

Responsible Innovation: What Challenges Does It Pose for the New Product Development Process?

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Abstract

Society faces increasing challenges which calls for more sustainable and socially responsible business practices. Over time, the focus of the product development process has evolved to consider more diverse stakeholder needs and input, culminating in the recent call for Responsible Innovation. The focus of most research on Responsible Innovation has been on science and its engagement with society. In this paper, we extend this to bring the principles of responsible innovation into the new product development process. Many of the mechanisms exist, but an holistic approach to considering responsible innovation in all key stages of the product development process has not been addressed. We describe the different tools at each stage of the process that can contribute towards responsible innovation. Finally we establish a future research agenda and call for further research to investigate best practice and gather empirical evidence for Responsible Innovation within the new product development process.

Keywords

Responsible innovation, product development process, corporate social responsibility, sustainable

1 Introduction

It is well established that society faces some big challenges ahead. This has led to a general call for more focus on sustainability and socially responsible business practices. It is now widely accepted that human-induced climate change is caused by production and consumption patterns that have emerged to meet society's evolving needs [Unruh, 2000; Foxon and Pearson, 2006]. There are increasing amounts of legislation to try to encourage more sustainable practices and to reduce carbon dioxide emissions. For example, the 2008 United Kingdom (UK) Climate Change Act [UK Parliament, 2008] states that "It is the duty of the Secretary of State to ensure that the net UK carbon account for the year 2050 is at least 80% lower than the 1990 baseline." [p. 1]. Other legislation is encouraging manufacturers to take back and recycle their products at the end of their useful lives.

This government push has also been met by consumer pull for organisations to be more responsible in their behavior and production processes. For example, the organic and fairtrade

markets have gone from being quite niche segments to more mainstream. In addition, many companies have been publically challenged over using sweatshops and child labour to produce their goods [Burke, 2000; Porter and Kramer 2006]. In response, the corporate social responsibility (CSR) agenda has become quite well-established in many organisations, with these firms looking to reduce their environmental and carbon footprints, to sell ethically sourced and manufactured products and to become engaged in national or international community projects to alleviate poverty, improve education and reinvest in the natural environment. In many cases, the CSR agenda exerts pressure on firms to pursue a tripartite of economic, environmental and social performance [Sarkis, Gonzalez-Torre, and Adenso-Diaz, 2010], which emphasises that the entire value chain of a business should also protect natural resources and the environment while contributing to society in a tangible way [Foerstl et al, 2010]. This need for sustainable development is forcing companies to reconsider their business models and restructure their entire operations [Brammer and Walker, 2011; Wu and Pagell, 2011].

The aim of this paper is to define and describe a relatively new topic: Responsible Innovation from a product development process perspective. This paper will explain the history and evolution of the topic, from Concurrent Engineering to Responsible Innovation and how the term Responsible Innovation has been used in the literature to date. The key contribution of this paper is to extend the use of the term from science and society to the new product development process (NPD). This paper will outline the stages in the new product development process and explore the types of Responsible Innovation tools and techniques that can be used at each stage. Finally, the paper will outline a future agenda for Responsible Innovation for both research and practice.

2 Relation to Existing Theories and Research

This section looks at existing theories and research on Responsible Innovation, tracing the history and evolution of the concept and building a definition for Responsible Innovation.

2.1 History and Evolution Towards Responsible Innovation

Up to the 1960s most organizations placed great emphasis on extending manufacturing capacities and capability and 'pushed' products to the market, with relative inefficiencies in other functional areas being tolerated. The 1970s brought with it increasing competition, meaning organisations needed to differentiate themselves more strongly from competitors. This led to a greater focus on the product development process and on the importance of sales as a means to persuade customers to buy their products. By the 1980s, more emphasis was being placed on upstream on research and on the service economy. From the 1990s, there was more focus on the need to dispose of an increasing number of products at the end of their useful lives. This led to consideration of not only Design for Assembly, but also Design for Disassembly [Boothroyd and Alting, 1992]. This was also the key decade for the rise of Concurrent or Simultaneous Engineering [Pennel and Winner, 1989; Riedel and Pawar, 1991; Lettice, Smart and Evans, 1995]. Organisations sought to become better internally integrated to be able to produce high quality products reliably and at lower cost in every faster product development cycles. Leading on from an increased internal integration was a shift to consider external integration. How could the supply chain be better managed and integrated? This was also enabled by new computer and IT technologies that allowed for the sharing of more data between an organization and its suppliers.

