Annex A

Possible New VRL-KCiP Task on Business Processes/Product Design Processes
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Product design processes are currently subject to many changes. Due to the continuous influx of new technology, the nature of the products is changing. But on top of that, simultaneously, considerable changes take place in as well the business processes that generate these products and in the users/user contexts where products are used as well. These enormous changes create a number of challenges, both for research and education in this field. Thanks to the influx of new technology it has become possible to design and implement a class of products that meets with the following criteria:

- Context- aware: Devices can recognize you, as a special customer, and your situational context
- Personalized: They can be tailored towards your needs
- Adaptive: They can change in response to you
- Anticipatory: They can anticipate your desires without conscious mediation.
- Embedded: Integrated into the environment in a Network context.

This class of products is often summarized under the term “Intelligent Systems”.

As this discussion paper will demonstrate a major problem with these systems is that they can not be designed using traditional design methods and that, therefore, new research and new education methods in this field are necessary.

Major problems in the design of Intelligent Systems

Most traditional design methods strongly rely on the use of specifications; a formalized description that can be used as a reference to describe the structure and the behavior of a product in it’s interaction with the environment. These specifications form the backbone of many design processes; they are used not only in the decomposition of a system into its modules, components etc but also in the verification and the validation of the product during integration and, later, during field use.

For Intelligent Systems this creates a major problem; not only that the systems are highly adaptive but they also have a strong interaction with an, often highly dynamic, environment. A possible solution to this could be a formal definition and specification of the (expected) interaction of the system with the outside world and/or a formal definition and specification of the degrees of freedom of the internal structure of the system. Although it is certainly possible to use this approach it would certainly restrict the possibilities for developing and using these products; only late in- or after the design cycle of a product has been completed it would become clear whether assumptions made earlier were valid or not in a field situation.

The interesting paradox, created by the earlier mentioned influx of new technology, is that not only this allows products with a complexity that exceeds anything designed before but also that it allows, thanks to advances in information and communication technology, business processes to generate them with a complexity that was also not possible before. This implies that the increasing advances in technology increase complexity in product creation in several ways:

- *Technology*: Increasing influx of new technology. New technology becomes available (Moore's law), not only in terms of processing power but also in terms of sensors and actuators.
- *Industrial processes*: Increasing role of (highly dynamic) networks in stead of monolithic (multi-national) companies. Advances in ICT allow a level of globalization of the economy where it becomes possible for organizations to outsource activities to specialized companies at specific locations, anywhere in the world, with specific (often local) competitive advantages. (examples: software in India, hardware manufacturing processes in China).
- *Users*: The influx of new technology allows the creation of products where users appreciate the functionality but have only a very limited understanding of the technological structure (examples: internet, GSM, Satellite TV). This creates an increasing distance between customers "mental models" of products and technical architecture; customers understand less of the internal structure of increasingly complex systems and therefore demand more of products in terms of user-friendliness and adaptability.

These trends have, especially in combination, a number of secondary effects:

- *Increasing pressure on time-to-market*; in order to effectively utilize new technology companies need to have a, time-wise, very efficient process to translate this new technology to products on the market. Being first at the market allows companies to explore, penetrate and saturate market channels before the competition.
- *Increasing gap between product specifications and customer requirements*: for highly adaptive systems such as intelligent systems, the actual user profiles will often grow during a certain amount of time. It is therefore extremely difficult to a-priori define a full set of specifications that cover completely the technical requirements to a new product from a user perspective. Furthermore it is likely that, due to the same influx of technology, the context in which a product operates will change during the lifetime of this product (eg new interconnectivity, field upgrades, etc) and even during the development traject. Since the specifications form the backbone of many product creation processes this will result in a considerable strain on (the structure of-) these processes.
- *Increasing impact of implicit communication/information in an international and multicultural context*. One of the major problems of designing intelligent systems in an international, networked, context is that on one side ICT allows easy transfer of information in a global network but it does not imply that the right information is transferred to the right people at the right moment; neither does it imply that, when the information reaches a business partner in another company/country/culture that it is interpreted in the same manner as intended by the sender.
- *Increasing strain on communications/information structures in a product lifecycle*. The globalization of both markets and business

processes/networks create a considerable strain on communication/information structures during a product's lifecycle. Global networks allow the generation of huge amounts of data. In theory it is possible to analyze the field use of every individual product at every individual user on any location; either directly (the "aware" product) or indirectly via internet/user forums etc. Due to the high degree of adaptability of AI systems this information is to a large extent unpredictable and therefore very difficult to handle; both due to the sheer volume of data but also due to the dynamics in the data itself.

- *Increasing impact of different cultures with respect to user requirements*. The fact that it is nowadays possible to create, adaptive, products for a global market implies a large number of widely different product/user combinations where factors like local culture can play a dominant role. This requires detailed knowledge, not only of variations in products but especially in the people using the products. Aspects like culture can play a dominant role in this context.

The idea of the new VRL-KciP task is to analyze industrial practices as well as relevant research at academic partners that can help to analyze and resolve the challenges described above. This task concentrates on several aspects of highly innovative business processes that are linked with the design, realization and utilization. The proposed task will include the following activities/deliverables:

1. The analysis of best practices in- and the development of fast feedback systems for use in the design process of strongly innovative products
   (get design feedback information faster).

2. The analysis of best practices in- and the development of dynamic high-resolution analysis systems for the root-cause identification of performance, quality and reliability problems *(get better information).*

3. The analysis of best practices in- and the development of design strategies that stimulate early product optimization by facilitating iterations with respect to performance, quality and reliability early in the design process.
   (analyze and improve best class ay of working).