[88]

The main considerations are: its attitude to human rights; its relation with developing countries; and the results of these activities. The focus here is the extent of the company's contribution toward human-centered development of society. This will include consideration of who the company relates with. It considers if the company is involved with controversial activities[89]. Such activities are directly opposed to sustainability in a very broad sense, and therefore these are seriously considered.

Ethical Economic Policy[90]

This is concerned with the ethical aspects of the company's economic policy. Some areas that are considered are: the internal control procedures to deal with internal and external risks; the interests of customers, suppliers, shareholders, the authorities and other stakeholders; the innovative capacity of the company.

Controversial Activities

In addition to the four primary criteria for evaluation listed above, the ETHIBEL evaluation model contains a separate cluster of research topics: controversial activities. The following are sectors that they consider controversial: armament, gambling, nuclear energy, tobacco, hazardous chemical, sex industry, genetically modified organisms in food and feed, alcohol, and animal mistreatment. From this set, the following will exclude the organization from further consideration by Ethibel, if the company has a major involvement in these activities: armament, gambling,

[87] Appendix 3 contains the themes covered in this policy.
[88] Appendix 4 contains the themes covered in this policy.
[89] The section on *Controversial Activities* in this section elaborates on this idea.
[90] Appendix 5 contains the themes covered in this policy.

nuclear energy and tobacco. The other controversial areas of business will lead to further investigation; it does not automatically exclude them from an assessment.

Sources of Information and Stakeholders Consultation

VIGEO GROUP analysts consult a wide variety of sources when researching companies. An important role in the ETHIBEL evaluation model is reserved for stakeholder consultation. Several stakeholders of the companies under research are contacted to ascertain their opinions of the company. Stakeholders can, for example, be trade unions, NGOs, consumer organizations or public authorities. Analysts balance the views of these companies' stakeholders with the information provided by the companies themselves in order to obtain a complete picture and to assess the companies from a broad point of view. In addition to company and stakeholder information, sources include news items and media, the Internet, specialized databases and external research of international networks. During the research the analyst also strives to engage in dialogue with the companies in order to obtain more detailed information and to better understand the companies' attitudes and behavior (Ethibel, 2005).

Company Classification System

In order to better differentiate between companies on the basis of their performance in terms of sustainability, companies are classified from A to E. The Register Committee, which is the independent advisory committee, advises the Forum ETHIBEL Board of Directors on the inclusion or exclusion of companies in the register and on the company classification. The five categories are (Ethibel, 2005):

A: Pioneers, acceptable for the register
B: Best-in-sector, acceptable for the register
C: Better than average, acceptable for the register
D: Average, not acceptable for the register
E: Below average or not transparent

Companies in categories A and B may be included in the ETHIBEL Pioneer label register. C-classified companies may be included in the ETHIBEL Excellence label register along with the A- and B-classified companies (Ethibel, 2005).

Register Committee

The quality of the work of the Register Committee is the key to the quality of the ETHIBEL Investment Register. It consists of international experts from different fields and backgrounds. The members of the Register Committee act in a personal capacity and do not represent the organizations to which they belong or where they have acquired their expertise (Ethibel, 2005).

Fund Classification System

Ethibel offers a classification of socially responsible investing based in four generations. The purpose of this classification is to indicate the ethical depth of socially responsible investment funds. Without such a classification, it is difficult for investors to select funds that are ethically based on a set of sustainable criteria that have been thoroughly considered. Only funds that are classified as fourth generation can obtain the Ethibel label certification.

First Generation

This is a negative based criterion. In this generation, the funds that do not engage in controversial activities can pass this classification.

Second Generation

This is a positive based criterion. Companies that engage in sectors that are sought after will pass this criterion.

Third Generation

In this generation, the funds must pass the above policies as outlined in the assessment methodology of Ethibel. This refers to the policies of: Internal Social policy, Environmental Policy; External Social Policy; and Ethical Economic Policy.

Fourth Generation

In this generation, all the criteria from third generation are required, plus the method of evaluation must include stakeholders. Therefore evaluations that include the stakeholders of the organization in question are involved in the evaluation process. This is the only assessment that will result in an Ethibel certification. In this evaluation method, Ethibel follows all the stakeholder discussions closely to complete the evaluation fields necessary for assessment.

4.1.4. FIDD Methodology for Sustainability Assessment

FIDD[91] is a Quebec based capital risk fund, which means that they provide funds for startup firms (typically small to medium size) that show exceptional growth potential; the organization in question should demonstrate a proactive attitude towards sustainable development. The basic definition of sustainable development that FIDD uses is based on the Brundtland definition (WCED, 1987). However, in seeking a more operational definition, they have adopted the following definition of sustainable development (Gendron & Reveret, 2000; Bisaillon, Gendron & Turcotte, 2005):

- *Society* is the objective or *goal*
- The *environment* is the *condition* (society's needs must be met, but not at the detriment to the environment).
- The *economy* is the *means*
- A system of *governance – participation* in decision making processes

Mission

FIDD's mission is to invest and develop successful businesses contributing to sustainable development. This fund constitutes an initiative for the development of more efficient technologies to small and medium-sized businesses. They define their mission statement as (FIDD, 2003):

[91] The web site for FIDD is URL=< http://www.fidd.qc.ca/Accueil.php>; this is the source of this document analysis.

> « *Le FIDD a pour mission de financer des entreprises ayant pour objet le développement et la commercialisation de technologies et de produits favorisant le développement durable. Il investit dans des entreprises proactives, environnementalement et socialement responsables.* »

FIDD's Evaluation Methodology

The main goal of their evaluation tool is to assess the organization's potential performance and not only their actual performance in terms of environmental and social impacts. Their methodology is based on life cycle analysis and is in line with the mission of LCI (Life Cycle Initiative). This methodology is used for revealing governance and also serves as a management tool. This tool is called CCM-SLCA (Cycle Capital Management - Social Life Cycle Analysis) and is a proprietary methodology. What is unique about FIDD is that they not only look at the environmental impacts, but also at the social impacts. There are four main parts to their assessment methodology: (1) contact the organization and conduct an analysis using both the CCM-SLCA tool (sustainability perspective) and a risk analysis (investment perspective); (2) the selection criteria (through an investment committee) and the identification of investment conditions are presented to the company, these are the improvement opportunities; (3) value creation via an active role in the company and creation of a sustainable development committee results if the choice for investing was taken; and (4) a reassessment of the progress using the CCM-SLCA tool is done before the second round of investment.

As a *first step*, an evaluation using the CCM-SLCA tool allows FIDD to understand the company in terms of investment risk and sustainable potential. In this step, FIDD also evaluates the business plan of the company. The proprietary methodology entails a questionnaire. The purpose of this questionnaire is to evaluate the sustainable development potential of the organization in question. This survey contains about 200 questions, which generate approximately 600 qualitative and quantitative units of data. This data is gathered by an external auditor. This questionnaire is based on a simplified LCA which was developed with the collaboration of CIRAIG (Interuniversity Research Center for the Life Cycle of Products, Processes and Services). CIRAIG is the second largest research group on

Life Cycle Analysis in the world. It is a research organization that brings together the research of several universities.

The questionnaire contains questions that consider social and environmental aspects, both at the product/technology level and at the organizational level. The questionnaire is a global evaluation tool to help guide FIDD in the assessment process of the organization's sustainable development potential; it seeks to understand the organization by not only contacting key members of the organization, but also by contacting its suppliers, and evaluating its products. Therefore this questionnaire allows FIDD to obtain quite a good picture of the potential performance of the organization with respect to sustainable development.

There may be questions within the questionnaire that the organization may not be able to answer because either of a lack of knowledge, or the question may not apply to the organization. The way in which FIDD handles this situation is that they search for additional information regarding the organization through alternate means, for example: the internet; visiting the organization; talking to the owners and employees of the organization; and talking to their customers and suppliers. Through this process of researching the company via alternate means, and in seeking a comprehensive image of the organization, they minimize their risks. This tool is not intended to be used as a final decision making tool, but instead it is intended to help them understand the potential performance of the organization. FIDD can also help the organization develop their potential since FIDD acts as a partner with the organization in question. If it is interested, then FIDD will proceed to the second step.

In the *second step*, the identification of the selection criteria and areas of improvement are presented to the company. This is where FIDD makes a decision to invest. FIDD's evaluation tool allows them to identify the strong and weak areas of the organization; they will work with them to help them optimize or improve these areas. These are suggestions for the organization, and will not be imposed, however will be encouraged as areas for improvement. Usually there will be four or five opportunities of improvement. In effect, if they impose too many improvements, the organization in question may lose interest in the partnership and that is why it tries to keep the number of improvements to a minimum. However, if the organization does

not cooperate, FIDD cannot consider them for investment. These improvements must be reasonable for both parties.

In the *third step*, FIDD seeks to support the company in the realization of the proposed improvements and to follow their progress. FIDD will provide added value through its active engagement with the company. This is where a communication protocol is established with the entrepreneur, if a decision to invest has resulted. FIDD wants to understand how the organization has or will adopt the suggestions from step two. FIDD will create a sustainable development committee within this organization, where there will be one or two members from FIDD (they will chair the committee). The purpose of this committee is to guide and support the organization in their efforts for improvement. The idea is so that the organization can become an autonomous entity with respect to such responsibilities. There will typically be two committee meetings a year for a given organization. This sustainable development committee encapsulates the health and safety committee, and any environmental committee.

The *fourth and last step* will be the closure of the investment deal. A reevaluation using the CCM-SLCA tool will be conducted. The purpose is to assess their efforts of improvement and ensure that the company has delivered on their commitments. Also, this is done in particular when a re-investment will be considered.

When does FIDD Intervene

FIDD only invests in technology that is at the beginning of the commercialization phase. This is because they want to minimize their risk and at this point in the process, most of the risks inherent with the development of a new technology have been addressed. However, this does not imply that there are no risks left; each phase is difficult in the development of a technology. The risks associated with the commercialization phase are, for example: the organization may need more employees; they may encounter problems scaling up; their need to develop a better network; and the need to create stronger partnerships. Therefore this is a very critical phase in the development of the organization, with its own set of risks.

Controversial and Preferred Sectors

There are sectors of the market that FIDD will not consider for funding: areas such as tobacco, pornography, nuclear, or armament; this demonstrates a social ethic. These areas impose risks to society and the environment so FIDD recognizes that they are a threat even before they begin the evaluation. What FIDD strives for is to be upstream of any potential risks. Therefore when FIDD is unsure of the technology (lack of knowledge), and the risks involved may be large (potential risk), they will probably decide not to invest.

The organizations that they evaluate for funding are mostly focused on renewable energy technologies or in technologies that reduce greenhouse gases. This is FIDD's area of specialty, and preferred investment sector. By limiting the choice of possible organizations for investment to these organizations that develop these technologies, FIDD has reduced their risk considerably. When FIDD considers risks, they consider them at all levels relevant for sustainability: financial, environmental and social risks. Each of these risks must be evaluated and managed. To illustrate what is meant by risk according to FIDD: Chernobyl is an environmental risk, whereas, Wal-Mart is a social risk. Wal-Mart's is considered a social risk because they do not consider the views of their stakeholders. FIDD seeks to avoid such risks because it seeks to go beyond predefined norms of acceptability.

They use GRI (Global Reporter Indicators) to guide their evaluation tool. In fact they compared GRI with their tool and found that their tool achieved 90% adherence to GRI guidelines. They use similar methods to that of Ethibel's method for evaluating organizations: they look at the chain of processes, and also look at the chain of values.

Data Collected from Semi-structured interviews

Two interviews were conducted with FIDD, but because of their proprietary disclosure policies, the transcription of these interviews could not be presented. However, based on the knowledge obtained from the interviews with FIDD, an analysis of their methodology will still be possible in the subsequent sections.

4.2. Preliminary Data Analysis

In the following section, the preliminary data analysis will be presented. Each of the methodologies will be studied in *two main steps*: (1) a *general preliminary analysis* outlining the key arguments based on an analysis of the data using the analytical grid proposed in section 3.2.3 on page 157 of this paper; and (2) a *detailed preliminary analysis* that elaborates on the arguments presented in the general analysis.

4.2.1. Eco-Indicator 99 Preliminary Analysis

In the general analysis, this methodology is effective for SMEs in assessing environmental and social impacts because it is easy to use. However, it is incomplete in some areas based on a perspective of a precautionary approach towards decision making and basic attitudes. The main areas of weakness in this perspective are: (1) it is product based; (2) it is solely deterministic; (3) social aspects are limited; (4) it deals with uncertainties using probabilities; (5) confuses precaution and prevention principles; (6) it ignores the organizational structures and its impacts; (7) and no attempt to understand the multiple value systems with respect to the cases of uncertainty.

Because it is product based, the more global problems of sustainability with respect to precaution cannot be addressed. This is because an approach that is focused on problem optimization, although extremely useful for assessing and helping to reduce the measurable environmental and social impacts, does not challenge the need or usefulness of the product or service in question. This can only be done in a perspective of understanding consumption habits and not the production of the product - even if this is done in a perspective of cradle-to-grave.

Its deterministic nature does not allow for an in depth analysis of some impacts that may not be quantifiable; this is because of the lack of data or the quality of data available[92]. The reason being is that when using only a quantitative approach based

[92]Section 1.2.3 of this paper further elaborates on this argument.

on probabilities for assessing social and environmental criteria that are laden with fundamental uncertainties, the analysis and therefore the assessment will not reflect the concerns of those experiencing the impacts.

The social aspects dealt with in this methodology are based on health and security measures as defined by existing norms (WHO, 1995, from Goedkoop & Spriensma, 2001). They do not include a more global perspective of social problems such as the working conditions of the employees based on the chain of suppliers; the equality of payment structures among gender or race; the abuse of certain groups within society, etc. This is a result of their lack of organizational perspective and so such assessments pertinent in a precautionary perspective are ignored.

Also, the way in which uncertainties are dealt with in this method is by assigning probabilities to such uncertainties. Doing this then reduces the complex concept of fundamental uncertainties to known risks, which are measurable. So even if they do differentiate between the two (uncertainties and risks) based on the models included in their cultural perspectives, they are in fact dealt with in very similar ways.

Instead of using a stakeholder approach that includes a wide set of stakeholder sets when weighting the results, decisions are made through a questionnaire distributed to a panel of LCA experts and LCA users. The results of the questionnaire will provide the values for the weighting of the damage categories. This cannot provide an in-depth understanding of the real issues and concerns from the set of stakeholders, since the recipients of this questionnaire are mostly LCA experts and users.

Therefore when uncertainties are dealt with in this manner, there is confusion as to what is considered prevention and what is considered precaution. In this methodology, even if they do seek to adopt a precautionary approach by using the Egalitarian cultural perspective, this approach is clearly not precautionary. In essence then, this methodology is a clear case of a preventive approach to assessing environmental and social impacts.

Detailed Preliminary Analysis of Eco-indicator 99

In the following section, a more detailed analysis of the methodology is provided supporting the above arguments. Table 12 depicts the three cultural perspectives used by the Eco-indicator 99 methodology. This table will be used for much of the following discussion.

Weighting Triangle

Weighting triangle may be too limiting a perspective of damage categories. The weighting triangle's three sides represent ecosystem quality, human health, and energy resources (Goedkoop & Spriensma, 2001). Eco-indicator 99 does not include in the inventory results categories such as equality, fairness, justice, responsibility, respect or freedom. These are social values that are not evaluated using this methodology. That is why the need emerges to include a social damage category. This weighting triangle limits the perspective of the damage categories to a scale that is on a micro level. A 'higher' perspective would benefit the evaluation by providing a more global and complex view of the damages of the product or service system in question. A possible fourth pole could be a social health category, over and above the *Human Health* category (Figure 15). In fact, by adding a social health damage category, this tool will then lean more towards a sustainable development assessment than its current methodology allows. Also, by adding a social health damage category, a more balanced perspective of damages to humanity will result, since human health is only one aspect of a more global societal health.

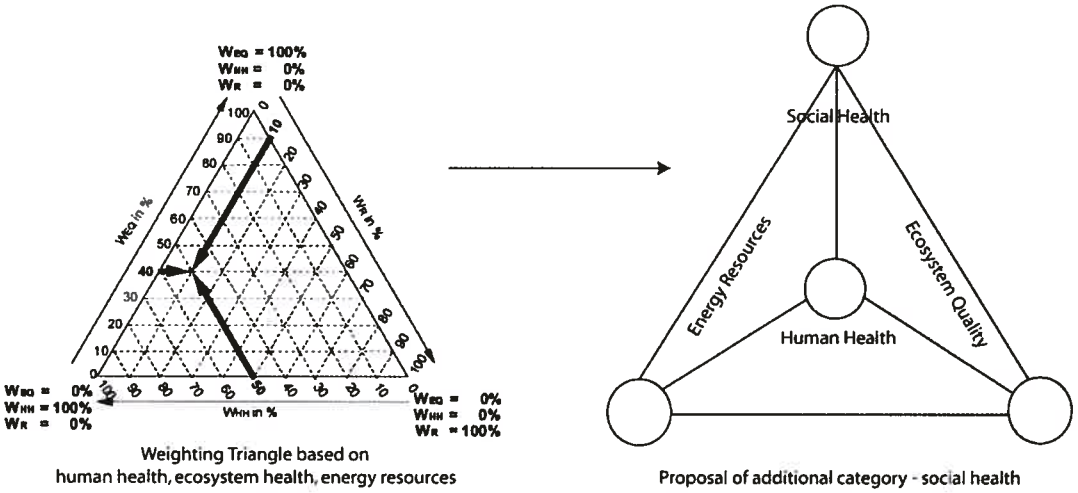

Figure 15: Proposal for additional damage category to existing weighting triangle.

