Editorial

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Creative processes, such as design and innovation processes, are becoming more and more complex, distributed and compressed, and their enhancement is an important issue nowadays. Academic and industrial researchers are pursuing novel methodologies to improve the performance indices of these processes. Over decades, it was a typical approach to consider creative processes as a whole and generate abstract process models that describe the general flow of the processes and the interrelationships between the generalised activities. The primary reason was that researchers intended to arrive at supporting methodologies that can be applied to multiple different processes and a wide range of application cases. The opportunities and the limits of this traditional approach have become reasonably well known by now. The major critique against the life-cycle-oriented process frameworks, structural models and workflows generated this way is that they are not sufficiently articulated and sensitive to specific characteristics of application processes, their sub-processes and activities. This raises the need for a different strategy and an underpinning theory of methodological process enhancement.

An alternative way of the investigation and improvement of creative processes is considering their features as a starting point. A process feature is a recurrent specific pattern of multiple processes, which allows characterising and understanding individual processes and process elements. Process features make it possible to provide a more articulated modelling and representation means for processes, and to handle the similarities and differences of processes from multiple aspects. The concept of process features can be applied to both semi-controlled creative processes and controlled implementation processes. A process feature can be described by an information construct that is reusable in planning new design and innovation processes. This way not only the structural and procedural aspects of processes can be considered at the time of their planning, but also the nature and meaning of the processes, sub-processes or activities. Though process-feature-based investigation and enhancement approaches seem to have a large potential, only the first pioneering steps of explorative research and methodology development have been made in this domain.

Complex creative processes can be characterised by a large number of process features. Obviously, a design process that is implemented based exclusively on human intuitions, knowledge and activities shows remarkable differences compared with a fully computer automated solution space exploration (search) or systematic composition process. This implies that the internal *logical patterns* of processes can be regarded as an important process feature. Logical pattern features of creative processes can be considered and investigated from multiple aspects, such as resolution of complexity, innovative constituents, or procedural reasoning mechanism. Nowadays, most design and innovation processes are completed as collaborative processes, involving communication, data and document exchange, and cooperative actions among various stakeholders and suppliers. These collaborative processes can be characterised by a process feature called *external connectivity*. Like logical pattern feature, external connectivity features can be studied, for instance, from the aspects of contents of communication, forming shared awareness, or means of interaction. Creative processes are knowledge-intensive processes by nature. Knowledge (both formal and tacit) needs to be imported into sub-processes and activities, and can be exported from sub-processes or activities. The occurrence of these can be identified as *knowledge ports*, which in turn can be regarded as a process feature. As such, they can also be dealt with from multiple aspects, such as capturing context, intensity of communication, conversion of semantics/meaning, availing meta-knowledge and knowledge preservation. Obviously, besides the above-mentioned three important features, many more can be defined, such as *critical decision points*, *tool involvements* and *informational bottlenecks*.

We do believe that a process-feature-oriented investigation and enhancement of methodology development is not only a novel perspective on creative processes, but also may become an important instrument for process planners and managers. This belief motivated our thinking towards this special issue. We were looking for papers in the pool of papers presented at the International Symposium on Tools and Methods of Competitive Engineering (TMCE 2010) in Ancona, Italy, that explicitly or implicitly addressed the issue of creative process enhancement through taking into consideration some sort of process features. Hence, this special issue concentrates on capturing design process features in design and innovation processes from various aspects, such as those mentioned in the preceding paragraph. The selected papers provide new insights in the concept of process features and their application, and offer specific reasoning models and best practice examples. The papers have been arranged in this special issue according to which one of the three major process features they addressed. It has been shown by the authors that the identified process features are somewhat difficult to be addressed individually because they are intertwined at various scales.

Addressing logical patterns as process features

From the seven papers included in this special issue, three papers address logical patterns of design processes from various aspects. The first paper focuses on the complexity of product engineering processes. In their paper, entitled '*A generalised framework to compass and to support complex product engineering processes*', Albers and Braun propose a framework that meets the requirements derived from the literature and from practical experiences. The new methodology facilitates the implementation of practical tools with which complexity management of dynamic product engineering processes can be improved. Their theory has been applied to real-life applications, which have validated the new approach and casted light on its advantages and limitations. A long-term perspective is the development of a front-end system for the improvement of the conduct and efficiency of product engineering processes based on the proposed iPeM methodology.