From the late 1990s and early 2000s, there was increasing recognition of the need for innovation to ensure survival and growth in an ever more competitive landscape. The attention shifted from the external integration of suppliers to a stronger customer focus. This led to tackling questions such as how could the voice of the customer be integrated into the product development process [Driva, Pawar and Menon, 2000]? How could organisations listen more empathically to their customers to better discover their expressed and latent needs? [Adiano and Roth, 1994; Leonard

and Rayport, 1997; Narver, Slater and MacLachlan, 2004]. Lead user and user-centred design techniques were being developed and more extensively trialled [Franke, von Hippel and Schreier, 2006].

As we move further into the 2010s, the sustainability movement has become more mainstream and there is increasing research on social entrepreneurship and social innovation in response to the need to tackle some of society's big challenges [Lettice and Parekh, 2010; Bridgstock, Lettice, Ozbilgin and Tatli, 2010]. This has been coupled with a social media revolution, opening up opportunities for different business models and approaches to business and new product development [Kenly and Poston, 2012].

This evolution of product development over the last few decades is summarised in the pyramid in Figure 1.



Figure 1: The Evolution of Product Development Towards Responsible Innovation

These steps have led to the development of a relatively new term: Responsible Innovation. The meaning of this term is discussed in the next section.

2.2 What Is Responsible Innovation?

One of the first researchers to use this term was Tomas Hellström [2003]. His argument was that as well as producing benefits, technological innovation also came with risks and a feeling that these risks were increasingly likely to overshadow the benefits and in many cases the problems caused may be largely irreversible. Hellström [2003] uses one example of agro-food production to show the complex interplay between science, environment and society. There is for example increasing concern over food security, our ability to feed a growing world population, concerns over new technologies such as genetically modified organisms, the effects of subsidies or their removal on farming systems and the increased unpredictability of crops caused by increasingly frequent extreme weather conditions.

Similarly, many pharmaceutical companies are augmenting their efforts in societal welfare whilst reducing their environmental footprints. In this context, by purchasing responsibly and managing suppliers to a high standard of quality and compliance, the risk of corporate reputational damage to the buying firm can be avoided [Foerstl et al., 2010]. In recent years, cases involving firms who operate irresponsibly have been widely reported in the media and have centred around

environmental and social issues [Federsel, 2006]. Quite often when safety issues are picked up by regulators, suppliers to pharmaceutical companies are held accountable, and this in turn forces companies to re-think their procurement practices. Recent incidents involving the suppliers of two global pharmaceutical companies, Pfizer and Baxter illustrate this point. In 2010 Pfizer recalled drugs made by Claris Life Sciences India from the US market after the Food and Drugs Authority (FDA) found contamination in the antibiotic and anti-nausea drug developed by the Indian supplier. Soon after, the facility in Ahmedabad was closed by the FDA. The FDA's investigation of Baxter's Heparin led them to the suppliers of the active ingredient which had been manufactured in China. At least 10 Chinese companies were involved in the supply chain for contaminated Heparin. Subsequently, the FDA tracked further companies that made or handled products contaminated with Heparin-like substances from Chinese suppliers.

When such cases crop up, drugs must be recalled and destroyed, suppliers' facilities are quarantined, the risk of supply disruptions is almost certain, financial liabilities are significant and corporate image issues can be devastating.

These examples and incidents combine to give a "complex array of human needs, economic interests, technoscientific uncertainties, and political responsibilities." [Hellström 2003, p.375] and competing stakeholder priorities. Hellström calls for the need to consider risk and unintended consequences throughout the innovation cycle, using extended peer communities to help with identifying the risks and consequences of proposed new technologies. He advocates the development of a framework for the "preventive foresight and governance of Responsible Innovation." [ibid, p.382].

