System Innovation for Sustainability at Product Development Level: A Scenario Method and a Workshop Process

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Abstract

It is now commonly accepted that, in order to achieve sustainability, we need societal transformation, which requires institutional, social/cultural, organisational as well as technological change. This type of massive societal transformation in which all aspects of society are expected to co-evolve towards and align with sustainability goals is defined as sustainability transition or system innovation for sustainability. One of the major actors in system innovation is industry. Nevertheless, neither the theory nor the operational approaches currently based on this emerging theory address how to link macro-level innovation (i.e. institutional and social-cultural innovation) to the micro-level innovation (i.e. product/service and technology innovation). This paper presents the results of a recently completed Ph.D. study. The overall objective of this study was to effectively link the activities/decisions at product development (micro-innovation) level in companies with the transformation which needs to take place at the societal (macro-innovation) level to achieve sustainability. The research took place in three distinguishable phases. In the first phase a broad literature review was carried out covering areas of sustainability science, futures studies and system innovation theory. In the second phase, a theory of system innovation at product development level was developed based on the findings and insights gathered from the review of the literature. This theory was used to develop a scenario method to help product development teams in planning for system innovation for sustainability. During this phase a workshop tool was also developed as the operational component of the scenario method. The third phase consisted of a field work carried out to test, improve and evaluate the scenario method using an action research methodology. The detailed evaluation of the effectiveness of the scenario method as a futures work and the potential of it to aid in system innovation for sustainability provided supportive evidence for the claim that the scenario method is a valuable and a viable method.

Keywords: system innovation for sustainability, action research

1. Introduction

Interest in system innovation for influencing a transition to sustainability started in the early 1990s, initiated by the Dutch National Inter-Ministerial Programme for Sustainable Technology Development (see Weaver et al., 2000). This was followed by several other projects (e.g., see, Vellinga & Herb, 1999; Vergragt, 2000; Quist et al, 2001; Green & Vergragt, 2002; Partidario, 2002; Partidario & Vergragt, 2002; Elzen et al., 2002; Hofman, 2005; Geels, 2002; Elzen et al., 2004; Raskin et al., 2006; Loorbach, 2007; Tukker et al., 2008).

System innovation is defined as "a transition from one socio-technical system to another (Geels, 2005a, p.2)". Since system innovation is a transformation which takes place at the wider societal context, it covers not only product and process innovations but also changes in user practices, markets, policy, regulations, culture, infrastructure, lifestyle, and management of firms (see, for example, Berkhout, 2002; Kemp & Rotmans, 2005; Sartorius, 2006; Geels, 2006). In other words, system innovation assumes structural changes take place in the socio-technical system. Companies are important actors in this transformation and will have important roles in developing the technologies of the new system (Charter et al., 2008). In addition, technology is not an abstract concept. It manifests itself through artefacts; i.e. infrastructure, products, and services, which are usually closely linked in a systemic structure. Products of a different technological paradigm will be essentially different from the products of current technological paradigm in terms of both technical characteristics and social meaning. Therefore, the development of tools and methods which would enable active participation of companies through their business practices in planning for system innovation is necessary both in order to effectively implement any plan at policy level and to increase the adaptive capacity of individual companies with regards to the substantial change which will take place through transitions.

Even though system innovation has become a central focus in policy development, especially within the European Union, a systematic theory on system innovations in general and how to use this theory to influence transitions towards sustainability in particular are currently emerging yet rapidly growing areas. This paper aims to contribute to this ongoing dialogue by presenting a scenario method developed as a result of a PhD project. The scenario method is intended for the use of product development teams of companies in planning for system innovation.

2. The Overall Research Methodology

The PhD research which resulted in the development of the scenario method took place in three distinguishable and progressive phases. The first phase involved a critical review of literature relevant to system innovation for sustainability. The topics reviewed during this phase covered sustainability science, characteristics of innovation for sustainability, the newly emerging theory of system innovation, futures studies, the relationship between futures studies, sustainability and system innovation, and, the role of industry in achieving sustainability. The second phase of the research built on the findings of the first part and integrated insights in order to first develop theory and models on how to involve product development teams in system level innovation for sustainability and second to develop a scenario method and a workshop process for product development teams of companies. Following the second phase, in order to test, improve and evaluate the scenario method, a field work was carried out.