This category cannot be included (or averaged) with the other damage categories. It is often the case that social, environmental, and economical categories may have contradictory elements, and obtaining an average of these damages will lead to meaningless results. It is best to leave this category separate, and use a consensus building process to decide on what category should reasonably (or justifiably) be compromised for a given situation. There are two reasons for this: (1) Eco-indicator 99 results in a unique number (mPt) but this result cannot be reached easily when society is involved through a simple assumption of variables and therefore (2) this means that a participatory approach that seeks a consensus may be beneficial in resolving the importance of the societal impact (the weight of this impact). This is because society is so diverse and the evaluation of these impacts as a result is also diverse[93]. A sustainable development perspective cannot be attained without the consideration of the society, and therefore this damage category should be considered in parallel to the three other categories that are already defined in this methodology.

Method Used to Assign Weights

As stated previously, weighting is a purely normative process. In the weighting step factors are assigned to the normalized results. The weighting factors are obtained from the views of society through a panel approach. A panel approach is defined as the direct questioning of a representative group in the society. A panel approach can be done using a consensus or discursive oriented approach, or through questionnaires. Eco-indicator 99 opted for a questionnaire, since they were not seeking a consensus, but wanted to obtain representative information within the society. In other words they did not want people to change their opinion to reach a consensus, but wanted to know what every respondent thought (representative information). This panel procedure used in the Eco-indicator 99 project was executed by Thomas Mettier (Mettier, 1999, from Goedkoop & Spriensma, 2001). The criteria for selecting the panel were (Goedkoop & Spriensma, 2001): (1) intended representativeness; (2) understanding the models and terms used; (3) panelist must

[93] Section 2.2.2 of this paper further elaborates on the requirement of a participatory approach when society is involved in the uncertain outcomes of technology.

feel motivated to collaborate; and (4) selective return. Based on these criteria, Eco-indicator 99 decided to use a panel consisting of LCA experts and LCA users, knowing that such a group is not representative of society, yet also understanding that the expected higher rate of return would make this selection more favorable, when compared to selecting a panel on a broader context. However, as will be discussed later, the rate of return was lower than expected.

In essence, Mettier wanted to obtain a statistical representation of a sample group to help them assign weights to each of the categories based on cultural perspective. There are several problems with assigning weights in this way. The primary being that the weights given by the respondents resulted in an average of all the respondents who fit a cultural perspective. If a respondent did not fit into a cultural perspective then their recommendations could not be used. As a result, the sample size of results that could be used to assign weight based on the cultural perspectives became very small and therefore the validity of these averages was questionable. Since they decided to select a process was not seeking consensus, the richness of a process based on dialogue was lost; a mutual comprehension of perspectives that may have resulted in new perspectives was foregone in the process that they followed (De Coninck, 2005; Boatright, 2006). Also an increased level of responsibility among actors could not result in such a process.

In addition, EI99 felt that by using a questionnaire, they saw the possibility of using a large panel. As it turned out, the recipients selected for the questionnaire were LCA experts and LCA users, and therefore not representative of society; this group is not diverse enough to pretend to be representative of society since they are made up of the LCA community. And, although they expected a high rate of return on the questionnaire, given that the recipients were LCA experts and LCA users, the real return rate was much lower than expected; 82 out of 365 recipients – 22% (Goedkoop & Spriensma, 2001). In the end, their goal of a statistical representative study of society was modified to obtaining statistically significant differences between the damage categories. The goal of obtaining a statistical representative study of society would require a much larger sample size.

Therefore, the method of panel selection is inadequate for several reasons: (1) the number of replies from recipients was very small (82 responded out of 365) and therefore results may be misleading. They may not be representative of the intended group; (2) there is no attempt of any discourse or interview (no interaction with recipients or among recipients) during the process of obtaining the information from the recipients (simply a questionnaire), and therefore there is a lack of an in depth understanding of the responses of the recipients; (3) because of this lack of discourse, the weighting factors may not be representative of the values of society and therefore misleading; (4) the recipients that were selected to for this questionnaire were chosen from a set of 'experts' (LCA experts and LCA users) and therefore there is no attempt to include a more general societal point of view; this may lead to views that are not representative of society; (5) there is typically a wide distribution in the answers, and therefore the meaning of the average value with this type of distribution is not very meaningful.

Cultural Perspectives

The table of cultural perspectives, which defines the three perspectives used in making value decisions within the assessment process, may have some missing distinctions. In other words the cultural perspectives have limited predictability variables. The reason why additional criteria may be important is because, based on an individual's perspective on a given criteria, this may impact the way in which they perceive the weighting of one of the damage categories. An example that may have an impact on the cultural perspectives is the perception of quality of life by individuals[94]. Quality of life may be defined in various ways, and the ways in which individuals define this may have a bearing on their vision of various other criteria. For example if quality of life is defined by the harmonious existence with nature, then the ecosystem health damage category may have a larger weighting factor that the human health damage category. By adding additional criteria, new cultural perspectives may emerge.

The cultural perspectives may be too limited in scope as well. Additional cultural perspectives may be necessary, since only 29 out of 49 respondents who included

[94] Section 1.3.3 of this paper elaborates on this topic.

weighting factors could be distinguished into a cultural perspective. This fact illustrates that it is not very clear on how to distinguish individual's into one of the three available cultural perspectives based on the information obtained from the questionnaire. There are several ways to clarify an individual's position within this model of cultural perspectives. One way to clarify the distinction is to conduct semi-structured interviews with them to help gain a better understanding of their views. Another way is through the introduction of additional predictability criteria (see previous argument). By adding more criteria, the task of distinguishing individuals within one of the cultural perspectives may be more evident, since there are more criteria to choose from.

One of the cultural perspectives (Individualist) does not answer to the ideas of sustainability and therefore is questionable in a sustainable development context. In the individualistic perspective, there is a greater responsibility towards the present than to the future. This contradicts the Brundtland definition of sustainable development, which states that "*sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own need*" (WCED, 1987, p. 43).

The Cultural Theory

The Autonomist perspective was not selected by EI99 as a cultural perspective. However, an Autonomist position signifies independence and is in fact nourished through a sense of inter-dependence (Morin, 2004). The core needs to fulfill in the development of a sense of empowerment[95] are: control (autonomy), competence, self-esteem, contribution, participation, and responsibility (Raeburn and Rootman, 1997; Thøgersen, 2005). These characteristics can help in social change since empowered individuals are competent and willing to participate within a community or their society since they feel that they have a sense of control over this milieu. Autonomy is nourished through the dependence towards others (Morin, 2005); therefore as the sense of autonomy increases, there is an increase in the capacity to make choices with and among others. In this perspective, the Autonomist is then the ideal form of cultural perspective for a precautionary approach, since it evokes the

[95] Section 1.3.2 of this paper further elaborates on this topic.

idea of choice, responsibility, competence and contribution, and therefore decisions can be based in ethic; not a prescriptive approach to decision making, but an exploratory approach. Therefore, the Autonomist, which can be equated to an empowered individual, should be included in the EI99 set of cultural perspectives since this cultural perspective is the most fertile for a precautionary approach to decision making.

Specific Criteria within Cultural Perspectives

The *management style* criterion defined within the cultural perspectives table is defined as *Preventive* for the Egalitarian perspective. This means that all uncertainties are included in the damage model; these uncertainties are included based on statistical modeling of the risks. Therefore this cultural perspective approaches uncertainties in a deterministic manner. Although this is coherent with a preventive approach, it is not coherent in dealing with uncertainties. There may be confusion between the two approaches (precaution and prevention)[96]. The epistemological framework that supports these principles is different. A preventive approach uses a deterministic approach to deal with known risks, while a precaution approach uses a complex approach to deal with uncertainties.

Uncertainty in Models

Life Cycle Impact Assessment methodologies are fundamental for stakeholders as they are an indispensable tool to assist them in their decision making. However, as significant as they may be, there is still room for improvement toward an ongoing pursuit of sustainability. A common area of weakness in this methodology is in situations of uncertainty. The way in which such decisions are made is through the predictability of three defined cultural perspectives. A very simplified characterization of these cultural perspectives using three criteria is shown in Table 13.

[96] Section 2.2.1 of this paper provides a detailed comparison of precaution and prevention.

Table 13: Simplified characterization of cultural perspectives (source: Plouffe, 2005, p. 20, section Eco-indicator 99).

	Time perspective	**Manageability**	**Required level of evidence**
H (Hierarchist)	Balance between short and long-term	Proper policy can avoid many problems	Inclusion based on consensus
I (Individualist)	Short term	Technology can avoid many problems	Only proven effects
E (Egalitarian)	Very long-term	Problems can lead to catastrophe	All possible effects

Through these criteria, they define the ways in which uncertainty, among others things, are dealt with. EI99 defines a systematic way of making such decisions. In this approach, the weighting is given regardless of the situation. In addition there is no screening of potential risks. This refers to assessing its seriousness, certainty, complexity, and ambiguity. Therefore it is not clear how situations with high uncertainty and low seriousness are treated in comparison with situations of high uncertainty and high seriousness.

4.2.2. SustainAbility Preliminary Analysis

In general this reporting methodology is comprehensive and up-to-date since it is constantly updated using best practice reporting methods; there is a direct connection between the reporting framework provided by GRI and the benchmark reporting assessment methodology of SustainAbility. This is important since without this effort, their sustainability reporting methodology would be futile; a sense of evolution within the methodology is pertinent for sustainability. This is because sustainable development reporting methods are continually evolving as sustainability issues, situations and the values needed to deal with emerging issues and situations, are more clearly understood.

The precautionary principle is mentioned as an element of risk management in SustainAbility's 2006 methodology for benchmarking sustainability reports. This reduces the precautionary principle to a rational decision making principle, based on available knowledge. In essence, this is closer to the prevention principle than it is to the precaution principle. This is because a risk management approach bases decisions on measurable data. In seeking to fit the problem with inherent

uncertainties into a risk management framework would result in decisions that are based on a lack of data, and therefore the relevance of the decision is questionable. Therefore the confusion between prevention and precaution principles may have as a result undesirable solutions. Even if there is some confusion with respect to the difference between prevention and precaution, there is substantial indication that this organization adopts a comprehensive approach towards precaution in their decision making. The following arguments will illustrate this.

SustainAbility does not elaborate on the precautionary principle in its current documentation, however, within their consultancy services, traces of a basic ethical framework of the precautionary principle are evident; for example it addresses: the issue of transparency of information (through their corporate reporting framework); justice and equality (through their dilemma resolution framework); discursive engagement and exchange of knowledge and concerns (through their stakeholder engagement process); exploration of alternative solutions (through their innovation program); corporate infrastructure necessary to effectively address corporate responsibility priorities (through their operational effectiveness), and; challenges faced in the developing world (through their emerging economies program). These are the main criteria that the organization has decided to address in their consulting services, but some criteria with respect to precaution not yet been addressed, such as: anticipative attitude towards situations of irreversibility; sense of responsibility for the future (beyond a reciprocal ethic); among others.

One limitation in this assessment methodology is that there is no consideration of addressing consumer habits and in incorporating such issues in the decision making of the organizations they consult. This implies that their approach to assessment and consultancy remain in the realm of organizational and product impacts; impacts based on what the organization produces and how it produces it. Therefore fundamental questions of how humans consume are not addressed. By not considering this perspective, their assessment remains in a preventive paradigm. This is where a precautionary approach is best applied, very early on in the conception of lifestyles. However, it can be said that they have started the transition towards a precautionary attitude, through their use of stakeholder engagement processes and their extensive value systems inherent in their decision process.

Detailed Preliminary Analysis of SustainAbility

In the following section, a more detailed analysis of the methodology is provided supporting the above arguments.

Reporting Framework recommended for Sustainability Reporting

GRI provides a reporting framework that is meant to be used by any size of enterprise. The GRI reporting framework is one example of a sustainability reporting methodology that can be used to produce a sustainability report for SustainAbility to assess. In particular, SMEs (small and medium sized enterprises) are encouraged to use this framework to help them in this reporting task. A question that arises is: why are SME's not reporting on their sustainability strategies and progresses as much as multi-national organizations, given that a reporting framework exists? Some intuitive answers to this question may be that these organizations, being small, may lack financial resources, and therefore cannot invest in such heavy reporting processes. However, further research is required to grasp a comprehensive understanding of this situation.

Assessment of Sustainability Reporting Available to Public

SustainAbility provides sustainability reporting assessment to the public, through their Global Reporters publication. This publication is publicly available on the internet, and therefore is accessible world-wide. This is an extremely necessary publication for the public since it permits them to understand the level of commitment towards sustainability of such organizations and their plans for further improvement. This report can also be used by venture capitalists that want to invest in socially responsible organizations. This sustainability reporting assessment provides an indication to the public of the commitment to sustainability from the reporting organization. The reporting that SustainAbility assesses is at a corporate level. At this level, organizations set goals, and develop strategies to achieve their sustainable goals; this indicates the ways in which they will deal with risks or uncertainties associated with their processes, products, or organizational structure.

Basic Criteria for Assessing Sustainability Reporting

The reporting assessment is limited to what an organization discloses in its reporting. It does not address whether an organization's efforts are good or bad in terms of sustainability. This methodology compares the performance of the organization based on the organization's documented intentions and overall level of commitment. The intention and level of commitment is a way to measure the level of integration within the company towards the commitment to sustainable development. If SustainAbility does not agree with the issues that are revealed in the reporting, it is not up to SustainAbility to comment on this. SustainAbility will only evaluate how well and effective the *reporting* of the impacts is done.

SustainAbility's reporting methodology is broken into four major areas: (1) Context and Commitments; (2) Management quality; (3) Performance over reporting period; and (4) Accessibility and assurance. In the Context and Commitments section, the main elements it addresses are: context, decision making, business case, and, vision. Therefore according to SustainAbility, the way in which decisions are made, based on the organization's vision is critical. Decisions in a sustainable context often require infrastructures present to be able to engage in stakeholders approaches; pertinent in a sustainable development context. If these infrastructures are not present within organizations, then this reflects badly for the organization's sustainability reporting.

Importance of LCA (or similar evaluation tools) in Sustainability Reporting

When SustainAbility assesses the reporting of an organization, a formal method for assessing environmental impacts (such as an LCA) based on their product systems is a requirement. Without such a formal method, the reporting available by an organization remains inadequate, and therefore the organization will be rated accordingly. For an organization to obtain a minimum score of 2, a systematic process to measure and evaluate contribution to climate change, air emissions, etc. is fundamental. A score that is less than 2 indicates that the organization may have provided some reporting but is inadequate in constructing a clear picture of the organization's impacts. Therefore, according to SustainAbility's reporting assessment methodology, the use of an LCA (or similar formal product impact assessment

methodology), is essential for an organization's successful environmental impact reporting; one part of their sustainability reporting.

Consultancy Services

SustainAbility also provides various consultancy services to its clients. The consultation provided by SustainAbility helps organizations by making the decision makers aware of specific organizational situations. This helps them in making changes to their organizational structure that will avoid unnecessary costs later by seeking to understand the impacts of issues early on. The knowledge acquired allows them to understand the social, environmental and economic impacts and helps them evaluate possible consequences in order to take an appropriate action early on.

In their consultancy services, there is no mention of the precautionary principle. So the ways in which risks or uncertainties (related to their product systems or their organizational structure) are managed is a decision that is made by the organization. However, in such cases SustainAbility may advise the integration of the precautionary principle for decision making. But there is no guidance by SustainAbility in this endeavor to integrate the precautionary principle in their policies. They may propose a stakeholder engagement so that decisions made in such situations can be justified. According to SustainAbility, decisions based on uncertainty cannot be justified without a stakeholder engagement since the lack of data makes such decisions difficult to rationalize. Therefore, although there is no formal mention of this principle in either their reporting assessment methodology, nor in their actual reporting of sustainable initiatives, their use of this principle is implicit.

Most consulting clients of SustainAbility are national or multinational corporations. It seems that larger corporations are in a position to reflect on triple bottom line reporting simply because of their size and financial power. Being so large, it is often difficult to shift gears quickly and therefore these organizations are preparing their groundwork for the eventual shift that will be required for sustainable development. Many large corporations have come to the realization that if they continue to conduct business as usual, they will not be able to continue doing business for very long. This

implies that they will have to make changes in their development strategies to shift from their current mode of development to a sustainable mode of development. One way that they may become aware of the disparity in their mode of development with respect to sustainable development is by going through such assessments of their sustainability strategies and reporting efforts.

Emergence of Knowledge based on Interviews

The interview revealed quite a lot of interesting information. The traditional organizations that embark on sustainable development initiatives do so in a totally reciprocal mindset; in other words, these goals will only be achieved if they are economically viable. So it seems that the economy is still a primary concern, when making decisions about sustainability issues. The only organizations that do not seem to follow this mindset are social entrepreneurs. In this type of organization, a sense of moving beyond a reciprocal approach, in contrast to the traditional win-win logic (more traditional form of returns) is their mode of operation. These organizations (social entrepreneurs) embark in such ventures because they actually want to make a positive social or environmental impact. This is interesting since, these organizations eventually become profitable without this being their primary goal.

Also, an important observation from the interview was that there is a fundamental gap in the decision making process when uncertainty arises. Decision makers experience an inability to make decisions in situations of uncertainty, let alone situations of uncertainty of harm. Most decision makers in organizations are stuck in a deterministic paradigm and have difficulty grasping the complexity inherent in the world. When it comes to a fundamental uncertainty of risks, often organizations ignore such situations or ignore the uncertainty. Organizations are not ready to deal with a concept like the precautionary principle because it is difficult for them to justify their decisions. However, it is interesting that according to SustainAbility, such decisions become justified if they are made within a stakeholders approach.