Another early paper on the topic was by Guston [2006], who proposed that universities need to be responsible and attach public value to their innovations and "add societal implications components to natural science research and training proposals." [Ibid p.21]. The next wave of literature on Responsible Innovation starts in 2008 with Ishizu, Sekiya, Ishibashi, Negami and Ata's [2008] focus on the potential societal impacts of nanotechnology. Nanotechnology is widely expected to contribute to progress, future innovation and benefits to society, but it is not without its environmental, health, economic and ethical impacts. They call for responsible R&D for parties involved in nanotechnology development, which means being aware of and responding to society's needs and concerns surrounding the new technologies. They also call for collaboration around standard-setting, to help reduce any risks. For instance, Boeing's 787 Dreamliner project, which is already three years behind schedule and billions of dollars over budget, has been delayed. More recently, the U.S. regulators grounded the global fleet in January 2013 due to undiagnosed battery problems which threatens to tarnish Boeing's flagship craft and the image of the company as a whole [Sunday Times, 2013].

Owen, Baxter, Maynard and Depledge [2009] also recognize that we are entering an era where there is a "growing awareness of the need to innovate, but to innovate responsibly". [Ibid, p6902]. They state the importance of government-led regulation, which has been instrumental in improving air and water quality and reducing exposure to contaminants such as pesticides and heavy metals, but also identify that this process is slow and lags innovative developments. This is a concern as once products are released, it is very hard to retract them, even when risks have been identified. The authors call for better foresight and tools including horizon scanning and risk governance mechanisms such as insurance to complement regulatory mechanisms. Their key message is for much stronger risk management around the upstream development of new technologies and innovations to promote responsible and sustainable development in a proactive way [Owen and Goldberg, 2010].

The term Responsible Research and Innovation (RRI) has even appeared within the EU policy discourse [European Commission, 2011], with Octavi Quintana, Director of the European Research Area calling for "your help to define responsible research and innovation." [quoted in Owen, Macnaghten and Stilgoe, 2012, p 752]. Again, the focus is predominantly on science, with calls for a transformation "from science in society to science for society, with society."

[Laroche, 2011, cited in Owen et al., 2012, p753] and for policy to support “the best science *for* the world rather than the best science *in* the world.” [Owen et al., 2012, p753].

A broad definition of RRI has been presented by Von Schomberg [2011] as:

“Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).”

In the next section, we take the broad guidelines developed recently by those researching and writing about Responsible Innovation, but rather than continue to focus on the development of science and scientific practice, we instead focus on the product development process within organisations, where we believe Responsible Innovation practices are equally important.

3 Research Approach

For this research, we have carried out an extensive literature review on Responsible Innovation to trace the development of the concept and its meaning. From this, we concluded that the term has been used mainly for science and for those scientists involved in new technologies and discoveries such as nanotechnologies, pharmaceutical drug discovery and development and geoen지니어ing, for example. We have then used this as a basis to argue for the concept to be extended into the product development process across multiple sectors and organisations, not just universities and high technology R&D laboratories. In the next section we develop a framework to apply the philosophy underpinning Responsible Innovation to the new product development process. This conceptual work requires empirical testing, which we acknowledge in the conclusions and agenda for future research required on this emergent topic.

4 Initial Findings – Responsible Innovation in the New Product Development Process

There are many different ways of conceptualizing the product development process. For the purposes of this paper, we will use Cooper’s [1990] widely adopted, stage gate process. He identifies that after an initial (0) discovery stage, there is (1) a scoping stage, (2) a build the business case stage, (3) a development stage, (4) a testing and validation stage and then (5) a launch stage. For an organization to be more responsible, we consider some of the mechanisms that can be used or activities that can be completed to ensure that a more responsible approach is taken. Checklists to ensure that these happen can be built into the stage gate process.

4.1 Discovery Stage

The discovery stage is where activities are focused on identifying opportunities and generating new product ideas. This stage is the best opportunity for organisations to consider how they can develop responsible innovations. Just as within the scientific domain, this stage is ideal for engaging the public, customers, suppliers and a broad range of external stakeholders. This can be achieved by using traditional market research techniques, such as surveys and focus groups. However, more organisations are starting to experiment with new technology-enabled methods such as “Enterprise 2.0” or “Crowdsourcing” [Howe 2006] and also sometimes referred as, “interactive value creation” [Reichwald and Piller 2009]. An example of such an approach can be found in the pharmaceutical industry, where an independent web platform links large pharmaceutical MNEs with external individuals who offer corresponding problem solutions for a fee. The business scenario is quite simple: The enterprise is looking for a solution to a problem which cannot be solved by the internal R&D department. It presents the problem with a

description an independent organisation's web platform and offers a reward (remuneration) to the person solving the problem best within a specified time span.