The field work consisted of receiving feedback from potential expert users through one-to-one consultation sessions and from potential members of product development teams through workshops following an action research methodology (i.e. iterative cycles of improvement). A potential expert user of the method was defined as any person who has expertise in providing advice/consultancy to businesses in the joint area of sustainability and innovation and/or any person who has expertise in facilitating group processes. A potential member of product development teams was defined as anyone with a professional qualification of product/service design, design engineering, innovation management, strategy development, environmental/ sustainability management, and sales and marketing who provides input to the team during product design/development phase. Expert users are not the end-users but potentially the intermediary users of the scenario method who can introduce the method to businesses and lead/facilitate workshops with product development teams. Product development teams of companies are the intended end-users of the method. Any member in these teams can assume the role of a change agent and lead/facilitate a workshop or a workshop can be delivered to these teams by external change agents (which are represented by the potential expert users).

The field work covered five action research cycles (ARC) over a period of six months (see Figure 1). A total of thirteen (eight local and five overseas) experts were consulted and a total of three workshops (one in New Zealand, one in the Netherlands and one in Turkey) were held. The scenario method (its conceptual and operational frameworks) was improved and evaluated based on observations during workshops and participant feedback (collected via open-ended questionnaires).

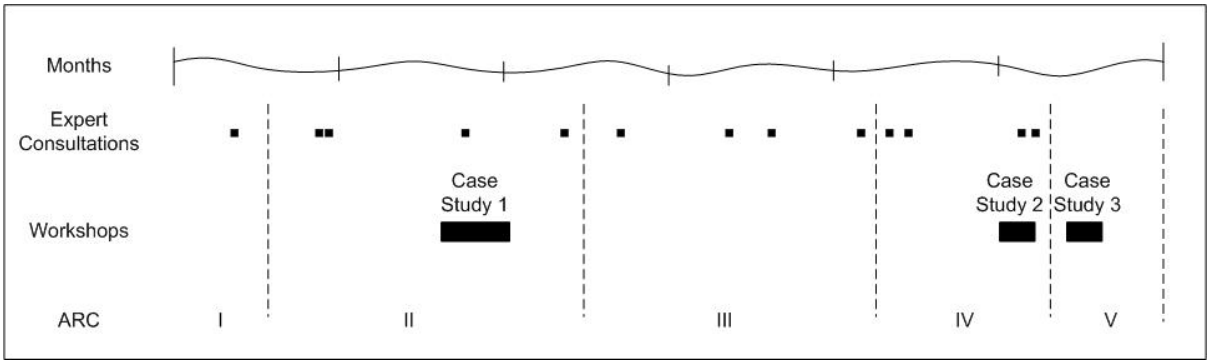

Figure 1. The schedule of the field work

At the end of the field work following the fifth ARC the final version of the scenario method was released. The next section presents the scenario method and its operational tool, i.e. a workshop process.

3. The Scenario Method: Final Version

The scenario method presented here is based on the multi-level perspective on system innovations (see Kemp, 1994; Van den Ende & Kemp, 1999; Kemp, Rip & Schot, 2001; Geels, 2005a; 2005b; Geels & Schot, 2007) and the theory and models developed as part of the PhD research (details can be found in Gaziulusoy & Boyle, 2008; Gaziulusoy, Boyle & McDowall, 2008a; 2008b; Gaziulusoy, Boyle & McDowall, 2009). The scenario method emphasises that the entity (i.e. the company) is within a context of complex socio-technical

system and the ultimate aim (i.e. the vision) of undertaking the process is to sustain the society (not necessarily the entity itself). It is developed to fulfil seven criteria:

1. The scenario method should be based on the strong sustainability model;
2. The scenario method should enable businesses to model themselves within the strong sustainability model;
3. The scenario method should link the planning periods applicable to companies (operational and strategic) to the long-term planning period (visionary) in order to enable companies to address long-term societal visions in their strategies and effectively implement these strategies in product development;
4. The scenario method should aid companies in identifying not only technology development requirements but also organisational/human development requirements;
5. The scenario method should aid companies in developing integrated business strategies aligned with societal level sustainability visions and day-to-day business activities and should facilitate integration of all business functions in line with the company strategy;
6. The scenario method should have a double-flow approach in order to link present and future in a realistic way and enable identification of alternative innovation paths which are possible from a technological point of view, acceptable from a social/cultural point of view and desirable from a sustainability point of view, and;
7. The scenario method should have a layered risk approach in order to identify implications of overarching sustainability risks on the companies' business as contextual risks. This way, sustainability can be internalised in the companies' organizational and product development strategy and active participation of companies in setting sustainability visions at societal level can be enabled.