4.2.3. Ethibel Preliminary Analysis

Ethibel seeks to assess the level of corporate social responsibility in an effort to provide an Ethibel certification (a form of transparency) as a way to inform investors seeking to invest in socially responsible funds. This methodology does not mention the precautionary principle, but has many implicit elements in their decision making that include a precautionary attitude. The four areas of their methodology (internal social policy, environmental policy, external social policy, ethical economic policy) respond to criteria that covers a list of comprehensive sustainable development aspects[97].

For example some values addressed in their internal social policy are: respect for others, equality, flexibility, solidarity, fairness, and promotion of well-being. In their environmental policy, some of the values and goals addressed are: responsibility towards the environment, respect for the environment and the employees, valorization for an empowered condition among stakeholders and a comprehension of multiple values systems. In their external social policy, some of the values and goals addressed are: transparency of information, respect of stakeholder and their concerns, justice, equality, respect, fairness, a valorization for empowerment, and the promotion of well-being. In their ethical economic policy, the following are some of the values and goals addressed pertinent to the precautionary principle: transparency of information, respect of stakeholder and their concerns, justice, equality, respect, fairness, a valorization for empowerment.

When looking at the comprehensiveness of this methodology, it may seem at first that it is clearly precautionary, because of the vast amount of values adopted pertinent to this principle. However, even if many of the values and goals pertinent to this principle are adhered to, there are areas that remain in a preventive paradigm. This is because they address the problem of reducing impacts from a perspective of the organization: what it produces; its effects on society and the environment; and its effects on the stakeholders. This is a socio-economic perspective, an approach that is predominantly preventive.

[97] Appendixes 2, 3, 4 and 5 provide details of the indicators used in each of these policies.

Therefore, although this methodology is very comprehensive and quite global in its perspective for establishing and evaluating indicators, there are still elements that remain within a preventive perspective. The main reason is that they do not challenge existing consumer habits (no mention of this activity); there is no indicator that relates to the assessment of the way in which consumer lifestyles impact society, the environment, and the economy (beyond a socio-economic perspective). So in this perspective, they remain within a preventive paradigm, but have started to bridge the gap through their value systems and their extensive use of a stakeholder approach in collecting data for the assessment and the evaluation of companies.

Therefore Ethibel can be considered to stimulate organizations to move towards sustainability; this is because more and more investors are taking into account sustainable aspects. In this regard, they assume many values inherent to a precautionary attitude. But they will be limited in their progress because there is a (more global and very long-term) perspective lacking in their set of indicators; the set of indicators that can help assess the level of involvement of consumers in the conceptualization of more sustainable modes consumption.

A global, very long-term perspective can be obtained by assessing current lifestyles and searching for innovative solutions to help them transform their modes of consumption. A transformation of human consumer behaviour is necessary for sustainability; and this cannot be done solely within a preventive paradigm or within a socio-economic perspective. However, Ethibel has indicated future plans to gradually focus on the stakeholder accountability aspects of SRI by linking up with NGOs, consumers, and trade unions. By involving consumers in this stakeholder process, consumers may be able to express their values and visions of consumer habits in an effort to reduce potential harm to the environment and society. If consumers are involved in this manner, then Ethibel will have adopted a precautionary as well as a preventive attitude towards sustainable development.

Detailed Preliminary Analysis of Ethibel

In the following section, a more detailed analysis of the methodology is provided supporting the above arguments.

Internal Social Policy

In their internal social policy, the criteria are primarily based on the working conditions of the employees, employment stability, the availability of training and education, equal opportunity policies, flexibility of employee needs, health and safety issues related to employment, presence or lack of social conflicts. There are many values reflected in this set of criteria that are fundamental to a precautionary approach, such as: respect for others, equality, flexibility, solidarity and fairness. Also the promotion of well-being is sought by ensuring that the employees are protected.

Environmental Policy

In their environmental policy, the criteria are based on a reduction of environmental impacts on the life cycle of the product, which includes the chain of production, environmental management systems, involvement of employees in the development of environmental policies. In this policy the values addressed are: responsibility towards the environment, respect for the environment and the employees. In fact, by involving the employees of such discussion, there is a valorization of empowerment among the employees, a consideration of the multiple values systems, and therefore a collective approach to making such decisions.

External Social Policy

In their external social policy, the criteria are based on the adoption of social improvement to the local communities using a stakeholder approach, transparency to stakeholders, policies on human and labour rights, local development, and social investment in developing countries. In this policy there are also criteria concerning controversial activities. This is similar to the FIDD policy of not considering organizations that are involved in activities that they consider controversial. This is an anticipative decision because they are acting before any harm could occur as a result of such activities. Some of the values pertinent for a precautionary approach are: transparency of information, respect of stakeholder and their concerns, justice, equality, respect, fairness, a valorization for empowerment. In adopting these values, there is a goal for the promotion of well-being.

Ethical Economic Policy

In their ethical economic policy, the criteria are based on the economic values of the shareholders and suppliers, their customer's relations, the provision of quality products, the establishment of a code of ethics. In this policy, the values relating to a precautionary attitude that are addressed here are: sense of responsibility toward shareholders, a respect for others based on their code of ethics. A goal that is addressed is the promotion of well-being among the shareholder, suppliers, and customers.

4.2.4. FIDD Preliminary Analysis

FIDD is a risk capital venture fund; they evaluate risk based on the four pillars of sustainability. Their involvement within a company is at the beginning of the commercialization of the technology. Their methodology is primarily an organizational level sustainability assessment for the purposes of developing a partnership with the company in question. An assessment of the company's technology is done using a Life Cycle Analysis tool (CCM-SLCA). Their assessment methodology is effective in assessing an organization's environmental and social impacts and commitments because it is comprehensive. The methodology uses both quantitative and qualitative evaluation methods. The assessment is done in order to understand the potential of sustainability and not only to assess the way the organization currently operates. This methodology does not mention the precautionary principle, but has many implicit elements in their decision making that include a precautionary attitude. It is very important to FIDD that the company in question is socially responsible and that they are willing to instill reasonable changes in order to adopt improvements towards sustainability.

Some of the reasons why it is so comprehensive is because (1) it has an organizational as well as a product level perspective for assessment; (2) collects both quantitative and qualitative information about the organization; (3) it seeks information beyond that provided by the organization to complete its assessment; (4) is anticipative in its decision making since it does not consider organizations that

engage in business activities they deem controversial; (5) it is proactive since it seeks to focus mostly on the clean energy sector; (6) seeks organizations that can provide innovative solutions to current problems; (7) builds the infrastructure necessary for a stakeholder approach; (8) adopts solutions that are beyond the recognized acceptable norms (9) requires some level of traceability.

So from this list of attitudes, this organization seems to have a head start in the transition towards a precautionary approach to assessing organizations. In fact, many of the pertinent areas of a precautionary approach seem to have been addressed in their methodology. However, one area that is lacking within their assessment of an organization is an understanding of how human consumption patterns can be transformed through the solution proposed by the organization. This knowledge would be useful as a way to design lifestyles rather than optimize current modes of living. This can help in the transformation of human behavior into a more responsible mode of consumption. Because their involvement is just before the commercialization phase of a technology, these considerations can no longer be applied, since the technology has already been developed. However, because the details of this methodology are not available, this consideration may in fact be an indicator in evaluating an organization, so in this case it is not entirely clear if this is considered in their evaluation.

It is important however to mention that, even with their implicit and extensive precautionary attitude toward decision making, there is a lack of knowledge with respect to this principle. For example: (1) FIDD is somewhat unclear about the difference between risk and uncertainty; (2) and confuses precaution and prevention principles in their approach to assessing risk and uncertainty.

Detailed Preliminary Analysis of FIDD

In the following section, a more detailed analysis of the methodology is provided supporting the above arguments.

Their tool is comprehensive because it is based on both an organizational understanding of the impacts, as well as a detailed understanding of the impacts of

their technology. This is very innovative as an approach, since it provides a product level as well as an organizational level perspective of the impacts. Based on this evaluation, FIDD can perceive if the company has the potential to become more sustainable and whether it is worth their investment as a partner.

The fact that the questionnaire used to evaluate the organizations is both a qualitative and a quantitative assessment; it allows a more comprehensive picture of the organization. In fact, when FIDD cannot obtain the information it seeks directly from the organization, FIDD conducts extensive research beyond the organization. Further investigations through web sites, suppliers, employees are conducted, which allows them to complete the picture of the enterprise as much as possible. They also verify the product chains (just like Ethibel) and ensure that their commitment to sustainability goes beyond the company walls.

This evaluation allows them to understand the strong and weak areas of the enterprise. This tool allows them to avoid problems instead of simply displacing problems. Their final decision does not rest solely on these results. This questionnaire is meant to evaluate the potential and not the actual level of sustainability. This is a significant difference since, they not only want to invest, but they also want to help improve proactive enterprises. Also, their stakeholder approach to solving some of the organizations weaker areas is a commitment to a decision making process that seeks to obtain a mutual comprehension of their values and visions.

FIDD has a goal of moving beyond the recognized levels of acceptability with respect to dealing with risks. This is an ambitious goal and is one of the reasons why they focus their investments primarily on the clean energy sector, but is not limited to this sector. In fact, FIDD does not consider organizations that engage in controversial activities. This is a proactive, anticipative attitude using a long-term perspective.

FIDD requires that the organization in question has obtained external certification for various incentives. In other words, FIDD wants the organization to be traceable. One way of achieving traceability is by being able to acquire such certifications that confirm the commitment towards the acquired certification.

Even with this inherent precautionary attitude, their knowledge of the precautionary principle is limited. They are aware of the definition of this principle, however are somewhat unclear about some of its details. When asked about the difference between risk and uncertainty, they did not have a clear distinction, and therefore their treatment of uncertainty and risk does not appear to be much different.

It is interesting that, according to SustainAbility, SME's produce a very small percentage of publicly available sustainability reporting; this according to SustainAbility is a result of lack of time and/or resources. In fact, FIDD also claims that SME's are not really willing to engage in large scale changes because of their lack of time and capital, (such as reporting on their progress towards sustainability). This is a huge gap in the goal towards sustainability, since SMEs account in Quebec for about 85% of all businesses[98].

Just like SustainAbility, FIDD stays up-to-date with current best practice for evaluating sustainability by keeping close ties with LCI and other similar organizations. In fact, they seek to adhere to GRI standards. This is important, because their methodology keeps evolving as the issues, concerns, and knowledge related to sustainability also keep evolving. So FIDD aims to adopt current best practice with respect to their methodology.

The extent to which FIDD adopts a precautionary attitude towards decision making is very wide-ranging; they use the precautionary principle inherently in their decision processes; even if their knowledge regarding this principle is limited. However, there is an inadequacy in their scope of assessing the organization and its technology. Their involvement occurs just before the commercialization of the technology; this means after the technology has been developed. At this point, FIDD will seek to optimize the technology based on social and environmental impacts. Such a late involvement cannot allow a reflection on a solution that can be obtained through an understanding and possible transformation of human consumption patterns. This implies that FIDD does not consider the involvement of non-experts (over and above

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[98] URL=<http://stat.gouv.qc.ca/>.

that of experts) in devising possible solutions that seek the transformation of current lifestyles towards those that are more sustainable.

Therefore this mode of involvement is more downstream than is appropriate for a precautionary approach. What this means is that the technology in question is based on a concept of eco-efficiency and not a notion of sufficiency. It is assessed based on the intent to reduce its environmental and social impacts; this remains a preventive approach. A precautionary approach would entail looking for solutions that seek to improve quality of life in a more upstream perspective; by satisfying fundamental human needs through innovative solutions that seek to transform lifestyles. Therefore in essence they are still primarily within a preventive paradigm, yet their decision making contains many elements that are precautionary.

4.3. Interpretation of Data Using Analytical Grids

Table 14, Table 15, Table 16, Table 17, and Table 18 synthesize the information acquired from the preliminary data analysis. These grids are based on the analysis criteria defined in the previous chapter. A '+' indicates that the organization in question has adopted the criteria. A '–' indicates it has not adopted the criteria. A '?' indicates it is not clear if the organization has adopted the criteria based on available data. An explanation is provided where a description is necessary.

Table 14: Analysis of precautionary values used within methodology.

Values	EI 99	Sustain-Ability	Ethibel	FIDD
Responsibility	+	+	+	+
Fairness	-	+	+	+
Respect	+	+	+	+
Futurity	-	+	+	+
Equality	-	+	+	+
Justice	-	+	+	+
Freedom	-	+	+	?
Empowerment	-	+	+	+
Solidarity	-	+	+	+
Dignity	-	+	+	+
Transparency	+	+	+	+
Non-maleficence	-	+	+	+
Flexibility	-	+	+	+

Table 15: Analysis of precautionary goals inherent in methodology.

Goals	EI 99	Sustain-Ability	Ethibel	FIDD
Social cohesion - Protection of common good	-	?	?	?
Promotion of well-being	+	+	+	+
Ensure Reversibility of actions	-	-	-	-
Ensure Non-substitutable damage is avoided	-	-	-	-
Harmony with nature – Ecological integrity	-	?	?	?
Major transformation of consumer habits	-	-	-	-

Table 16: Analysis of general decision making strategies adopted.

	EI 99	Sustain-Ability	Ethibel	FIDD
Temporal perspective (long-term or very long-term)	Medium term	Medium and Long-term	Medium and long-term	Medium and long-term
Scope of problem (global spatial perspective of assessment)	Product/ process (cradle-to-grave)	Global when considering developing countries	Product chain and global when considering developing countries	Product chain and global when considering developing countries
Impacts Criteria upstream of production considerations	Product/ process	Corporate/ product	Corporate/ product	Corporate/ product
Epistemological approach towards methodology	Statistical	Statistical/ Heuristic	Statistical/ Heuristic	Statistical/ Heuristic
Uncertainty/Risk Process Adopted	Expert-expert	?	Expert - expert	?
Solution type in cases of uncertainty	Problem optimization (alternative materials, processes, form) - Tactics	?	?	?
What measure is most often taken in cases of uncertainty	Pre-defined assumption	No action	?	?
What type of stakeholder approach is adopted	Only if weighting is not selected – experts only	All stakeholders of organization	All stakeholders of organization	All stakeholders of organization
How are the multiple values systems comprehended?	Not considered	Only consulted	Only consulted	Only consulted

Table 17: Analysis of adherence towards a general precautionary approach.

	Precautionary Attributes	EI 99	Sustain-Ability	Ethibel	FIDD
Ontological Perspective	Collective process in decision making	-	+/-	+/-	+/-
	Comprehension of multiple value systems	-	+	+	+
	Consideration of temporal and spatial consequences (global, long-term solutions)	-	+	+	+
Epistemological Perspective	Based on values and knowledge	-	+	+	+
	Anticipative decision	-	-	-	-
	Sense of solidarity towards common sustainable goals	-	+	+	+
	Complex vision of world (inter-dependence of elements)	-	+	+	+
Methodological Perspective	Adaptive approach to defining norms	-	-	?	?
	Normative stakeholder approach	-	+	+	+
	Looking for global solutions and not problem optimization	-	?	-	-
Teleological Perspective	Proactive solution	-	?	-	-
	Considers health and safety beyond satisfaction of norms	-	+	+	+
	Solution entails a reversibility of action	-	-	-	-

Table 18: Analysis of general knowledge of precautionary principle.

	EI 99	Sustain-Ability	Ethibel	FIDD
Aware of the Precautionary Principle	+	+	+	+
Clear Definition of the Precautionary Principle	+	+	+	+
Differentiation between risks and uncertainties	+	+	?	?
Different treatment between risk and uncertainty	-	-	-	-
Differentiation between prevention and precaution approaches	-	-	-	-
Are stakeholder approaches used for decisions taken in cases of uncertainty	-	-/+	-/+	-/+
Are there existing Tools or Framework used for supporting decisions of uncertainty (besides a deterministic approach)	-	?	?	?
Is the measure taken proportional to the perceived danger	?	?	?	?

An important observation from the above classification of data is that all organizations studied have not yet adopted methods of searching for solutions where fundamental changes to consumer habits are considered. The idea of adopting transformational changes based on existing consumption habits in seeking sustainability is lacking on the most part based on the data available for this analysis. These organizations are primarily concerned with improving the social and environmental conditions based on the impacts of the technology at hand, the product or service, or the organization's behaviour. These perspectives remain within one of optimization based on production and not within a perspective of transformation based on consumption. Even if the criteria that the studied organizations use is based on a cradle-to-grave perspective or a world-wide perspective, the main issue of over-consumption has not yet been addressed. The inability to measure the impacts of consumer habits and understand how such habits can be radically transformed is a primary area of concern is seeking sustainable development, and in particular a sustainable mode of design. This refers to transformational changes within society and not only marginal or incremental changes towards the current modes of production.

In fact, according to Princen (2003) even if a public participatory method were used in a context of optimization of current modes of production (the idea of efficiency) this would not be enough to move towards sustainability. He suggests that public participation be used in a context where individuals or groups of individuals confront risks with the intent of searching for innovative solutions that entail long-term well-being. He refers to this as the idea of 'sufficiency'. This is where fundamental human needs have been addressed in a more in-depth and comprehensive non-materialistic manner.

In the next section, a more comprehensive discussion of the results of this research will be presented. The intent is to emphasise the key concepts that emerged as a result of not only the field work, but the literature review as well.

General Discussion and Results

This paper is separated in two main parts: (1) the literature review and critique; and (2) the research protocol and field work. The intent of the literature review and critique was to lay the foundation of this study which included a historical perspective of sustainable development, the limits of current design approaches for moving towards sustainable development, a justification of the use of the precautionary principle for sustainable design and the theoretical framework used in this study. The literature review and critique resulted in the establishment of the main concepts used for developing the criteria necessary for data analysis in the field work.