Some large organisations are using formal strategies to promote more external engagement, and this has been termed open innovation [Chesborough, 2003]. A famous example is Proctor and Gamble's Connect and Develop programme (www.pg.com/connect_develop) where they have increased the number of innovations sourced from outside their organization to over fifty percent. There has also been a growth in the number of websites that connect organisations with inventors, such as Innocentive (www.innocentive.com) and Ninesigma (www.ninesigma.com).

There has been some debate over whether or not such crowdsourcing techniques work and whether users or non-experts can develop better new product ideas than experts or professionals. Nonetheless many companies have been experimenting with these approaches, including Dell, Threadless (t-shirts), Apache/Linux, Muji and 3M. In a study on baby products, Poetz and Shreier [2012] found that users generally came up with better solutions that met customer needs, although these proposed solutions may be slightly less feasible. They conclude that depending on the complexity of knowledge needed, which will depend on the industry sector or product category, users can be a good source of new ideas for the NPD pipeline. However, it is important that organisations using this approach frame the problem well, provide appropriate incentives, have the means and the right people to filter and select a wide range of ideas and carefully manage any intellectual property issues.

Sets of tools that can help to frame the problem are now emerging [Lettice and Parekh, 2010]. These include aspects such as changing the lens, scenario planning and scanning the periphery. Additionally, informal social media tools are being adopted at this stage of the process. Kenly and Poston [2012] found that companies are using social media and Web 2.0 tools to generate new product ideas and requirements at lower cost. They are also using the tools to monitor social networks for customer needs and to gauge the market's perception of brand. But a significant proportion of companies surveyed reported that they lack the internal expertise or best practices required to use these techniques.

At this stage, ideas can be sought from a wide range of stakeholders and tested to see if they are responsible or whether there are too many risks to pursue. By framing good problems that are focused around social responsibility, the pursuit of more Responsible Innovation can be realised.

Although social media and Web 2.0 tools are being used, there is a need for more research to see how these tools can be better designed to gather and process product ideas and to identify and share best practice as it emerges.

4.2 Scoping Stage

The scoping stage is an assessment of the technical merits of the product and its potential market.

As well as the technical and market assessments, an ethical assessment of the product can be made at this stage. A detailed risk assessment of the societal and environmental impacts and risks can be included in the scoping analyses. Although there will be many uncertainties, making risks difficult to quantify, by paying attention to these aspects, Responsible Innovation will be easier to achieve.

4.3 Build the Business Case Stage

This is the feasibility stage to ensure that the project has a good product definition, a strong justification and a plan for delivery. Here, the focus is typically on the technical, market and financial feasibility of the product. For Responsible Innovation, the ethical and environmental feasibility of the product and associated manufacturing and consumption processes should also be considered.

Increasingly more organizations are relying on sourcing raw materials and components from external sources, often from obscure locations. As argued earlier, sometimes the inappropriate

and unethical actions of suppliers can seriously damage the image and reputation of large multinational enterprises. Therefore organizations have to move beyond their legal, environmental and social obligations, as stipulated by CSR directives and guidelines. There are many examples where suppliers, in their desire to increase profit margins, exhibit socially irresponsible behaviours, such as employing child labour, exploiting employees, putting consumers at risk, poisoning the environment, and violating regulatory laws.

At this stage, different business models can be considered. For example, there are increasing trends towards product service systems [Baines et al., 2007]. For example, Du Pont have shifted from selling floor coverings to providing total servicing to customers including installation, tailored maintenance, take back and recycling. This is coupled with another similar concept: collaborative consumption. New technology enables consumers to form peer communities to share, barter, lend, trade, rent and swap products to enable more sustainable and responsible consumption patterns. This is discussed in more detail in Section 4.6.

4.4 Development Stage

The development stage is when the actual design and development of the product occurs. Raw materials should be sourced appropriately. They should be created in safe facilities by workers who are well-treated and paid suitable wages to work legal hours. Care needs to be taken not to use child labour and prison workers. Recent cases with IKEA in Eastern Europe and Apple in China have shown that it is not always straightforward for organisations to achieve these standards throughout their supply chains. The suppliers also need to respect the environment in the manufacture of the products, using materials from sustainable sources and implementing effective pollution and emissions measures and controls.