Figure 2 shows the outline of the scenario method. As seen, there are three phases: preparation, scenario development and completion. The first task is to develop understanding of the system by analysing the relationships between the environment, society and economy as well as the interactions between the organisation and these three subcomponents. This is followed by identifying sustainability risks, analysing the dynamic relationships between these risks and articulating the implications of the risks on the business of the organisation. The third task in the preparation phase is identifying the social function being met by the products and services provided by the organisation and analysing how this social function is currently being met. The scenario development phase starts with developing a sustainable society vision within which the sustainability risks previously identified are either mitigated or adapted to. Then, how the social function is being fulfilled in this sustainable society is articulated. Following visioning, forward and backward scenarios are developed. The forward scenarios start from present and identify the successive technological and organisational changes necessary to reach the envisioned state. The backward scenarios stat from the vision and identify the preceding technological and organisational changes necessary to reach the present state. The aligning paths are identified as the alternative innovation paths that the organisation can follow towards system innovation. The scenario development task is followed by analysing the present and future stakeholders and placing them on the scenario map where they can be of high influence in achieving associated goals. Also, product and service ideas are generated and placed on the scenario map where they can be introduced if that particular state is reached in the future. In the completion phase an action plan or strategy is prepared to identify the steps to be taken, the responsibilities and the follow up procedure.