The research protocol and field work allowed an emergence of the key elements arising from the literature review and critique. In this section, the aim was to comprehend the ways in which the precautionary principle is used by organizations in decision making processes when assessing sustainability. The approach to data collection was a qualitative approach; the methodological tools adopted for this research were document analysis and semi-structured interviews. The data collected during the field work were analyzed using the criteria established in the first part. The following is a summary of the results of both parts of this research.

Literature Review and Critique

Sustainable development is an encompassing term that includes the idea of "*(...) development that meets the needs of the present without compromising those of future generations*". Because of its general nature and in particular its ambiguity regarding responsibility towards the environment, society, and the economy, it has been a difficult task to operationalize. The definition of sustainable development by Gendron and Reveret[99] (2000) has attempted to provide a definition that is operational and seeks a convergence of the three main pillars of sustainable development: environment, society, and economy. In fact without the 4th pillar of sustainable development 'governance' as defined by Bisaillon, Gendron, and Turcotte (2005), it seems that an implementation and progress towards sustainability

[99] This definition is: the ecological integrity is the *condition*, the economy is the *means*, and the social and individual development is both a *goal* and a *means*.

will continue to be limited. One of the main reasons is that decisions are still predominantly made within an economic perspective, whether they are regarding impacts to the environment or society. This is the definition of sustainable development adopted by this paper.

Historical Perspective

The environmental and social problems that face humans today such as: the degradation in biodiversity; degradation in the quality of air, water and soil; reduction of natural resources; and living conditions of people living in poorer countries, are unprecedented. In addition, world population has risen dramatically in the past 200 years resulting in continued stress on natural resources. However, it is not only world population that is a concern with regards to the developmental crisis, since 80% of the earth's resources are consumed by 20% of the earth's population, and the other 80% of the population wants to achieve the same standard of living as the 20% (Durning, 1992). Therefore, it becomes clear that it is not only a growing population that is a concern for the current crisis, but the consumption habits of the affluent societies as well. Therefore if a mode of sustainable development is envisioned for the future, without which the future of humanity faces disaster, the impacts of consumption habits are to be understood and transformed into more sustainable modes.

Design has become an increasingly significant means for achieving sustainability. The responsibility of designers has become more complex because design now has to consider the environmental, social and economical impacts of production and consumption. Tools and strategies for establishing and assessing such impacts have evolved considerably; they have evolved to deal with the emerging problems. At first, strategies were primarily end-of-pipe, meaning that pollution prevention at the production site was the main method. This meant that technology was developed to clean up contaminated air, water or soil as a result of production processes. These were considered strategies within a green design approach. It soon became evident that these provided a very limited view of the problem, and therefore, in addition to end-of-pipe, middle of pipe and front-of-pipe solutions were established. These strategies were part of an eco-design approach. Other strategies such as DFX and

life cycle assessment methodologies were also established within this approach. Life cycle assessment tools sought to evaluate environmental and social impacts of product and service systems based on multi-criteria methods with a cradle-to-grave perspective. They continue to be essential tools for designers since they help designers optimize their product and service systems based on the environmental and social impacts assessed. As pertinent as they continue to be, some limitations have arisen as well. For example, even if social aspects are considered in these tools, the scope is not at the most global scale since these impacts are based on existing norms and laws of health and safety. In addition the perspective of life cycle assessment tools is based on the product or service system, therefore limiting the more global perspective of impacts that lie outside this realm. Sustainable design seeks to address the limitation of scope by considering global, long-term perspectives of not only impacts based on production, but also on consumption. This is because environmental and social impacts do not depend only on what is produced, but also on how humans consume.

Comparison of Precautionary and Preventive Approaches

A comparison among the evolving design strategies and their corresponding paradigms revealed that both green and eco-design fall in the realm of preventive approaches. This is because they are primarily concerned with optimizing solutions, finding the most efficient and socially beneficial methods for producing products and services. These approaches are preventive because they address concerns and issues based on production, and seek solutions that are short and medium term.

On the other hand sustainable design, the most recent of the design strategies, addresses current issues and concerns on a more upstream way. It seeks innovative ways to satisfy fundamental human needs by focusing, among others, on human consumption patterns. This is a different perspective than that of preventive approaches that focus on impacts based on the production of product and service systems.

Precaution as a complement to Prevention

Therefore, based on the fact that prevention and precaution address different problems, the precautionary principle can therefore be used as a complement to LCA. A precautionary approach pulls the reflection to the very beginning of conceptualization and asks a different set of questions compared to a preventive approach. This approach is based on finding solutions to problems that may have catastrophic consequences and therefore seeks transformational changes and not optimizations to existing situations. A preventive approach can be used during the design of product or service systems and asks questions based on their optimization. Therefore in this scenario, they complement each other; in fact, prevention and precaution become a new learning cycle as the results from an LCA can be used in future reflections within a precautionary approach.

Efficiency and Sufficiency

In fact, an attitude of prevention can be equated to the principle of efficiency; whereas an attitude of precaution is more closely adapted to the principle of sufficiency (Princen, 2003). Efficiency entails the optimization of products and services so that they will produce the least possible negative environmental impacts; it is primarily a medium term approach. This remains in the environmental improvement category of solutions, where strategies are related to marginal or incremental changes. Sufficiency, on the other hand, seeks to transform the ways in which humans live; it is a very long-term, global vision. This entails an attitude of living within ecological limits and engages individuals to reconsider current habits of over-consumption (Princen, 2003). This implies alternative forms of social organization. Ecological integrity and social cohesion are important concepts for sufficiency according to Princen (2003).

Epistemological Barrier

In essence then, each of these principles, precaution and prevention, fall into different epistemological frameworks. The prevention principle is dealt with using a first generation system's approach; a system's analysis approach which works within a system that is structured, deterministic, and closed. This approach falls within a

neo-mechanist epistemology. The precaution principle, on the other hand is dealt with using a second generation systems approach; this is a constructivist approach where the system is assumed open and dynamic. It adheres to the framework of complexity.

Therefore the types of problems that the precaution and prevention principles seek to solve are intrinsically different. In a preventive approach, the problems are well-defined and well suited to the deterministic approach it abides by because the objective is to optimize a product or service system based on available data. In a precaution approach, the problems are considered ill-defined and therefore a deterministic approach is not suitable. Because of the inherent uncertainty of knowledge regarding potential catastrophic danger in a precautionary situation, impacts cannot be assessed based on expert knowledge alone. This is because the experts disagree on the consequences of the technology, and therefore knowledge and values beyond the 'knowledge producers' becomes fundamental when searching for possible sustainable solutions. According to Bachelard (1938), science has progressed against the notion of common-sense and ordinary knowledge; this has become a source of epistemological obstacles to the advancement of science. The realization that an epistemological barrier exists as decisions shift from a preventive approach to a precautionary approach is fundamental in comprehending an operationalization of the precautionary principle.

Theoretical Implementation of the Precautionary Principle – Ethical Framework

Therefore in a precautionary paradigm, the decision making process is characterized by its anticipative, subjective qualities. Because of the upstream point of view, a more heuristic approach prevails. Instead of searching for solutions through the optimization of the problem, solutions are sought through the search for innovative alternatives. In addition, because situations that require a precautionary approach are based on uncertainty of potential harm, then to justify decisions requires the knowledge, values, and visions of non-experts as well as that of experts, since the experts disagree among themselves regarding the impacts or outcome of an action. It is therefore evident that uncertainty becomes a weakness when it has to serve as a predictor by which to take action. Since humans are responsible for their actions,

and ethics is based in action, then decisions based in uncertainty require an ethical framework.

An ethical framework for the precautionary principle would typically be a dynamic and complex process since it requires an understanding of the evolving human condition. There is a sense a recursion in this process since the understanding of a situation will change the perspective of future situations. Therefore such an approach would be approached within a systemic paradigm using a complex approach. This would allow an understanding of real world conditions, constraints, and opportunities. A systemic paradigm, in contrast to a mechanist paradigm, will allow a comprehension of the various interrelated elements in a situation to emerge. This will require a global perspective seeking short, medium, long and very long-term solutions. A sense of responsibility to others, including those not yet born becomes a basic value for a precautionary approach to decision making.

Methodological Implementation of the Precautionary Principle – Stakeholder Process

The complex epistemological framework that characterizes a precautionary approach for sustainable design will encourage multiple points of view in the process of problem resolution. A stakeholder approach to decision making is a promising method, not only for the justification of decisions, but also encourages the creation of a wide set of possible alternatives. This will have as a result, not only a more insightful final solution, but also the permeation of the manifested knowledge to the stakeholders involved.

Such an understanding would encourage stakeholders in an ethic and rhetoric that they are not accustomed to. Therefore this new way of thinking when addressing problems must be learned, used, developed, and adjusted. In this manner, the precautionary principle will allow an adaptive approach to decision making based on several reasons: (1) it adapts to each situation, (2) it allows an adaptation of any previous understanding of controversial situations to current situations without having any of the values imposed. This refers to the general context of prudence; decisions based on prudence seek to use any available (current and/or previous) information to use as a starting point, and adapt to the new situation based on a collective

discursive process where the visions and values of each stakeholder are revealed. It therefore becomes an adaptive process; requires the acceptability of criteria which are defined by the stakeholders, where consensual solutions emerge.

This process will allow the rights of the various stakeholders, which includes the rights of future generations, to be taken into consideration. Empowerment becomes an essential characteristic for the stakeholders. A sense of autonomy, competence and relatedness to others therefore must be addressed for such a process to be effective. Empowerment allows individuals or communities to take control of situations they perceive as unacceptable and therefore enables them to contribute to innovative alternatives. In a context of sustainable development, and in particular, a precautionary situation, these individuals or communities have contributed to a long-term, global, sustainable solution. In this case then, the stakeholders have become global citizens and can use each situation as a value and knowledge building exercise; in which their current values and knowledge can be applied within the perspective of sustainable design.

Stakeholders should be able to rely on a general conceptual framework that would allow them to realize projects, define procedures for participation, and to respond to crucial issues of sustainable development. This will result in a common philosophy, as well as a dialog among stakeholders. This basis of collaboration and exchange among partners will encourage an emergence of co-creation processes of projects and co-formulation processes for solutions and projects. These processes are based on dialogue and will encourage a larger mutual comprehension of new perspectives and an increased level of responsibility among actors (De Coninck, 2005). This approach therefore responds to the purpose of design proposed by Levy (from De Coninck 2005) since it changes the world in a recursive way.

Research Protocol and Field Work

In this part, sustainable assessment methodologies were studied. They were looked at through a perspective of the precautionary principle for design resulting from the first part. This research sought to comprehend how such methodologies dealt with situations of uncertainty in their decision processes. The methodologies that were

studied were Eco-indicator 99, SustainAbility, Ethibel, and FIDD. Eco-indicator 99 is based on a Life Cycle Analysis framework, and therefore adopts a 'cradle to grave' perspective of the product or service system. SustainAbility, Ethibel, and FIDD are organizational level sustainable assessment methodologies, and therefore adopt an organizational perspective. FIDD is based on life cycle thinking. The research tools used in this part were semi-structured interviews and document analysis. A discussion of the semi-structured interviews will be presented first, followed by a general discussion of the findings from the document analysis.

Semi-structured Interviews

Semi-structured interviews were conducted with key representatives from both SustainAbility and FIDD. The interview transcription for FIDD could not be included in this paper because of non-disclosure policies. However, the FIDD knowledge obtained through these interviews allowed me to understand their methodology without having to reveal any of its details.

For the semi-structured interviews, there was an initial set of questions set out, and provided to SustainAbility. However, according to SustainAbility, these questions required too much specific knowledge about the precautionary principle and design, and therefore this initial set of questions was revised. A second set of questions was prepared for the interviews; which became the guideline for the interviews conducted. Even this set of questions, after reviewing the results of the analysis and attempting to classify the information according to the analytical grids, became evident that these questions could have been asked differently. This realization was a result of the incomplete knowledge in the final analysis[100]; there is still much information that needs to be collected in order to fully understand the positions of the organizations studied.

The representative of SustainAbility that was interviewed was knowledgeable about the precautionary principle. But because this principle is not elaborated in their methodology; it seemed unclear how this principle could be used effectively in decision making within organizations. According to this interviewee, most

[100] The results based on the analytical grid are provided in section 4.3.

organizations ignore fundamental uncertainties and prefer to deal with known risks since these are easily assessed and decisions can be made based on the data available. However, in cases of uncertainty, organizations cannot easily justify decisions, so when an organization decides not to ignore such situations, then a stakeholder engagement process is necessary for a justification of a decision.

From the interviews conducted with FIDD, it became evident that their understanding of the precautionary principle was limited. They were aware of its definition, but their understanding of how it can be approached in a decision process was unclear; similar to SustainAbility. In fact, their distinction between risk and uncertainty seemed weak; they used these terms interchangeably. When they talked about the assessment of risks and in seeking to reduce these, there was little consideration about fundamental uncertainties; their primary concern was to reduce the risks that they had control over – which is primarily a preventive approach.

The next section will present the findings from the document analysis. It is divided into three main parts: (1) a discussion about the four methodologies studied; (2) a discussion about the product level methodology studied (Eco-indicator 99); and finally (3) a discussion about the organizational level methodologies studied (SustainAbility, Ethibel, and FIDD).

Eco-indicator 99, SustainABility, Ethibel, and FIDD (The four methodlogies)

To begin this section, it is important to understand that SustainAbility, FIDD and Ethibel do not have a formal definition of the precautionary principle in their methodologies. SustainAbility mentions it in their methodology, but with no elaboration on its definition or use. In fact, it seems that even if the definition of the precaution principle is known (information obtained through the interview), very little else is. This is not an alarming fact, since this principle is ambiguous and controversial, and therefore organizations prefer to steer away from it. However, they all seem to embed basic values of the precautionary principle informally within their evaluation processes.

This is in contrast to Eco-indicator 99 which claims to include the precautionary principle in their assessment methodology of a product system's impacts. However, this integration seems weak. Eco-indicator 99 implements the precautionary principle through probabilistic methods. Very little stakeholder engagement is done, and if at all, it is within the expert LCA community. Therefore, even if they claim to be precautionary, this methodology is clearly not.

The integration of this principle that is informally executed by SustainAbility, Ethibel, and FIDD through their values, stakeholder approach, and visions is more effective than that of Eco-indicator 99. And in these cases there is no explicit intent in using it. These three methodologies assess an organization based on their stakeholder engagement processes adopted. To obtain an acceptable rating, it is required that this process is one of mutual comprehension of the values among the stakeholders, and not one of simple consultation. In this respect, then they seek to understand the goals and values of the stakeholders of organizations, and based on these they seek sustainable (or more sustainable) solutions that can be integrated into the organizations.

However, this is not enough to conclude a precautionary approach has been adopted by simply adopting a stakeholder approach. To establish if a precautionary approach has been adopted, it is important to understand how these organizations approach their decision making, in particular, how they perceive the problems of sustainability. Using a lens that is constantly looking at the production and organization alone, ignores an essential dimension; that of understanding human consumption and seeking to improve the quality of life for all by consuming the least amount of commodities. This entails the social acceptability of this transformation of lifestyles. The following paragraphs will elaborate on this criterion.

Eco-indicator 99 (Product level assessment methodology)

LCA is the basis of the Eco-indicator 99 methodology. LCA is fundamental in a prevention approach and problem optimization approach to sustainable design. It is a very sophisticated tool that after analysis, results in a list of the impacts of a product or service system. It defines 10-12 pertinent damage categories. Using these

categories, an assessment is made where decision makers use this information to support their ultimate course of action. These tools are indispensable for product and service system development when decisions are to be made downstream (when a product or service system is ready for analysis). Eco-indicator 99 is a tool adapted to SMEs, since a full blown LCA is too expensive and time-consuming for such organizations to use.

As fundamental as Eco-indicator 99 methodology is for designers, some basic shortfalls have emerged: (1) the impacts are expressed in damage categories, and therefore the actual source of the problem is not known; (2) the units are normalized for the European scale and therefore are not accessible to organizations outside of Europe; (3) there is no attempt for a consensus building process in the assessment of uncertainties, except within experts; and (4) the assessment is at the product level and therefore may be too far downstream the development process to be able to avoid unnecessary costs incurred during development.

After studying this tool, it became evident that although it is indispensable to designers for product and service system optimization, in cases where data is lacking, or the source of the data is questionable, the output of this process becomes less reliable. In such cases it is not sufficient to fill in the 'gaps' by making assumptions, since based on these assumptions, the outcome of this process may be very different. Therefore a more systematic process for assessing situations in cases of lack of knowledge or reliable data is required. It is appropriate to conclude that this assessment methodology does not adopt a precautionary approach in the manner that has been elaborated in this research.

SustainAbility, Ethibel and FIDD (Organizational level assessment methodology)

The three organizations studied have very different mission statements, yet are all concerned with assessing aspects of sustainability for organizations. SustainAbility assesses organizational sustainability reporting and produces a bi-yearly report of the best sustainable reporting organizations based on their publicly available methodology. FIDD assesses an organization's sustainability potential with the intent of possible and eventual funding. FIDD's methodology is based on life cycle thinking.

Both are based on best practice reporting frameworks and guidelines by GRI. The purpose for Ethibel's assessment is to obtain a 'corporate social responsible' certification. All three organizations require a stakeholder approach for completing evaluations of the organizations in question. In many of these stakeholder processes, the intent is more than consultation, it is in fact seeking consensus among stakeholders.

The power of sustainability assessment methodologies at an organizational level is their ability to visualize problems upstream of the development of product systems. This means that decisions can be made before products are designed and therefore these methodologies can address situations before the actual product system is conceptualized. This is beneficial for organizations as their inherent costs of development are drastically reduced. This type of methodology allows for a perspective with a broader scope of the situation and therefore designers can actually make decisions about adherence to sustainability prior and during the conceptualization of the product or service. This allows designers the ability to acquire a global view of the situation; compared with decisions that are made on product systems alone.