The second paper, '*Methodological enhancements for concept exploration in product design*', written by Russo, Regazzoni and Montecchi, considers the logic of the design process from the perspective of its outcomes. They argue that the lack of use of systematic methods in a design process will result in the lack of innovative solutions or breakthrough ideas. To improve the innovativeness of product designs, they present an interesting new creative design method that has been inspired by TRIZ Laws of Technical System Evolution (LTSE) and has been developed based on several years design cooperation with industry. This method tackles the challenges that small- and medium-sized enterprises are typically facing in the early stages of product development. By providing a structured approach to solution innovation, LTSE reduces the dependency of the results on personal preferences. The new method involves a set of guidelines and rules for conceptual design to foster innovativeness of designers. To evaluate the proposed method, 20 test cases were studied. The evaluation has shown the suitability of the proposed design method for household appliances design.

The influence of the used methods on the logical pattern of the design process is addressed from a third aspect by Daalhuizen and Badke-Schaub. Their paper entitled '*The use of methods by advanced beginner and expert industrial designers in non-routine* *situations: a quasi-experiment*' reports on the study of the behaviour of designers in realistic environments with the objective to understand the need for, and the use of methods by practitioners. In addition to investigating the interaction of the process and the methods in different contexts, a quantitative evaluation of the usefulness of methods is also given. This is usually a hard and critical topic for investigation. The results indicate that the use of methods in non-routine situations improves design performance up to a level where experts and advanced beginners perform equally well. The authors propose that future research should replicate these findings with other types of design problems.

Considering external connectivity features of creative processes

One aspect in which connectivity features of collaborative design processes can be studied is development and maintaining trust. The paper of Völz, Anderl, Schilcher and Petendra, entitled '*Balancing trust and knowledge protection in inter-organisational product design collaboration*', describes a project that aimed at constructing technical methods for measuring, analysing and managing trust in inter-organisational product development activities. The specific goal of the project was to provide some collaborative design management tools with new concepts for managing and protecting the engineering knowledge and trust. The authors have studied the role of trust in inter-organisational product development activities and how it is being managed. The paper also discusses the different technical methods for knowledge protection and reveals the correlation between knowledge protection and trust.

Another aspect of investigation of the external connectivity features of collaborative design processes is the intensiveness of interactions among the collaborative partners. The paper '*Supporting virtual teamwork in Collaborative Product Development*' written by Mengoni, Germani, Peruzzini and Mandolini reports on the development of a virtual collaborative environment with the involvement of a number of Italian universities. To realise a well-functioning extended virtual enterprise, two main challenges should at least be addressed: the necessary involvement of multidisciplinary teamwork during product design and the consequent enlargement of the company boundaries into the extended enterprise. The authors proposed a methodology, which allows bringing the stakeholders together in virtual teams in a virtual enterprise and intensifying their interactions. This is unavoidable with a view to the growing complexity of products. The paper describes a new way of supporting multidisciplinary workgroups and an innovative co-design platform to manage interrelations between the partners across organisations.

Handling knowledge ports of design processes

Knowledge sharing is an important aspect of highly collaborative design processes. The paper '*Engineering 2.0: an approach to support cross-functional teams in overcoming knowledge-sharing barriers in PSS design*', by Bertoni and Larsson, discusses seven knowledge-sharing barriers for product designers. To learn from the current practice, two empirical case studies were carried out and data gathering through questionnaires was made. Both studies enquired about the use of social software, such as wikis, blogs and forums, to overcome the identified knowledge-sharing barriers between cross-functional design teams. The study revealed that bottom-up and lightweight technologies:

- can enable the implementation of more value-driven development processes
- can be considered as means for locating expertise in the extended organisation
- can support capturing the 'context' of the information managed
- enable assessing and validating knowledge assets in a more collaborative fashion.

The lessons and best practices learned informed the authors how to cope with the barriers of using web 2.0 technologies for knowledge sharing within design processes.

Knowledge formulated as a set of constraints can play an important role in design processes. Constraints evolve as the insights of designers are advancing in the design process and may be considered at various ports of product development processes. They not only reflect the advancement of the design process, but also embed the design decisions having been made. Thus, constraints are regarded as knowledge-intensive guides of design process. The seventh and last paper in this special issue, co-authored by Ding, Matthews and Mullineux, deals with the topic of '*Capturing constraint evolution: a technique to preserve and handle design knowledge*'. They considered constraints as knowledge used throughout design. The paper presents a method for constraint specification, annotation generation and management of constraints evolution. An implementation case study assists in understanding the use of annotations in different phases of a design process. The paper proposes a hybrid approach that captures constraint evolution by XML-based design constraint description and CAD model annotations. The results of the proposed approach indicate that the reasons for changes in the design can be linked to the evolution of constraints in the design process, and the cases when constraints are violated can be detected.

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