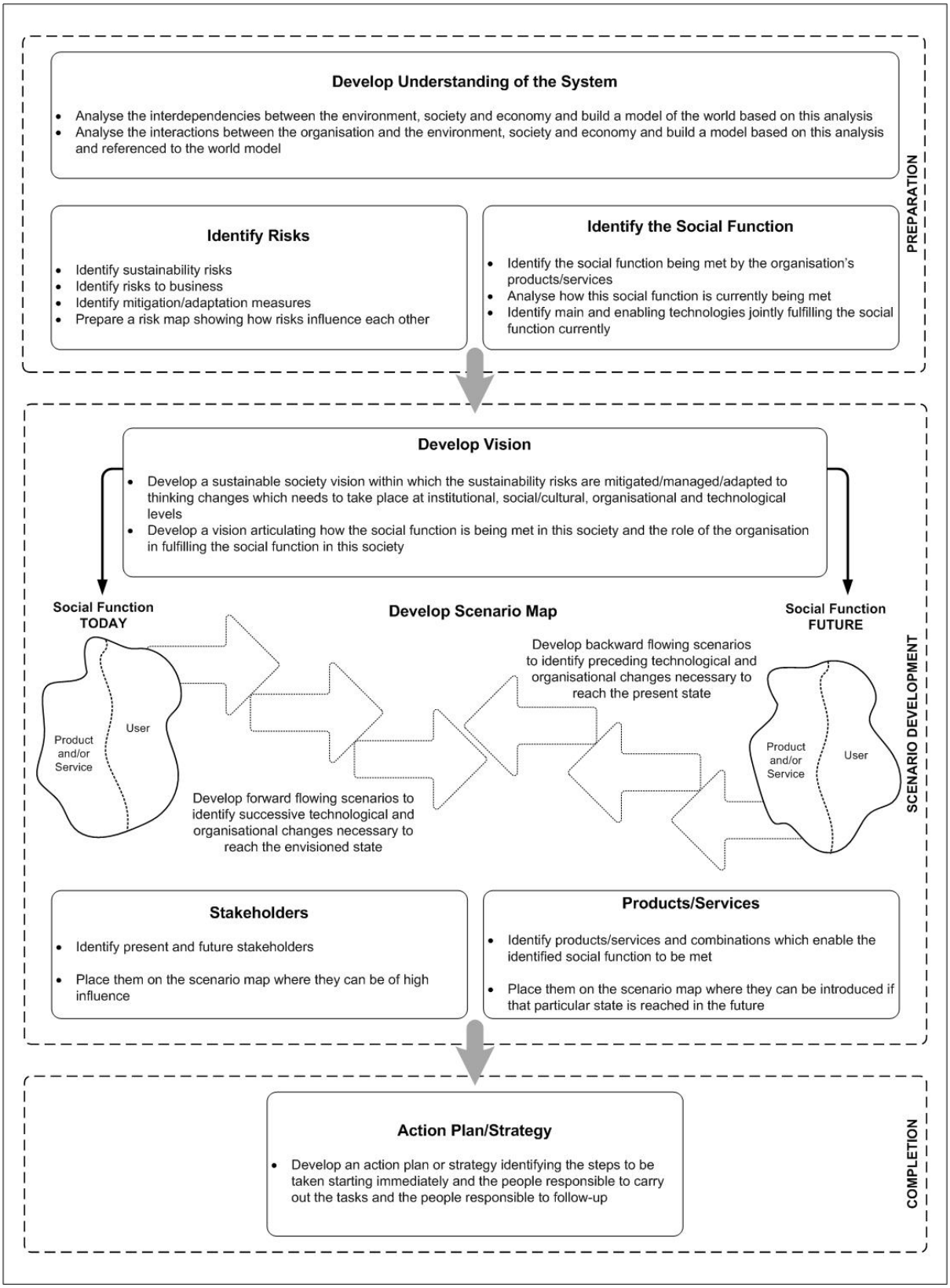

Figure 2. The outline of the scenario method

Based on this outline, a workshop process is designed which can be followed by facilitators. Table 1 shows the progression of the workshop modules along with brief explanations of what the module involves and what are the expected outcomes. This table also provides indicative times for completion of each module.

Table 1. The workshop process

	Min. Duration	Module	Activity	Outcome/Deliverable
1st Half-Day	45 mins.	0. Introduction	1. The participants check-in; 2. The facilitator briefs the group about the purpose and agenda of the workshop and gives a short presentation clarifying the concepts used.	**Outcome:** Everybody checked-in, common understanding of the purpose of the workshop and the concepts used, group ready to start.
	40 mins.	1. We are a system	1. The group builds a world model showing the interrelationships between the environment, society and economy; 2. The participants position their organisation on this world model and articulate the interactions taking place between each sub-system and their organisation; 3. (Optional) The participants draw a life-cycle map of one of their organisation's product/service.	**Outcome:** Participants understand the irreversible and hierarchical relationships between the environment, society and economy. The participants understand the major interactions taking place and dependencies between their organisation and the three sub-systems. **Deliverable:** A world model based on the hierarchical interdependencies between the environment, society and economy showing the interactions taking place between the organisation and the three sub-systems.
	80 mins.	2. Risks	1. The group prepares a list of risks to sustainability; 2. The facilitator checks this list against a pre-prepared list compiled from different resources (e.g. Kates et al., 2001; MEA, 2005; IPPC, 2007; UNEP, 2009) and makes suggestions to expand the list if any risk relevant to the organisation is missing; 3. These risks are mapped on the world model the group built in the previous module and the dynamic relationships between them are identified; 4. The participants identify implications of the risks to sustainability to the business of their organisation.	**Outcome:** The group understands how long-term wider-scale sustainability risks which threaten the society do and will affect the organisation's business and products/services it delivers. **Deliverable:** A list of risks to sustainability; a risk map (mapped on the world model developed in the previous module) showing dynamic relationships between risks; a list of implications of risks to sustainability on the organisation and the products/services it delivers.
2nd Half-Day	60 mins.	3. Social Function	1. The group identifies the social function fulfilled by the products/services offered by the organisation	**Outcome:** The group starts to think conceptually and is able to shift the existential focus of the organisation from itself to the wider context of society. **Deliverable:** Written expression of social function.