SustainAbility, Ethibel, and FIDD, corporate level sustainability assessment methodologies, require the use of a systematic method for assessing environmental impacts based on their technologies or products, and relating such results against the organization's objectives. In this perspective, the use of a Life Cycle Analysis tool (or similar) is fundamental. Therefore when organizations use a combination of LCA assessment for product level impacts, and a form of corporate level sustainability reporting to report on their progress towards sustainability, this allows a global perspective of their situation. In this approach, the key issues and concerns emerge as a result of the combined approaches. The corporate level reporting allows an emergence of the issues related to the organization, their governance, their approaches to risk management, their social impacts, etc., while the product assessments allow them to measure the impacts of their products or services and compare these against their corporate objectives.

Having said this however, what is not considered in these organizations is the way in which the companies conceptualize new product or service systems. In all these cases, they are concerned with the impacts of the products and seek optimization for these. There are no indicators that can measure if these organizations are addressing issues related to consumption practices, in an effort to reduce and transform the ways in which humans consume. Such indicators would be useful for assessing progress towards sustainability since they would allow an understanding of the relationship that humans have with their environment (this includes their societies). Such indicators could only be established using a stakeholder approach. None of these companies adopt this type of thinking. Therefore, although they all have very comprehensive methodologies in assessing organizational trends towards sustainability, a fundamental perspective is absent. Without this approach to conceptualization of products and services, then these organizations remain, in part, within the realm of prevention, since they seek to optimize their organizations' activities based on the production of their technologies or products.

It seems however, that the most effective level to adopt a precautionary attitude is at the organizational level and not at the product level (as in a methodology like Eco-indicator 99). This is where transformative attitudes could take place. Indicators that address consumption practices and their impacts on society and the environment can be added at this level since these can affect the way in which decisions are made at the very early phases of conceptualization. Having such indicators will provide methods of assessing the level of transformation of human behaviour with respect to consumption patterns and the impacts that result.

Therefore a precautionary attitude is not *entirely* manifested, even if at first glance, these methodologies may seem to be *primarily* precautionary. The inherent values and goals of each of these organizational level assessment methods are definitely coincident with sustainable thinking, and in fact with a precautionary attitude. However, even if they are moving towards a sustainable paradigm, they will be limited in their progress because of the limitations in their way of thinking. They are thinking about efficient ways to solve the problems they address, and not ways to transform human consumption behaviour.

This is where the epistemological and methodological paradigms become fundamental. If these companies want to really embrace sustainability, they must adopt a precautionary approach in addition to a preventive approach. This entails a transformation in their thinking and practice; to move beyond an attitude of efficiency and adopt an attitude of sufficiency (Princen, 2003). This is where the epistemological gap discussed earlier resides. This means that the way in which design is approached is not only though cooperation from citizen (Marchand, De Coninck & Walker, 2005), but also through an understanding of human behaviour, an understanding of fundamental human needs and how *the most needs can be satisfied with the least amount of commodities*. This is an approach of sufficiency and this is what is necessary for adopting a precautionary attitude for design. In fact, this is what will allow the shift from an eco-design into a sustainable design mode of conception.

So even if these three organizations (SustainAbility, Ethibel and FIDD) have inherently many characteristics that are pertinent for a precautionary approach towards decision processes, they still remain, to some extent, in a preventive paradigm based on the fact that they are still within an optimization mode (efficiency) and not one of transformation (sufficiency) mode of problem solving. A precautionary approach implies a preventive approach is also prevalent, just as a sustainable design mode entails that an eco-design mode is also prevalent. These attitudes are complementary, yet incremental because they do not oppose each other; a precaution attitude encapsulates prevention; while a sustainable mode of design encapsulates eco-design. This refers to their co-presence and co-determinism; each requires the other so that the 'system of assessing impacts' can evolve in a manner that is consistent with the concerns of humans.

However, the main obstacles in confronting and integrating concerns related to the precautionary principle within each of the four organizations studied are a reflection of the difficulties that emerged from the literature review. This means that there is an aversion to dealing with long-term uncertainties, situations in which it is very difficult, if not impossible to assess with any certainty the potential danger of such long-term consequences. Therefore in adopting a precautionary attitude, and therefore a sustainable mode of design, more global, long-term solutions will be the result.

In closing, it seems that Eco-indicator, although it seeks to integrate the precautionary principle within its assessment methodology has adopted the weakest form of precaution; it is based on probabilities primarily. So in essence, this methodology can be considered to exist within the paradigm of prevention, and therefore a deterministic paradigm. However, it is difficult to conclude with absolute certainty if SustainAbility, Ethibel, and FIDD are more precautionary than preventive. This would require more investigations, since some of the ways in which decision are made is not entirely clear. Although, they have adopted most precautionary values and goals, and many modes of decision making pertinent to precaution, some fundamental gaps still exist in the ways in which sustainable solutions are adopted. As mentioned, they seem to remain in a mode of addressing problems through optimization, and not through a transformation of human habits. In this sense, the relationship that the stakeholders have with the world may not change as drastically as is necessary for a significant engagement towards sustainable development.

Conclusion and Recommendations

One of the main obstacles in an implementation of sustainable development is the fact that, often, development, in the hope of benefiting all, intensifies contradictions and results in social tension. This is because the benefits of development are not only economic, but are also benefits of access or capacity of resources. The acceleration of development towards the progress of technology and economy, although may result in various social benefits for numerous individuals and communities, often also results in destructive effects for many as well.

Agenda 21[101] was established as a plan of action towards sustainable development at the Rio Earth Summit. However, the lack of progress towards sustainable development was evident at the Johannesburg World Summit on Sustainable Development (WSSD), ten years later in 2002 when ongoing discussions continued to reveal a division in values and visions. In the *United Nations Framework Convention on Climate Change*[102], a key principle was identified called "The Common but Differentiated Responsibility" (CBDR). This principle revealed that industrialized countries must take the lead in addressing the climate problem as they are disproportionately responsible for the effects of green house gas emissions.

This refers to the fact that the degradation of the environment as a result of the uneven nature of the world economy has resulted in a gap that is very difficult to resolve. This gap, sometimes referred to as the north-south gap, represents the fact that globalization has resulted in production and consumption patterns that are inequitable to countries that have a weak position within the world economy. The north has a greater responsibility for resolving the current crisis because of its greater contribution regarding the deterioration of the environment as a result of its vastly greater economic development and therefore environmental needs (Aubertin & Vivien, 2006). The Rio Earth Summit was critical in positioning the environmental crisis at the top of international agendas. The idea was to seek a more equitable economic development while seeking to resolve the environmental crisis. However,

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[101] This is one of the five agreements adopted at the Rio Earth Summit. Further information on this agreement can be found at URL=<http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm>.

[102] This is one of the five agreements adopted at the Rio Earth Summit. Further information on this agreement can be found at URL=<http://unfccc.int/2860.php>.

the inequality between north and south in terms of responsibilities was and continues to be a major hurdle in the progress towards sustainability.

Therefore the effects of inequality and injustice; the intolerance of others; the vast socio-economic differences; the dishonesty in business practices; the links between economic and political power; the possibility of equal access and capacity; etc. are critical concerns in a reflection towards sustainable development. An ethical reflection based on such concerns becomes an essential point of departure. New areas of justice and responsibility must be discovered; otherwise the tyranny of money will eventually destroy quality of life; the goal of achieving harmony with the environment; the preservation of individual and community identities; and community and family values. Therefore, sustainable development is more than an ecological project; it is inherently a social project.

The dilemma is that the world environment continues to be devastated as a result of the lack of progress towards sustainable development. For example, forests are disappearing at an alarming rate and have become a major concern; between the years 2000 and 2005, the world had a net loss of 37 million hectares of forest[103] (equivalent to 91 million acres). This has as a consequence the disappearance of species that are dependant on these ecosystems; a drastic reduction in biodiversity. In addition, the demand for fish has reached levels where fisheries are experiencing declining fish stocks, resulting in reduced catches, and threatened fisheries[104]. And carbon emissions have risen approximately 3 percent per year since 1900. In fact, the United States, in 2005 accounted for 21.2 percent of the global total of carbon emissions[105], yet has rejected the Kyoto Protocol[106]. There is an emergence of multi-national organizations demanding that their governments impose new laws and regulations that will enforce an adherence towards sustainability, including a demand for strategies that will allow them to respect the Kyoto protocol.

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[103] Compiled by Earth Policy Institute from U.N. Food and Agriculture Organization, *Global Forest Resources Assessment 2005* (Rome: 2006), URL=<www.fao.org/forestry/site/32038/en>.

[104] Compiled by Earth Policy Institute from U.N. Food and Agriculture Organization, FISHSTAT Plus, electronic database, at URL=<www.fao.org/fi/statist/FISOFT/FISHPLUS.asp>, updated March 2005; United Nations, World Population Prospects: The 2004 Revision (New York: February 2005).

[105] Calculated by Earth Policy Institute from U. S. Department of Energy, Energy Information Administration, International Energy Annual 2004 (Washington, DC: July 2006), at URL=<www.eia.doe.gov/emeu/iea>; BP, BP Statistical Review of World Energy (London: 2006).

[106] This protocol is referred to as the *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. Further information is available on URL=<http://unfccc.int/resource/docs/convkp/kpeng.html>.

In addition, current techno-scientific innovations also contribute to environmental and societal risks. Technologies such as genetic engineering, pose risks that are unprecedented to humanity. The ease with which the creators of these technologies can escape the responsibility of releasing potential catastrophic threats based on their technologies has become a major concern. Their accountability towards these threats is not adequately dealt with. Such technologies, among others, have irreversible and non-substitutable effects on the environment and societies; in some cases centuries may pass before effects are felt. Therefore situations that require an analytical framework taking into account long-term perspectives and their irreversible effects have emerged. The examples are numerous: destruction of forests; effects of reduced biodiversity; effects of nuclear waste; effects of carbon emissions; use of pesticides, effects of genetic engineering, etc. All of these have fundamental consequences to society and therefore societal concerns cannot be overlooked when establishing sustainable solutions.

As a result of radically transforming ecosystems because of the unknown outcomes of techno-scientific innovation, means of assessing such global impacts has become an imperative. It follows that an analytical framework to assess such problems requires an ethical process. This is because current technology has acquired an inherent power over nature, society and humans and therefore entails some level of prudence and moderation in the search for sustainable solutions. If an ethical analysis in decisions of long-term uncertainty is averted, irreversible or tragic consequences for humans and the environment may result. An attitude that ignores such consequences is in effect in denial of the dangers that modernity and its thinking entail.

Addressing such concerns requires the need to go beyond prescriptive measures and adopt measures that involve a consideration of the future, which are anticipative and heuristic. In other words, a need to go beyond existing norms and laws and accept the fact that social involvement and responsibility can contribute to the reversal of this crisis. Environmental improvement signifies a deceleration of the rate of degradation. It is a preventive approach, and although it is essential, it is inadequate on its own for dealing with the current crisis. This approach remains in an

expert realm, and therefore does not consider the concerns of others. Sustainability implies moving beyond environmental improvement, since this concept will not resolve the crisis but simply slow it down. Sustainability strives for ecological integrity; moving beyond the status quo of the environment, while providing an equitable exchange of resources and capacities to all members of current and future generations. This necessitates a critique of existing norms. Therefore norms can no longer be thought of as final, but are continually evolving to reflect the values and visions of those affected.

What this implies is not only addressing environmental and social issues from a perspective of searching for efficient solutions based on problem optimization approaches, but also implies dealing with such issues based on an attitude of sufficiency (Princen. 2003). This requires a shift in perspective of the problems that face humanity. By focusing on a transformation of human behaviour and their modes of consumption, then design can respond with innovative ways that will not only improve harmony with the environment and societies, but also responds to an improved quality of life for all. Therefore the changes that are sought are not marginal or incremental; they are not based only on providing the most efficient solutions. Instead, the aim is in searching for innovative modes of living within communities; in ways that can contribute to long-term positive impacts on the environment and society.

The focus therefore moves from the optimization of products and services to the transformation of consumption patterns. This will encourage innovation at the source of the problem; changes in human behavior can provide global, long-term improvements to current social and environmental problems. Without a perspective of reducing the impacts as a result of human behavior and consumption habits, in contrast to assessing impacts based solely on the production of goods and services, a fundamental perspective of possible alternatives may be ignored. Such an understanding can be based on the system of fundamental human needs as proposed by Max-Neef[107]. In this perspective all needs are accessible and in fact it is recommended to address as many needs as possible with the least amount of

[107] Section 1.3.3 of this paper elaborates on this system of needs.

satisfiers and resources; implying that the idea of moderation is embedded within solutions.

Therefore without the values of moderation and prudence, infinite sustainability is not possible. This requires a type of development that places an accent on projects that seek to improve the quality of life for current and future generations; where the effects are reversible. Flexibility, diversity, and adaptability are key elements of this type of development; a system that is adjustable and correctable is necessary when failure occurs. An attitude of sufficiency is therefore essential since it strives for solutions that are beyond the value neutral (or normative neutral) solutions proposed by optimization techniques. Therefore the adaptability and flexibility of norms becomes a necessary condition in this approach.

An attitude of precaution falls directly under the notion of sufficiency since it seeks to address the issues of responsibility regarding potential threats, while enabling social integrity and equity. A precautionary approach identifies when a potential risk is too great, and therefore imposes an alternative course of action. In fact, this approach seeks to eliminate threats, not displace them, by assessing various alternatives before a course of action is selected. Therefore a precautionary approach supports innovation; in contrast to its detractors, which perceive this principle as a spoke in the wheels of innovation. And so it responds to the purpose of design and in particular contributes to the development of the well-being of individuals and society. Design can achieve this through a recommendation of new concepts and experiences that will ultimately change the world in a recursive way.

However, tools or frameworks must be available for designers in this endeavour. This work cannot be done in isolation or within the realm of experts alone, since a comprehension of the various value systems based on the plural visions of the common-good will be necessary and cannot be achieved within the current frameworks of decision processes. A stakeholder approach that considers the values of all could then address the idea of the common-good. Therefore current approaches to decision making when seeking to reduce environmental and social impacts remain insufficient on their own. This is because current methods for decision making are predominantly preventive and based on the values and

knowledge of experts alone. A precautionary approach towards design requires a different framework since it has moved beyond the expert realm, beyond the problem optimization approach, and has adopted a global, long-term perspective.

In an attempt to include an implementation of the precautionary principle within the epistemology of the prevention principle, a limitation immediately arises. Precaution cannot simply be fitted into the same way of thinking as prevention; this cannot be because precaution prescribes to a different set of conditions compared to the conditions that the prevention principle abides by. In a preventive approach, risks are known and measurable. Uncertainty of harm is at the core of the precautionary principle, and therefore cannot use the same method of assessing the problem as the prevention principle. A lack of scientific data in a precautionary situation renders the preventive approach to decision making process problematic. Alternative means of decision making are then required, since it is not evident what action to take based on scientific data alone.

A requirement for an ethical framework emerges, one that is based on the fundamental values of a society, and not only based on the respect of norms and practises; therefore to substitute a deontology with an axiology as a framework for the decision making process. This entails that beyond the professional deontological responsibility, there is a need to consider the process of decision making based on an ethic of the future. This implies the development of a framework which is more global and fundamental. Such a process will require alternate forms of social organization necessary so that stakeholders can present their values and visions to others, in an effort to justify innovative courses of action and ultimately adopt an axiology of decision making.

Shared goals and an agreed upon ethic are necessary for social change. A sense of solidarity, which refers to a sense of equity and respect among stakeholders and seeks to achieve the common-good, is an essential condition. This also entails a sense of empowerment; individuals who feel competent, autonomous and want to be involved in the establishment of solutions that aim to improve the quality of their lives and that of their communities. In this perspective humans are no longer powerless regarding the consequences of technological innovations. This would result in an

eventual transformation of the relationship that humans have to their world. Instead of seeing the world as an entity that simply provides the elements for the well-being of humans, it would be perceived as a place where a harmonious existence is essential for a continued future for humanity.

Therefore an understanding of the various values systems and sustainable visions becomes a starting point. A participatory deliberative process would allow an emergence of these through debates and eventually a definition of shared values and goals would result. Through this framework, the stakeholders can identify and assess various alternatives to unacceptable situations. Assessing the alternatives in cases of uncertainty is not evident: How can the complex impacts of the behaviour of human consumption be 'calculated' using a deterministic tool when the impacts are so diverse, complex and uncertain? Yet, assessment methods are pertinent as they allow an evaluation of the alternatives proposed. These assessment methods, not yet developed in a perspective of precaution, are essential to this process of deliberation.

In seeking to assess progress towards sustainability, indicators can be used as a means for evaluating progress. These indicators would be the result of an ethic, a set of values, and visions used to assess progress towards an improved quality of life while remaining in harmony with nature. Therefore the aim of such indicators in this perspective would be to understand and assess human consumption patterns in order to transform these habits into sustainable and responsible modes of behaviour.

The main differences between the existing prevention and the proposed precaution approaches for establishing and assessing impacts are presented in Table 19. This table compares LCA, current SLCA methods and the proposed SLCA based on this study. These 3 methodologies are compared using an ontological, epistemological, teleological and methodological perspective. This comparison reveals the shift necessary in adopting a precautionary attitude for the development and evaluation of indicators in a sustainable development context. The results of this synthesis were obtained from both the literature review and field work and are based on various authors cited throughout this paper. Some of the information from Table 2 on page 19 is integrated within this table since it elaborates on the major differences between

the various design approaches. There are also some similarities between this table (Table 19) and Table 9 on page 117. This is because a point of departure in understanding the main differences between the three methodologies originated from a comprehensive understanding of the fundamental differences between prevention and precaution.