4.5 Testing and Validation Stage

Here the entire project is examined, including the product itself, the manufacturing processes, customer acceptance and the economics of the project. Care should be taken to incorporate the holistic issues covered in the earlier stages of the NPD process.

Moreover, this stage requires ensuring that the product lives up to the claims being made. The product needs to be reliable, maintainable and safe to ensure that customers will not be injured by defective products. Recent examples of using lead paint for toys e.g. Mattel (www.nytimes.com/2007/08/02/business/02toy.html) have shown that this is not always achieved throughout the supply chain. In addition, organisations need to ensure that they are not violating patent, trademark or copyright laws. For some industrial sectors, ensuring that there is no animal testing or experimentation might also be important.

As well as the typical testing to ensure that the product meets technical and marketing requirements, there needs to be processes to ensure ethical and environmental standards are met. Waste reduction, recycling and reuse options need to be monitored and improved and detailed life cycle analyses performed to ensure that the products meet standard at all stages of the lifecycle.

4.6 Launch Stage

This stage is the full commercialization of the product, the beginning of full production and commercial launch. Global consumers are increasingly expressing that they want brands to do well while doing good and prefer to buy from organisations that are supporting good causes than those that are not [Edelman, 2012]. In the fashion sector, Marks and Spencer, H&M and Uniqlo provide opportunities for their customers to recycle and donate old clothes to charity, which promotes environmental sustainability and supports people living in poverty. Innocent drinks have launched the Big Knit to support older people during the colder winter months. Supporters of the brand and the cause knit woolly hats for the smoothie bottles and 25p from every hatted

bottle sold goes to Age UK, which raised over £1m in 2012 (www.innocentdrinks.co.uk/bigknit). These are examples of encouraging responsible consumerism.

In addition, organisations should ensure that when their products are launched, sufficient information is available to consumers to allow them to make informed decisions and hence purchases. Much eco-labelling is voluntary, but some global and local standards have emerged, such as the Fairtrade label, the Forest Stewardship Council (FSC) for wood-based products from sustainably managed forests and the Marine Stewardship Council (MSC) for sustainable fishing. The European Commission introduced the EU Eco Label in 1992 to ensure that organisations adhere to high standards of environmental performance and quality. The take up of the labeling is mixed, and the proliferation of labels can be confusing, but with time they should help with the move towards more sustainable and responsible consumption of responsible innovations.

The different mechanisms and activities for each stage are summarised in Table 1.

| Stage | Mechanisms and Activities |
|---------------------------|---|
| 0 Discovery | <ul style="list-style-type: none"> • Engage broad range of stakeholders: surveys, focus groups, crowdsourcing, open innovation, social media, Web 2.0 • Monitor trends, gather and process product ideas, identify and share best practice |
| 1 Scoping | <ul style="list-style-type: none"> • Risk assessment: market, technical, ethical, societal and environmental impacts and risks of product ideas |
| 2 Build the Business Case | <ul style="list-style-type: none"> • Ethical and environmental feasibility: beyond CSR and into the supply chain • Product service systems and collaborative consumption |
| 3 Development | <ul style="list-style-type: none"> • Raw materials from safe facilities and not using child and/or prison labourers • Sustainability factors: sustainable sources, effective pollution and emissions measures and controls throughout the supply chain |
| 4 Testing and Validation | <ul style="list-style-type: none"> • Product/service needs to be reliable, maintainable and safe • Legal factors: not violating patent, trademark or copyright laws, • Life cycle factors: detailed life cycle analyses and ensuring waste reduction, recycling and reuse options monitored and improved |
| 5 Launch | <ul style="list-style-type: none"> • Finishing touches - encourage responsible consumerism, eco-labelling, etc. |

Table 1: Mechanisms and Activities for Each Stage of the NPD Process

The biggest opportunities to influence more responsible innovation lie in the earlier stages of the innovation cycle, which is illustrated graphically in Figure 2. In the later stages, assessments can be made to ensure that the highest standards are being met. And finally, labeling can help consumers to identify and purchase the products of Responsible Innovation processes.