	105 min.	4. Visions	1. The group develops a normative vision for a sustainable society within which the risks identified in the previous section are mitigated/ managed/adapted to; 2. The group develops an organisational vision (can be referenced to the social function the organisation would like to fulfil) compatible with the vision of a sustainable society.	**Outcome:** The group involves in development of societal visions for sustainability and understands the systemic relations between the future of the society and their organisation. The group understands how institutional and social/cultural changes need to go in parallel with organisational and technological innovations to achieve sustainability. **Deliverable:** Vision(s) of a sustainable society documented on paper in written form (can be accompanied with imagery).
3rd Half-Day	130 mins.	5. Scenario Development	1. The group is divided into two sub-groups; 2. One group develops forward flowing, explorative scenarios; 3. The other group develops backward flowing, normative scenarios; 4. Some group members switch between groups to cross-fertilise each flow; 5. Two groups share their work with each other; 6. Aligning paths are identified and further work can be done to help some other paths to align.	**Outcome:** The group gains an understanding on the availability and characteristics of the possible innovation paths the organisation can utilise towards system innovation. **Deliverable:** A scenario map
4th Half-Day	50 mins.	6. Products/Services	1. The group brainstorms to generate product/service ideas which can be introduced if particular events anticipated happen; 2. These ideas are mapped on the scenario map; 3. (Optional) The product/service ideas are evaluated.	**Outcome:** The group gains an understanding on the availability and characteristics of products/services that can be introduced along the innovation paths developed in the previous module. **Deliverable:** A scenario map with the products/services layer added onto it.
	50 mins.	7. Stakeholders	1. The group prepares a list of stakeholders; 2. The group maps the stakeholders on the two-axis stakeholder model; 3. The group maps the stakeholders on the event trees or connections of the scenario map where they are likely to be most influential.	**Outcome:** The group gains an understanding of the current and future stakeholders, their intentions and possible influences along the innovation paths identified. **Deliverable:** A list of stakeholders, a stakeholder map and a scenario map with the products/services and stakeholders layers added onto it.
	50 mins.	8. Action Plan	1. The group reviews the scenario map; 2. The group identifies actions to be taken in the following week, month, year; 3. For each action identified, a responsible person is allocated; 4. A follow-up meeting to review the scenario map is scheduled in a year's time.	**Outcome:** The group identifies the immediate steps needed to be taken to realise the innovation paths towards system innovation for sustainability and commitment is established to the action plan developed. **Deliverable:** An action plan agreed upon by the participants and documented in written form.

The results of the evaluation of the scenario method by the research participants provided evidence that the research participants, who are also potential users/facilitators of the scenario method, found the scenario method to be:

1. An effective way to aid product development teams to incorporate sustainability issues into their decision making;
2. Able to influence the business transformation which needs to take place as part of the societal transformation to achieve sustainability, and;
3. A worthwhile activity for their respective companies.

The results of the evaluation of the scenario method provided evidence that the scenario method effectively assists product development teams in:

1. Understanding the hierarchical irreversible relationships between the environment, society and economy and between their organisation and these three sub-systems;
2. Understanding the issues threatening the sustainability of the society (i.e. risks to sustainability of the society), the dynamic relationships among these issues and the implications of these on the business or their organisation;
3. Generating normative long-term societal visions within which the risks to sustainability were mitigated/managed/adapted to by the society through a combination of institutional, social/cultural, organisational and technological changes, and;
4. Developing scenario maps to link present to the long-term future visions of a sustainable society they developed enabling alternative innovation paths to be identified.

These results indicate that the scenario method can now be used in real life projects where product development teams would like to align their activities and decisions with longer-term wider-context requirements of sustainability.

4. Discussion and Closure

The lack of systemic understanding and the blind attachment to growth oriented policies and strategies are still prevailing in business models of companies. Nevertheless, in some companies a belief on a broader social purpose exists on a voluntary and long-term basis. There are also good reasons to believe that in some other companies such understanding will evolve shortly through crisis as a result of not being able to foresee the implications of long-term sustainability related trends on business (White, 2006). A recent study which investigated two cases of firm uptake of system innovation thinking emphasized the power of companies to influence system level change (Van Bakel et al., 2007). This study, on the basis of two cases investigated, concluded that even though companies realize the opportunities rising from identifying sustainability issues at societal level, they find managing all business activities with system innovation in mind very challenging and these companies generally run such strategies as ‘shadow-track’ strategies. The study also suggests that the core conditions of success for running these shadow track strategies are management support, time and funding and “a gradual attunement between the shadow-track and regular policy when ideas and innovations mature (p. 12)” as well as support at government level. Observations in New Zealand can also confirm a shift taking place in businesses towards a desire and effort to understand the implications of long-term sustainability risks on their businesses which is accelerated with the economic recession. The confusion on how to relate long-term sustainability requirements to their day to day decisions prevails as their primary problem due to the lack of models and tools. Therefore, it is believed that the scenario method is timely and it hopefully will contribute the ongoing dialogue about system level innovation in product development, business management and governance areas.

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