Both LCA and current SLCA are tools within the eco-design approach because of (1) the way in which decisions are made; (2) the scope of their concern; (3) what they seek to achieve through their approach; and (4) how they achieve it. They adopt preventive measures using a meso level scope (product and service systems), and medium term temporality. Both LCA and current SLCA assume predominantly deterministic methods for the calculation of impacts. The means of arriving at solutions is through a mode of problem optimization based on eco-efficiency. The impacts in both these approaches are founded on the ability to assess the degradation of the environment and society within a perspective of the economy. This implies that the impacts are negative based since they seek to assess degradation. This assessment is deliberated within experts. This is in contrast with the proposed SLCA.

The proposed SLCA, based on the precautionary principle resulting from this study, assumes a different way of thinking and adopts diverse methods for identifying and arriving at solutions. A precautionary approach responds to the vision of sustainable development more adequately because of several reasons: (1) it seeks very long-term and global solutions; (2) it provides an additional perspective, based on lifestyles and human needs; (3) it seeks to establish and assess impacts based on a positive perspective and not the traditional negative impacts used in current approaches; (4) it is based on an approach of sufficiency which encourages social cohesion and ecological integrity more adequately than an approach of efficiency; (5) it is based on a complex framework and therefore can contribute to integrated solutions; and (6) because the reflection occurs very early during conceptualization, innovative solutions to lifestyles can be obtained. For these reasons, the proposed SLCA based on this study more directly adheres to a mode of sustainable design. Table 19 summarizes the 3 methodologies described.

Table 19: General summary of preventive and precautionary approaches toward the establishment and assessment of solutions towards sustainability. © Cucuzzella, C., 2007

		LCA	SLCA (current research)	SLCA (proposed research)
Ontology	**Principle**	Prevention	Prevention	Precaution
	Scope	Meso – medium term (product and service systems)	Meso – medium term and (product and service systems)	Macro – very long-term and global (lifestyles)
Epistemology	**Epistemological paradigm**	Systemic 1st generation	Systemic 1st generation	Systemic 2nd generation
	Epistemological framework	deterministic	deterministic	complex
	Approach	Efficiency	Efficiency	Sufficiency
Teleology	**Decision basis**	Production	Production	Consumption and human needs
	Perspective	Negative based (assesses degradation to environment primarily)	Negative based (assesses degradation to society and environment)	Positive based (assesses lifestyle transformations; how the most fundamental human needs could be satisfied based on a integrated solution)
	What is assessed?	Environmental and social impacts based on the production process of a product or service system	Environmental and social impacts based on the production process of a product or service system	Sense of responsibility towards environment and society and adherence to set of values of stakeholders
Methodology	**Applicability**	Any product and service system	Any product and service system	Any project that presents potential catastrophic dangers
	When is it applicable?	When product or service system is developed	When product or service system is developed	Before any product or service system is conceptualized; based on satisfaction of fundamental human needs
	How are indicators assessed?	Among experts	Among experts	Among stakeholders

Indicators and the assessment of impacts are essential for all 3 approaches described in Table 19. In a preventive approach this is done when the product or service system is developed, therefore the changes possible are incremental, based on the scope of the product. A measurement step is necessary to calculate the

impacts; this is done through the data collection based on the inventory component. It is a predominantly quantitative process within a deterministic paradigm. If uncertainties exist with the data, they are typically treated using subjective statistical methods. The indicators are based on the effects of chemical use, resource use, and specific industrial processes. The results of these indicators are the impacts and are typically values such as carbon emissions, levels of toxicity, levels of acidification, etc, in other words, negative impacts. An assessment of these results is necessary in order to evaluate the environmental risks. This is a quantitative or qualitative process, and is done through classification, characterization and valuation. The values of the expert are inherently embedded within the assessment.

The process of establishing and assessing impacts of *products and services* based on a *preventive* approach differs from the process of establishing and assessing impacts of *scenarios* based on a *precautionary* approach. In effect, the types of indicators used in a precautionary approach are of a different scale and perspective. To illustrate this difference, Table 20 presents a possible example of such an indicator. The way in which this indicator example was established is based on an understanding of various elements presented in this paper, such as: (1) the evolution of design approaches and their respective strategies; (2) the precautionary principle in a general sense; (3) and, in particular, the precautionary principle for design practice; (4) the various ethical theories and their pertinence with respect to precaution; (5) the satisfaction of fundamental human needs founded on values and existential considerations; (6) the theory of empowerment as a driver for social change; and (7) an understanding of current sustainable assessment methodologies. Also, the models in Figure 8 and Figure 9, on pages 134 and 136 respectively provide the groundwork for this indicator example since these models illustrate the evolution of concerns adopted in the various design approaches. This example's pertinence rests on the fact that humans are not only socio-economic beings, and therefore the indicators used to assess social impacts must include concerns that are beyond a socio-economic perspective, as this indictor example presents.

Table 20: Example of a possible indicator based on a precautionary approach. © Cucuzzella, C., 2007

Indicator Category: ***Global Vision***	**Guiding Principle:** ***Precaution***	**Indicator:** ***Fundamental Values***	**Variables:** ***Existential Variables*** (being, having, doing, interacting)	**Result:** ***Positive Impact***
Social Cohesion	Anticipative Reversibility Multiples values Valorizes future generations Proactive Safety and Health beyond norms Global spatial perspective Very long-term temporal perspective	Freedom	*Being* -autonomy, passion, self-esteem, open-mindedness *Having* - equal rights *Doing* - choose, develop, awareness, dissent *Interacting* - anywhere	Assess the level of freedom (based on the scenario and the points of view of each stakeholder)
		Identity	*Being* - sense of belonging, self-esteem, passion, open-mindedness *Having* - language, religion, work, customs, norms *Doing* - grow, get to know oneself, commit oneself *Interacting* - everyday settings, places one belongs to	Assess the level of identity
		Understanding	*Being* - critical capacity, curiosity, intuition *Having* - literature, teachers, policies, educational *Doing* - analyse, study, meditate, investigate *Interacting* - schools, families, universities, communities	Asses the level of understanding

The first step in assessing impacts of scenarios within a precautionary approach, necessitates a precautionary framework: the consideration of the level of uncertainty; the level of perceived danger; the action taken (will it adhere to laws, norms or beyond?); and the proportionality of solutions adopted (based on economic constraints, socially acceptable norms, etc.). Because indicators in a precautionary approach evaluate scenarios or lifestyles, the reflection in this approach is done at a much broader scope than in a typical LCA. In addition, they are based on the values and visions of each stakeholder regarding the effects of these scenarios or lifestyles, and therefore cannot be calculated using a deterministic method as in a preventive approach. The process of assessment is a qualitative process, within a systemic paradigm. This is because the assessment requires the cooperation of stakeholders and considers the point of view of each seriously. Variables are necessary in assessing the indicators as they allow a way to characterize the pertinent areas of concern. However, unlike the variables within a typical LCA, they are based on

existential considerations and are therefore flexible and adaptable within a participative process. Some examples of indicators are freedom, equality, etc., in short, positive impacts are sought. At the core of the impact assessment is an evaluation of the level of adherence towards the vision within a precautionary framework. The debates, through which the deliberation can take place, will allow the emergence of the various points of view, as well as the possible sustainable solutions. This process will not only result in an increased responsibility among the stakeholders, but the social acceptability of the proposed solutions as well.

The indicator example presented in Table 20 can be used to assess a scenario or lifestyle with the intent of seeking a sustainable solution. This implies that the impacts of consumption habits can be assessed using such an indicator. The results of such an assessment would reveal how fundamental human needs have been addressed through a comprehension of the impacts. As a means of comparison it may be necessary to understand the impacts of both, the situation to improve, and the proposed solution. The *indicator category* represents a vision towards sustainability, and the specific *indicator* represents fundamental human values. The attributes of the precautionary principle as defined in Table 9 on page 117 are used as a model for the assessment of the variables; the *guiding principle*. The possibilities of attributes that can satisfy the *variables* will be based on each stakeholder, and what they deem significant. It becomes evident that such indicators are no longer in a perspective of socio-economic concerns, but a broader perspective of social and environmental responsibility.

Therefore a new set of indicators may be necessary which are based on an ethical framework of the precautionary principle. Ethics and values are reflected in the selection of indicator sets; the choice of indicators comes out of the consideration of an ethic. This choice of indicators will be established through a participative forum and therefore a system of governance is essential for this process so that it can ensure that the common-good of the stakeholders is considered. In this approach, then society not only is the main consideration of such indicators, but they are also the means through which these indicators are established. The definition of

sustainable development[108] adopted in this study has therefore been addressed through such types of indicators, since the society is both a *goal* and a *means* for achieving sustainability in this approach.

These indicators will focus on problems at the source; on understanding human behaviour, and how fundamental needs could be satisfied while seeking to stay within a harmonious relationship with the environment and society. So an understanding of human behaviour, in particular human consumption habits with respect to fundamental human needs become the foundation of these indicators. These indicators will be established for the purpose of assessing current problems on a global scale that impose an alternate course of action and therefore require a complex framework for their reflection. Such problems and their assessment will be in constant evolution as the reflection required to understand them evolves as well. This will result in solutions that will seek to transform human consumption behaviour; essentially a social change.

This approach is not intended to replace existing assessment methodologies. It cannot, since on its own it is insufficient as well. Both a preventive and a precautionary approach are pertinent in shifting towards sustainable development as presented in Figure 9 on page 136. Each one has its purposes; and based on the perspective of the problem, the appropriate approach will be used. In some cases, a combination of both approaches may be necessary. For example, when alternatives have been proposed based on precautionary approach, it will be necessary to assess the particular impacts of the proposed product or service systems using preventive based indicators. This will be done at a later phase of design; through the perspective of the production of the solution, and not a perspective of an understanding of human behaviour. Existing preventive assessment methodologies remain fundamental because assessing known impacts on a product perspective will continue to be an essential support for decision making. Therefore the approach that is being proposed will be used as a complement to existing preventive approaches.

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[108] The definition of sustainable development adopted in this study is: the ecological integrity is the *condition*, the economy is the *means*, and the social and individual development is both a *goal* and a *means* (Gendron & Reveret, 2000). This definition is presented in section 1.2 of this paper.

In essence then, to shift from eco-design towards sustainable design, it becomes essential to adopt a precautionary attitude in addition to a preventive attitude for decision making. This implies that over and above existing methodologies that are primarily based in a preventive paradigm, it is necessary to establish a new dynamic among stakeholders and to establish a process where it is possible to comprehend, consider, and debate, before any decisions are reached. It is therefore necessary to set up structures and processes that will allow such stakeholders a venue where their individual value systems will be used as a point of departure for these discussions.

This approach for the establishment and assessment of indicators is precautionary because it seeks solutions at the very beginning of conceptualization; seeking solutions that can satisfy as many real fundamental human needs as possible with the least resource consumption as possible. This approach requires a social vision of humanity; in other words, a new form of social organization is necessary if humanity is to survive this crisis. This is why it is considered a very long-term approach. It therefore implies that the valorization of humans can be founded on cooperation and collaboration and not only on the theory of natural selection where the strongest species survive (a Darwinian vision).

A precautionary approach towards design, as a complement to current preventive approaches, in situations of catastrophic danger can therefore encourage a shift towards sustainable design. This approach does not address products or services, but addresses lifestyles or scenarios. The reason for this is that changes to products and services will not result in transformational changes necessary for sustainability, and in particular in cases where a precautionary approach is warranted, however changes to lifestyles can. It is innovative since assessments are based on positive indicators, in contrast to the traditional negative indicators used in preventive approaches. These new indicators are seeking to assess how alternate solutions can satisfy fundamental human needs while preserving ecological integrity and social cohesion. The basis of this perspective is that current approaches for assessing progress and instilling changes towards sustainability are insufficient on their own since they do not address the complex situations imposed by the current environmental crisis. The benefits of this approach are that solutions obtained are

integrated within the community and therefore can contribute to social change. This social change is founded on the fact that individual or community involvement towards the search for solutions will change the relationship that these individuals or communities have with their world.

In closing then, this study sought to justify the use of the precautionary principle for the conceptualization of sustainable solutions based on an ethic of the future. In an attempt to guide this study, the question presented in the *General Introduction* was: *How can an operationalization of the precautionary principle contribute to the shift from eco-design towards sustainable design?* The pertinence of this question rests on the need to escape from a mode of theorization of sustainable development and into a mode of operationalization.

The methodology adopted in this research was used for several reasons as previously stated in the *Research Protocol* section of this paper. An analysis of each of four assessment methodologies allowed an initial understanding of the ways in which the precautionary principle is used in their decision making. It exposed the main obstacles, benefits and limits of using (or not) such a principle within their methodologies. After this analysis, it became quite evident that a principle like the precautionary principle is best embedded into a decision support system in which the scope of evaluation is broader than the product and service system alone. It must help evaluate criteria based on fundamental needs before the products are developed, as has already been mentioned. Therefore the questioning of the proposed products themselves becomes a question to consider.

The intent of the interviews was to obtain a greater depth of understanding of how this principle is used by such methodologies, if at all. At first the intent was to interview a representative of each of the four organizations. But after the document analysis was complete, it became increasingly evident that an appropriate level of scope for this principle had to be greater than that of the product or service system, and therefore Eco-indicator99 was not selected for interview. Also, as mentioned in the *Research Protocol* of this paper, it was important to obtain both a North American and European perspective of the way this principle is (or can be) embedded into assessment methodologies. The main reason for this is that the perception of this

principle is different for both continents. FIDD operates in Quebec and since FIDD granted the researcher an interview, the North American perspective was covered. Sustainability, based in the UK also offered to be interviewed and therefore the European perspective was included in this research. It would have been preferable to obtain an interview with Ethibel, but their availability did not coincide with the time frame of this paper, and therefore this interview could not take place.

It is evident that with only two interviews there is not enough empirical data to conclude any theory; however, this was not the intent at this level of research. For the master research, the intent was to obtain a general understanding of the state of the situation. This understanding will be used within a later doctorate research to develop sustainable indicators based on this principle. However, in achieving this new goal, the interviews and analysis will need to be more in-depth if new theory is to be developed.

The expected results for this study were achieved, given that: (1) the realization that an implementation of this principle for design *can* enable a shift from eco-design towards sustainable design based on literature review and analysis; (2) an understanding of this principle and how it is currently used in existing sustainable assessment methodologies was obtained; (3) the fact that it is not explicitly used within the sustainable assessment methodologies studied reveals a gap in current decision making processes; (4) based on literature analysis and field work, an indication of what this gap entails was obtained; and (5) as a preliminary response to this gap, an example of a social indicator based on the precautionary principle was presented as a preliminary proposal for its operationalization. Therefore, based on these results, this paper has addressed and responded in part to this question, since further research is still required to render this principle operational for design practice. This will be dealt with in the author's further doctorate studies. The following introduces some of these additional research areas.

First it becomes necessary to understand the appropriate type of participative process necessary for such an approach to be feasible. In other words, to define an appropriate system of governance based on a stakeholder process. Questions that can be considered in this area are: What type of process can encourage consensus

given the various values and visions of the stakeholders? How is this process defined? How may a concrete decision that proposes a sustainable solution be made based on these various values and visions? How can the complexity that arises from the decision making process be dealt with, since a practical decision must be made that will result in some action? This is just a small fraction of possible questions.

Secondly, the choice of indicators, how they are selected, and how they are constructed for the establishment and assessment of sustainable consumption and lifestyles would require further research as well. In other words, the categories of indicators, their variables, as well as the types of impacts (which are based on fundamental human needs) need to be established. This will provide an ethical framework necessary for public deliberation. An understanding of human consumption patterns is pertinent in this reflection. Some questions arising in this area are: What is the basis for the selection of indicators? How is this basis established? Who selects the indicators and why? How can they be constructed so that assessments can be made in a systematic manner? One idea seems prevalent, is that both these areas (the definition of the stakeholder process and the establishment and assessment of indicators) will be closely inter-related.

This is because public participation using a precautionary approach for design within a context of sustainability addresses issues and concerns on a human scale. Therefore the establishment and assessment of indicators based on such a perspective will allow the emergence of innovative sustainable solutions that consider the common-good. This cannot be achieved unless a system of governance is established that can allow this type of deliberation. The solutions will seek to reflect the global nature of the current crisis and therefore new conceptions of lifestyles may be considered as possible alternate solutions to current unsustainable situations. Hence, transformational changes to current consumption behaviors become realizable, therefore enabling the shift from eco-design towards sustainable design.

Appendices

1. Description of LCA Framework

The purpose of this appendix is to describe the LCA framework. In Figure 16, the LCA framework is described through four main phases (Jensen *et al.*, 1997; Consoli *et al.*, 1993):

- goal and scope definitions
- inventory analysis
- impact assessment
- improvement assessment (or interpretation)

A more comprehensive explanation of each of these phases will be elaborated in the following sections.