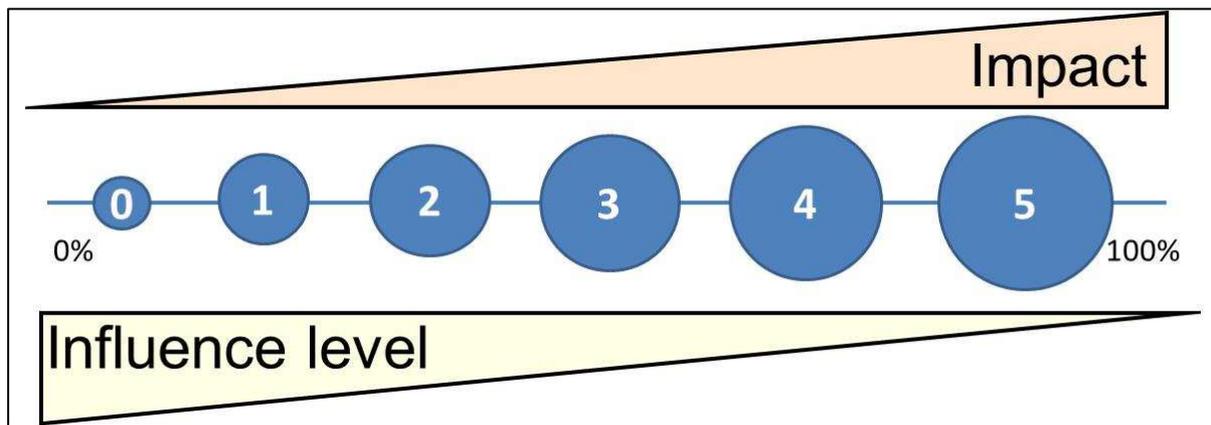


Figure 2: Impact and Influence by Stage of NPD Process

5 Conclusion and Agenda for Future Research and Practice

The focus thus far has been on Responsible Innovation for science and particularly around the development of genomics, nanotechnologies, geo-engineering, synthetic biology and information and communication technologies [Owen et al., 2012]. There has been a call for more public or civic engagement in the upstream science phases, to help foresee unintended consequences or risks and to reduce public misunderstanding of these new technologies. There has also been a call for more risk management techniques and mechanisms to identify and better mitigate these risks. This does not aim to replace government-led regulation, but instead helps to shorten the lag between the ever-faster development of new technologies and the slower speed at which government regulation can be enacted.

In this paper, we identified some ways in which mechanisms and activities can be introduced at key stages in the new product development process to move towards more Responsible Innovation.

At each stage of the product development process, there are opportunities for organisations to consider more Responsible Innovation. As well as focusing internally, the organization must consider consumers and the supply chain to transform traditional innovation practices to Responsible Innovation practices.

New technologies and materials will inevitably enable more solutions towards Responsible Innovation. But with all new innovation, a risk assessment is required with wide stakeholder involvement to ensure that risks and unintended consequences are identified and mitigated. Many of the tools, techniques and approaches outlined in this paper are not new. But their use in an integrated way across the product development process is to be encouraged. Organisations are experimenting with different techniques and some will be more or less suitable depending on the product and sector. A better understanding of which tools to use and when is needed.

In line with our initial findings and reflections on Responsible Innovation and NPD, we propose the following research agenda:

1. Ongoing literature review of developments in Responsible Innovation during NPD
 - » Reflect on lessons learnt from CSR – bring in Responsible Innovation to organizational processes
 - » leading to a thorough classification of the state of the art
2. Subsequent survey via a large scale online questionnaire or in depth interviews
 - » empirically based comparative studies on an international basis
 - » gain an insight from managers and scholars as to their RI readiness for NPD
 - » what are the key activities and measures?

3. Develop a framework
 - » Leading to a Responsible Innovation for NPD maturity assessment
 - » In this way a more in depth picture of the differing requirements by sector would emerge, providing the foundations for more informed decision making
4. Develop strategies for implementation
 - » How should these frameworks be implemented?
 - » Will this lead to the need to develop new tools or add functionality to existing tools and techniques?

In summary, we call for extending this thinking beyond universities and high technology industries to all sectors that are innovating and are involved in developing new products and services (for both public and private sector organisations). This is an extension of the corporate social responsibility agenda with the aim of more fully embracing the new product development process. This could lead to the development of a special interest group for RI within the International Conference on Concurrent Enterprising (ICE) community and in the longer term in the wider business and academic community.

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