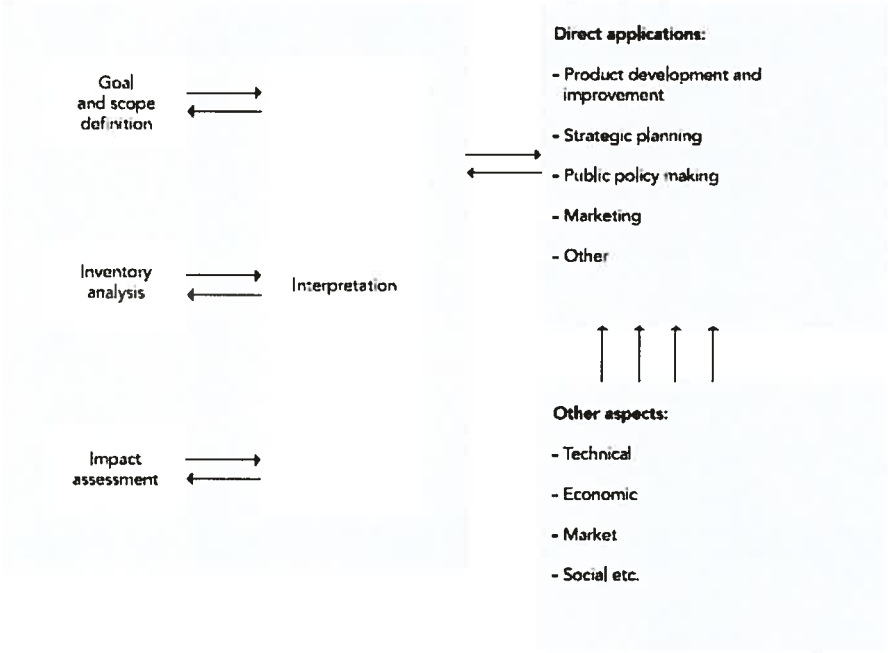

Figure 16: Life Cycle Assessment framework – phases of an LCA (source: (Jensen et al., 1997, p 51).

The terminology and structure of the ISO Environmental Management Systems, tools and standards on LCA, are used in the presentation of the principles, procedures and methods of LCA. The following standards are used:

- FDIS/ISO 14 040: Environmental management – Life cycle assessment – Principles and framework ISO (1997a).
- DIS/ISO 14 041.2: Environmental management – Life cycle assessment Goal and scope definition and inventory analysis. ISO (1997b).
- CD/ISO 14 042.1: Environmental management – Life cycle assessment – Life cycle impact assessment. ISO (1997c).
- CD/ISO 14 043.1B: Environmental management – Life cycle assessment – Life cycle interpretation. ISO (1997d).

The technical framework for LCA developed by SETAC in 1993 (Consoli *et al.*, 1993) is shown in Figure 17. Each of the phases will be briefly described in the following sections.

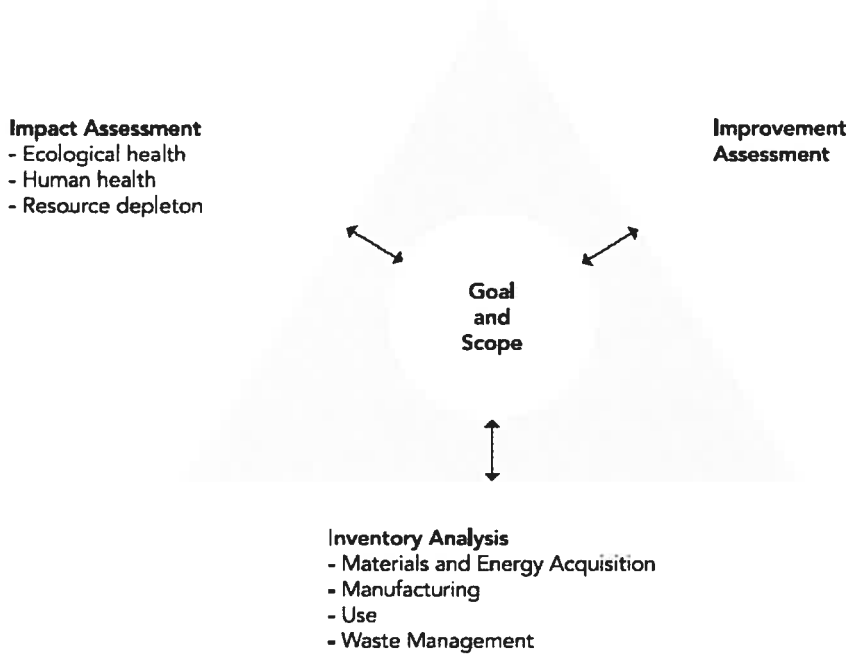

Figure 17: LCA technical framework (source: Consoli et al., 1993, p.11; Jensen et al., 1997, p 53).

Goal and Scope

The definitions of goal and scope are the first phase in a life cycle assessment and they contain the following core issues (Consoli *et al.*, 1993; Jensen *et al.*, 1997):

- goal (purpose)
- scope

- functional unit
- system boundaries
- data quality
- critical review process

Goal and scope are significant to the outcome of an LCA since these elements have a considerable effect on the result of the LCA. The *goal* of an LCA defines the reasons for carrying out the study and for whom the study is intended. The *scope* answers questions such as: What is in the system and what detailed assessment methods are to be used? It sets the borders of the assessment. A *functional unit* is related to the function that a product or service will deliver. The definition of a functional unit is actually very much linked to the question asked. There are many functional units, depending on the type of question to be answered. Energy, raw materials and environmental emissions are calculated on the basis of this functional unit. The *system boundaries* define the processes/operations, and the inputs and outputs to be taken into account in the LCA. The quality of an LCA is a reflection of the quality of the data used in the life cycle inventory. It is important that the *data quality* is described and assessed in a systematic way. The quality of the life cycle assessment is ensured through the *critical review process*.

Inventory Analysis

The main concerns in the inventory analysis phase, the second phase in a life cycle assessment, are the following (Consoli *et al.*, 1993; Jensen *et al.*, 1997):

- data collection
- refining system boundaries
- calculation
- validation of data
- relating data to the specific system
- allocation

A flow sheet can be used to support the inventory analysis phase. In this phase the various tasks necessary for extraction, fabrication, transportation, usage and disposal of a product are specified. An example of a flow sheet can be seen in Figure

18. Each of the various tasks can themselves be cumulative processes. For example, the production of a range of raw materials for a product can be combined in a single task called 'material production'.

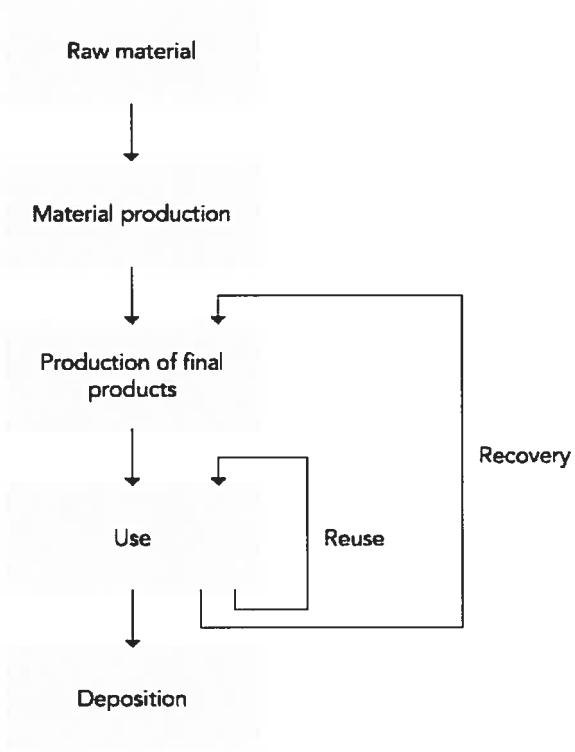

Figure 18: Example of a single flow sheet to be used as a support in the data collection (source: Jensen et al., 1997, p. 58).

The *data collection* involves the inventory of material consumption, waste and emissions for the whole life cycle of the considered product. In a life-cycle assessment, data collection is frequently the largest part of a life cycle assessment. Initially, the *system boundaries* are defined during the scope definition procedure. However, after the initial data collection, the system boundaries can be refined. *Validation of data* is done throughout the data collection process so as to improve the general quality of data (Consoli *et al.*, 1993; Jensen *et al.*, 1997).

Impact Assessment

The main concerns in the impact assessment phase in a life cycle assessment are the following (Consoli *et al.*, 1993; Jensen *et al.*, 1997):

- category definition
- classification
- characterization
- valuation/weighting

As a first step, the definition of the impact *categories* must be considered (ISO, 1997c). The second step is the *classification* which aims to assign inventory input and output data to the specified categories resulting from the first step. Because of the way choices are made in this phase, classification is a qualitative step (Jensen *et al.*, 1997). However, it is based on scientific studies of applicable environmental processes. The third step in impact assessment is the characterization of the inventory data (ISO, 1997c). The outcome of this step is a quantitative account of the different impact categories. A comparison of this characterization is not directly achievable, therefore, a fourth step, which is a *valuation/weighting* of the impact categories against each other will be necessary (ISO, 1997c).

The aim of the weighting step is to rank, weight, or, aggregate the outcomes of various categories with the intention of arriving at the relative significance of these diverse results. The weighting process is not technical, scientific, or objective since the various results cannot be easily compared; the purpose of the weighting step is to be able to make some relative comparisons (Consoli *et al.*, 1993; Jensen *et al.*, 1997). A variety of tools, referred to as decision theory techniques, can be applied to render this process more rational (Consoli *et al.*, 1993).

In this methodology, Human Health (a social concern) is evaluated using a qualitative method, based on the health and security impacts from the product and service system. It is based on a toxicological perspective (health/security). The types of indicators in this category are for example: (1) damage caused by carcinogenic substances; (2) damage caused by respiratory effects; (3) damage caused by climate change.

Improvement Assessment (Interpretation)

The fourth phase is the interpretation phase which contains the concerns (Consoli *et al.*, 1993; Jensen *et al.*, 1997):

- identification of significant environmental issues
- evaluation
- conclusions and recommendations (selection of options for environmental improvements in products or processes)

The improvement assessment (or interpretation) is basically a phase that consists of interpreting the results of a life cycle assessment. This interpretation entails a systematic procedure for identifying, qualifying, checking, and evaluating the information from the outcomes of the inventory analysis and/or impact assessment of a system (Consoli *et al.*, 1993; Jensen *et al.*, 1997).

The objective of the identification step is to structure the information from the inventory analysis. This is a selection of key outcomes which is done in manner that is 'justified'. This is done in order to determine the significant environmental concerns with respect to the goal and scope defined in the first phase (Jensen *et al.*, 1997).

The evaluation step is the second step in the improvement assessment phase. In this step, there are three components (Jensen *et al.*, 1997):

- to conduct a qualitative check of the selection of data, processes etc. e.g. to discuss the possible consequences of leaving out information,
- to apply a systematic qualitative or quantitative analysis of any implications of changes in the input data (directly as data uncertainty and indirectly caused by methodological or epistemological uncertainties)
- to discuss the variations identified in the frame of the goal and scope, e.g. the data quality goals of the study.

The main purpose of this step is to establish some assurance in the outcome of the study (Jensen *et al.*, 1997). This is based on the previous phases completed, as well as on the major environmental concerns that were identified in the first step of this phase (the identification step). In the final step of the improvement assessment phase (interpretation), a traditional scientific and technical conclusion and

recommendation is done. However, data alone are not sufficient; the final report should explain the results with respect to the initial goals of the study (Consoli *et al.*, 1993). This is the main objective of this step, and the concluding step of the LCA study.

2. ETHIBEL's Research Domains - Domain 1: Internal Social Policy

(source: URL=><http://www.ethibel.org>)

THEMES	TOPICS	APPRECIATION (What is appreciated?)	INDICATOR (What is assessed?)
Strategy	Principles	The degree to which a company's personnel policy is formalised and the scope and quality of the principles	Comprehensiveness and quality of the policy statement
	Reporting	The degree to which a company releases information on its social policy	Frequency, quantity and quality of information
Employment	Employment stability	The degree to which a company creates and maintains employment	Evolution of employment compared to the industry, measures to avoid dismissals
Job Content	Training and education	The degree to which a company demonstrates efforts to broaden the skills of its workforce	Quantitative (% of employees involved, training hours per employee) and qualitative training efforts (functional, multifunctional, employability)
	Job enrichment and career development	The efforts demonstrated by a company for the personal development of its employees	Presence of systems of internal promotion, evaluation talks, individual career plans
	Communication and consultation	The degree to which a company supports open and two-way communication with its employees	Presence of (formal) communication channels and consultative bodies
	Equal opportunities - Principles	The degree to which a company has formalised its equopps policy and to which it integrates the policy in its business principles.	Absence or presence of a formalised policy, its quality in terms of scope, depth (non- or anti-discrimination) and area of application.
	Equal opportunities - Initiatives	The degree to which a company demonstrates efforts to promote equopps.	Presence of equopps initiatives and involvement of employees
	Realisations	The degree to which a company realises a reduction of inequalities (in comparison to the community where it is active).	The average employment rate of disadvantaged groups and its evolution (as provided by trade unions, industry associations etc.).
Terms of Employment	Remuneration policy	The degree to which a company's remuneration policy is considered as internally fair and equitable	The presence of systems of job classification and performance appraisal
	Flexibility	The degree to which the organisation of flexibility takes into account the needs and expectations of the employees	Systems of flexible organisation, involvement of employees when organising flexibility
	Quality of contracts	The degree to which a company offers qualitatively good employment	Quality of contracts (temporary contracts, , systematic use of overtime and temporary unemployment, ...)
Working Conditions	Health & Safety - Policy	The degree to which a company emphasises the importance of its H&S policy	Presence of a formal policy concerning health and safety , and its quality
	Physical Health and Safety - Initiatives or achievements	The degree to which a company demonstrates efforts to create good physical working conditions or realises a reduction of labour accidents	Presence of H&S initiatives, safety measures, and involvement of employees Or Frequency and evolution of labour accidents
	Mental Health and Safety - Initiatives or achievements	The degree to which a company demonstrates efforts to cope pro-actively with work pressure Or to create a supportive working environment (climate)	Presence of initiatives concerning mental health and stress: stress management, reduction of work pressure, employee lifestyle counselling, psychological assistance, prevention of harassment... Or evaluation of work pressure by employees' representatives

Industrial relations	Consultation and negotiation	The degree to which employee/trade union(s) representatives are recognised as a dialogue partner	Presence of formal consultation bodies and the evaluation of the social dialogue by trade unions
	Conflicts	Presence of social conflicts	Number, content and nature of conflicts

3. ETHIBEL's Research Domains - Domain 2: Environmental policy

(source: URL=<http://www.ethibel.org>)

THEMES	TOPICS	APPRECIATION (What is appreciated?)	INDICATOR (What is assessed?)
Strategy	Principles	The degree to which a company has formalised its environmental policy, the quality of the formal environmental principles, and degree to which the environmental policy is integrated in the entire company activities	Comprehensiveness, scope and quality of the (public) environmental policy
	Public commitment	The degree to which the company □ enters into the dialogue with environmental stakeholders □ and/or co-operates with environmental initiatives that surpass the company level (the nature of this cooperation) □ and/or behave towards legal requirements	Memberships of activist or campaign groups, lobbying, infringements, anticipation on future legislation, membership of co-operation platforms (qualitative and quantitative), quantity and quality of the stakeholders communication
	Publications in the field of environment	The extent to which the public is informed about the company's environmental responsibility	Quality of the publications
Management	Environmental management system (EMS)	The existence , quality and external certification of an EMS	comprehensiveness (environmental impacts that are dealt with), completeness (presence of the elements inventory, target and objectives, programs and feedback), field of application (part of the company where the system is implemented) or Number of ISO14001 or EMAS or equivalent certified plants
	Involvement of employees	The degree to which the employees are involved in the development and the realisation of the environmental policy	Attention paid to environmental matters in training and communication Passive/active involvement
	Environmental responsibilities and instruments.	The degree to which the environmental responsibility is integrated in the hierarchical structure of the company	Hierarchical level of the highest placed person(s) with environmental responsibilities and supportive staff
Production	Measures to reduce the environmental impact: input	Degree to which a company does or has done efforts to reduce the use of energy and raw materials	Measures are evaluated against the background of the state of the technology (BAT), the situation in the industry and the achieved results
	Measures to reduce the environmental impact: output	Degree to which a company does or has done efforts to reduce the emissions into air, water and soil	Measures are evaluated against the background of the state of the technology (BAT), the situation in the industry and the achieved results A separate evaluation is made for every environmental compartment. The global rating for the topic is the rounded off average of the separate scores.
	Measures to reduce the environmental impact: waste	Degree to which a company does or has done efforts to reduce the quantity and the harmfulness produced waste and to guarantee the use of environmentally friendly waste treatment methods	Measures are evaluated against the background of the state of the technology (BAT), the situation in the industry and the achieved results
	Environmental conditions imposed on	Degree to which a company does efforts to reduce the environmental impact of the supply chain	Conditions imposed to suppliers and subcontractors

	suppliers and subcontractors		
Products	Environmental impact	Degree and nature of the environmental impact of products	Environmental impact during the entire lifecycle
	Measures to reduce the environmental impact of products	Degree to which a company does efforts to reduce the adverse environmental impact of its products or to reduce or avoid adverse environmental effects connected to the use and end of life of the products	Environmentally inspired adaptation of product design (eco-design), research aimed at the development of environmentally friendlier products, elements of product stewardship management, advice to customers on how to use products in a more environmental-friendly way

4. ETHIBEL's Research Domains - Domain 3: External social policy

(source: URL=<http://www.ethibel.org>)

THEMES	TOPICS	APPRECIATION (What is appreciated?)	INDICATOR (What is assessed?)
Societal impact of the company's core activities, products and services **Optional (only if relevant)**		Impact on the quality of the society	Positive or negative impact of the company's activities on the quality of the society development Measures to reduce the negative/improve the positive impact
Communication with stakeholders		The degree to which the company is transparent for stakeholders about its societal impacts and is freely engaged in stakeholder dialogue	Extent and quality of the stakeholders communication and the responsiveness to stakeholders' requests for information
Human rights	Strategy	Degree to which a company has a formal policy on human rights and the scope and quality of the principles	Global issue: Quality of the policy framework addressing human rights Human Resources issue: Completeness of the Human Rights and/or Human Resources policy
	Management and/or Realisations	Degree to which a company distinguishes itself (in a positive or negative sense) in the field of respect for human rights	Non-compliance, condemnations, realisations, initiatives Responsibilities for and support systems for human rights (reporting, monitoring, training, external verification, ..)
	Sourcing principles and practices	Degree to which a company does efforts to avoid violations of international conventions on human and labour rights by its suppliers and subcontractors	Sensitive sourcing from developing countries (eg. toys, footwear, textile), Formal conditions imposed on suppliers addressing human rights, Presence of monitoring and verification systems
Social investments		Degree to which a company supports external societal initiatives with money, people or logistic support, Societal impact of supported projects (social investment in developing countries is included)	Nature of the supported initiatives Value of the support
Socio-economic		Degree to which company activities	Negative reports (eg. pricing policy, bio-piracy),
relations with developing countries		contribute to the realisation of sustainable trade relations and to the local socio-economic development	Positive impacts (eg. fair trade involvement, joint ventures, local market development, local workforce, transfer of knowledge)

5. ETHIBEL's Research Domains - Domain 4: Economic Policy

(source: URL=<http://www.ethibel.org>)

THEMES	TOPICS	APPRECIATION (What is appreciated?)	INDICATOR (What is assessed?)
Economic Potential	Value creating Potential	The degree to which a company guarantees its growth and existence by creating value	EBITDA/EBIT/Operational profit as % of turnover and share of net profit retained by the company (average over last 3 years)
Economic Risks	Internal control procedures	The degree to which a company disposes of internal procedures to cope with internal and external risks to safeguard its assets	Presence of a policy, organisation and action plans
Clients	Quality control	The degree to which a company is able to offer quality products	The presence of quality certificates (ISO 9000, EFQM, TQM), awards and quality management systems
	Customers: communication	The degree to which a company pays attention to customer relations	Presence of instruments to establish a dialogue with customers: complaint management, satisfaction, surveys. Quality of product information provided to customers
Corporate Governance	Board of Directors	The degree to which the Board of Directors safeguards the interests of all shareholders	Composition and organisation of the Board of Directors
	Reporting	The degree to which all shareholders dispose in time of all relevant information	Quality of financial information and reporting concerning Corporate Governance
Suppliers	Relations with suppliers	The degree to which a company respects the rights of its suppliers	Absence of abuse and the engagement in co-operative relationships
Business ethics	Code of ethics	The degree to which a company's business ethics (code, mission statement, key values) are formalised and the scope and quality of the principles	Comprehensiveness and quality of the code of conduct
	Management system or achievements	The system the company has established for implementing the code, the way the company complies with economic legislation	Seriousness/absence of infringements, initiatives aimed at applying the system, checking and remedying non-compliance

6. Transcription of Email Exchanges

Name: Jean Philippe Renaut
Organization: SustainAbility
Position within organization: Advisor

First series of email exchanges

Date: Sun, 29 Oct 2006 18:35:18 -0000
From: "JP Renaut" <[redacted]
To: "Carmen Cucuzzella" <[redacted]
Subject: RE: info about SustainAbility methodology
No, they are external "Inverstor Relations" publications we examine. Sorry for the acronym.

JP
From: Carmen Cucuzzella [mailto:[redacted]
Sent: Sun 29/10/2006 6:23 PM
To: JP Renaut
Subject: RE: info about SustainAbility methodology

Hi JP,

Thanks again, I will call you this Thursday. I will also wait for the report to come out in the next few weeks.

One more question... What are the official IR publications? Are these internal reports that are used by the organization being studied?

Thanks again,
Carmen

On Sun, 29 Oct 2006 17:30:19 -0000, JP Renaut wrote
> Hello Carmen,
>
> I am away from the office until Thursday. You can try me then.
>
> As for the document where it is refered, our methodology to assess sustainability report comes out in a few weeks and will be publicly available on the web. I am afraid it is not that sophisticated; we look for explanations and examples from the company in their official IR publications and communications.
>
> We can talk more towards the end of the week. Feel free to contact me on Skype [redacted] if it is convenient/cheaper for you.
>
> JP
>
>
>**From:** Carmen Cucuzzella [mailto:[redacted]
> **Sent:** Sun 29/10/2006 1:13 AM
> **To:** JP Renaut

> **Subject:** RE: info about SustainAbility methodology
>
> Hi JP,
>
> Thank you very much for your response. And thanks for the offer to speak in
> French, but I am an anglophone, so I welcome the opportunity to communicate in
> English.
>
> Would you know which document mentions the precautionary principle? I would
> like to understand the context in which it is discussed.
>
> Another thing I would like to understand is, if the precautionary principle is
> an example of an approach to risk management, how to auditors preparing the
> assessment reports know how to use this principle when assessing risks?
>
> I would very much like to speak to you. I will try to call you Monday or
> Tuesday (October 30 -31).
>
> Thanks again,
> Carmen Cucuzzella
> University of Montreal
>
> **On Fri, 27 Oct 2006 09:26:39 +0100, JP Renaut wrote**
> > Hello Carmen,
> >
> > Matt Loose has forwarded me your email. I'd be happy to answer to your
> > some of your questions. I have been working for the past months looking
> > at CSR reports.
> >
> > I have to say straight of the bat that very few reports make mention
> > of the precautionary principle. If they do, it will be of course a feature
> > of their risk management strategy, for which we would see it favourably
> > in our evaluation. Indeed, our criteria examining the risk
> > management process of companies mention the precautionary principle
> > as one example of an approach on the subject.
> >
> > Hope this helps. Feel free to email or call me today between now and
> > 6pm (GMT).
> >
> > Et si tu preferes parler francais, je n'ai aucun probleme. Je suis
> > un francophone de Montreal qui a etudi'e a McGill!
> >
> > A bientot,
> >
> > JP
> >
> > Jean-Philippe Renaut
> >
> > SustainAbility Ltd
> > 20-22 Bedford Row
> > London WC1R 4EB
> > United Kingdom
> >
> > Tel: [redacted]
> > Fax:
> > Skype:

> > Email: [redacted]
> >
> > New thinking on www.sustainability.com
> > - Taxing Issues: Responsible Business and Tax: our latest report puts
> > tax and transparency in the spotlight
> > - Many of our reports are available in diverse languages & are free
> > to download.
> >
> > This message is for the attention of the addressee only. SustainAbility
> > employees have differing views, and are encouraged to express them,
> > so it should be noted that where opinions are given they are not
> > necessarily those of SustainAbility Ltd/Inc.
> >
> > -----Original Message-----
> > From: Carmen Cucuzzella [mailto:[redacted]
> > Sent: 26 October 2006 18:43
> > To: Matt Loose
> > Subject: info about SustainAbility methodology
> >
> > Dear Mr. Loose,
> >
> > I am a master's student conducting research on operationalizing the
> > precautionary principle of sustainable development. I am in the process
> > of studying several assessment methodologies to understand if this
> > principle is taken into account when these methodologies were
> > established or when they are used in reporting.
> >
> > Would it be possible to speak to you at your convenience (by
> > telephone). I live in Montreal, Canada.
> >
> > Thanking you in advance,
> > Carmen Cucuzzella
> > University of Montreal
> > School of Industrial Design

Second series of email exchanges

Date: Wed, 8 Nov 2006 10:54:47 -0500
From: "Carmen Cucuzzella" <[redacted]
To: "JP Renaut" [redacted]
Subject: RE: questions for research
Dear JP,

I appreciate your reply, and I really also appreciate any information you can provide. I understand that you may not be in a position to answer all the questions, but your perspective is very important to me. Just your interpretation of sustainability and precaution in a corporate context would be great... Is it still OK to call you Tuesday, early afternoon (your time)?

Thank you,
Carmen

PS: You are correct in your assumption that when I speak of a designer, I speak of an individual who is in a position to address human needs in a very upstream context.

On Wed, 8 Nov 2006 09:10:07 -0000, JP Renaut wrote
> Hi Carmen,
>
> I have to say, this is a rather long list. Having just finished my own
> studies, I understand where they come from. However, if this is
> important to you, I dont mind spending 20 minutes discussing on the
> semantics of "Sustainabile Development" and the "Precautionary
> Principle".
>
> As for the role of designers, I have to say that this is really not
> my area of expertise. I understand what you mean by d"designers" (assuming
> you mean someone like McDonough and Braungart, or even people that shape
> and "design" business models such as social entrepreuneurs).
> However, my experience/knowledge is really limited in this area.
>
> Our reporting benchmarking methodology is going public on Thursday.
> I just created the pdf last night.
>
> jp
>
> -----Original Message-----
> From: Carmen Cucuzzella [mailto:[redacted]
> Sent: 07 November 2006 16:20
> To: JP Renaut
> Subject: questions for research
>
> Hi JP,
>
> First I would like to thank you again for your time in helping me
> with my research. I have compiled a few questions. You had mentioned
> that I send you my questions before calling so that you may reflect a
> little longer on some of the answers. The following is my list of
questions:
>
> 1. How do you interpret sustainable development?
> 2. What role do designers have in sustainable development?
> 3. How do you interpret the precautionary principle?
> 4. In what cases would this principle be useful?
> 5. Can designers make use of such a principle in their practise? How?
>
> 6. What ethical framework do you feel is necessary in a perspective
> of precaution? How can this ethical framework be used in the course
> of decision making? Why is this ethical framework necessary?
> 7. How do you perceive the use of a stakeholder engagement in supporting
> the precautionary principle? Why is this approach useful for
> precaution, or why is it not useful?
> 8. To what degree can precautionary thinking be embedded within
> industrial design?
> 9. What are the current barriers for designers when making decisions
> based in precaution?
> 10. What must be done so that designers take on a more precautionary

> approach towards design?
>
> I will try to call you next Tuesday morning (my time - early
> afternoon for you). If this is not a good time, please let me know
> what is a good time for you.
>
> Thank you very much,
> Carmen Cucuzzella
> University of Montreal
> School of Industrial Design

Third series of email exchanges

Date: Tue, 14 Nov 2006 14:01:39 -0000
From: "JP Renaut" [redacted]
To: "Carmen Cucuzzella" [redacted]
Subject: FW: The Paradoxes of Businesses as Do-Gooders

Hi Carmen,

I think we had a very interesting conversation. I just read this article and, although not directly relevant, it clearly shows that the precautionary principle as a concept is far from the boardrooms and stakeholder discussions. The overall framework is still that win-win logic.

JP

November 11, 2006

TALKING BUSINESS

The Paradoxes of Businesses as Do-Gooders

By JOE NOCERA

The annual Business for Social Responsibility conference came to New York this week, and it only seemed as though half of corporate America ground to a halt to attend. Starbucks was there, of course, in force, but companies like Chevron, J. C. Penney, Pfizer, McDonald's, Ford Motor and Exxon Mobil all had representatives as well, according to the program. You'd be surprised at the range of companies that are embracing the corporate responsibility mantle. Certainly, I was.

Corporate Social Responsibility, as the movement is called by its adherents, has gone mainstream. The Grand Hyatt Hotel in Midtown Manhattan was teeming with some 1,200 corporate practitioners, experts, headhunters, academics and consultants. (Business for Social Responsibility, which runs the conference, is one of the leading consultants.) "It's become a sexy field, and lots of people want to get into it," said someone at my luncheon table on Wednesday, the first day of the conference. That was easy enough to see.

You could walk through the exhibition area and pick up fat reports — fatter in some cases than the annual report —from General Electric or Coca-Cola listing all the things they are doing to make the world a better place: saving the environment, building projects in the third world, ensuring that the labor they employ in developing countries work in decent conditions and get a fair wage. You could attend

packed breakout sessions with titles like "Being Green Is Glorious: Beijing's Green Olympics." You could watch Time Warner's chief executive, Richard D. Parsons, parry questions about corporate responsibility in the media industry. You could listen to just about everybody talk about the need for corporations to confront climate change.

And you could listen to people say over and over that being socially responsible just made good business sense, and had become critical to the way their companies did business. "This is core to the way we do business," said Bob Langert of McDonald's, the company's vice president for corporate citizenship.

And you could wonder about that.

OVER 35 years ago, the economist Milton Friedman wrote a famous article for The New York Times Magazine entitled, "The Social Responsibility of Business Is to Increase its Profits." It's not hard to find critics of corporate social responsibility who still take that hard-line view.

"C.S.R. is a misguided attempt by a subcategory of business managers to deal with the crisis of corporate legitimacy," said Isaac Post of the Competitive Enterprise Institute. Russell Roberts, an economist at George Mason University, said: "Doesn't it make more sense to have companies do what they do best, make good products at fair prices, and then let consumers use the savings for the charity of their choice?" Their essential point is that companies are simply not equipped to "save the world" — nor is it their mission. That's what governments are supposed to do.

The truth is, though, companies have rarely viewed their role solely as generating profit. Do the shareholders come first — above other "stakeholders" (a favorite buzzword at the conference, by the way, encompassing customers, employees, activists, and so on)? Of course. And in hard times, when profits evaporate, social goals tend to disappear as well. But there is something a little too nihilistic about so narrow and mercenary a goal; most people want more purpose than that. Back in the 1950s and 1960s, the major American companies tended to underwrite many of the large, important endeavors in their headquarters cities: the opera, the big charities, the museums, and so on. These were clearly peripheral to what the company did, but nobody seemed to mind. Nor did they care that the money came out of the shareholders' pockets.

Much of that old paternalism died as the global economy heated up, and "shareholder value" became the modern mantra. And in fact, what initially spurred the modern corporate social responsibility movement was the rise of nonprofit activist groups, which pushed and prodded — and boycotted — companies to force them toward, say, treating workers better in developing countries.

But then the thing took on a life of its own. Nike, which had been the subject of fierce criticism in the 1990s over the labor practices in the factories it engaged to make its goods, decided it made sense to go the other way completely. It has worked to raise labor standards in the factories it does business with, and now has an extensive monitoring program. Its customers took comfort in that, and so did its employees. Did it help sales? It's hard to say. But no one's complaining that shareholder money is being wasted. That's what the culture was demanding.

Most recently, the environment has taken center stage; indeed, it would be hard to think of anything that has done more to propel the corporate social responsibility movement than the realization that global warming is a real phenomenon with potentially dire consequences. So corporations have raced to get on the right side of that issue.

"We struggled with climate change at Ford," said Niel Golightly, who was formerly Ford Motor's corporate responsibility maven. (He recently moved to Shell.) "We were among the first in the industry to openly acknowledge it," — and that was something, he added, that he took pride in. Ford also worked to make its plants "environmentally responsible," to use the words on its Web site.

In fact, virtually all of the companies at the conference have set goals for reducing greenhouse gases, and making their operations more energy efficient. I talked to Mark F. Buckley, the vice president for environmental affairs at Staples. He waxed on about how the company had set carbon reduction goals, and had reduced the energy used per square foot in its stores by 14 percent. It was working to help its

customers recycle, and reducing the environmental impact of its own branded products. "And it makes the company money," he said.

From the left, the essential criticism of corporate social responsibility is that it is little more than window-dressing, intended to give companies a good name without having to back it up with real deeds. "There is a whole lot of lip service," said Judith Melby of Christian Aid, a British-based aid group — and a tough critic of corporate behavior. But when you actually see what these companies are doing, at least the ones at the conference, it is hard to write it off as all window-dressing. Surely, it's a good thing that companies are trying to lower their energy costs and become more environmentally sensitive. Will that alone solve the problem of global warming? Hardly. But I wound up thinking: why not? It's better than nothing. And the fact that most corporations are now facing up to the problem of global warming instead of denying it — that's real progress.

But as to whether it really is "core" to their business, that struck me as another question entirely. "It always makes sense for people to act more responsibly," said Paul Hawken, the co-founder of Smith & Hawken and a well-known corporate critic and environmentalist. "But what are they responding to? They are responding to stakeholder pressure. To the zeitgeist. To their own internal cultures, as employees retire and younger people take their place. But," he added, "corporate social responsibility is a very safe place to talk about these things. By safe, I mean it doesn't challenge the business model."

And he's right about that. McDonald's may support sustainable fisheries, but its core business is still selling Big Macs. Big oil companies can talk all they want about reducing greenhouse emissions but they are still drilling for hydrocarbons. And Ford Motor, well, think for a minute about the predicament that company is in.

When William Clay Ford Jr., great-grandson of the founder, first became chairman in 1999, he talked up his environmental credentials. And internally, Ford has had a first-rate corporate social responsibility program. But for most of his tenure as both chairman and chief executive (he recently stepped down as C.E.O.), the bulk of Ford's profits have come from gas-guzzling trucks and S.U.V.'s — even as Toyota was working on hybrids and other autos that get better gas mileage and are better for the environment. Would Mr. Ford and his company have been better off if he had taken those environmental values and applied them to the core business of making cars? It's hard to imagine it could have made things worse.

"Bill Ford understood that we needed to be prepared for better fuel economy," Mr. Golightly said, "but those things are difficult to do."

On the second day of the conference, Amory Lovins, co-founder of the Rocky Mountain Institute, made a passionate speech laying out a logical — if quite radical — plan for significantly lowering energy consumption. He showed pictures of prototypes of aerodynamic automobiles that used light-weight materials and could get three to five times better fuel economy. The people in the audience were dazzled — as was I — but I couldn't help thinking that that kind of radical new auto design, which spoke directly to the business model of the auto industry, wasn't about to happen anytime soon. It's a lot easier to come out against global warming than it is to change, fundamentally, the way you do business.

"Value systems change," said Dr. Daniel Vasella, the chief executive of Novartis, during his keynote, "and it is our duty to adapt our behavior when and where appropriate." That's really what has happened here: as the values of Western consuming culture have changed, companies have begun to change with them. That is what the rise of corporate social responsibility really represents.

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