ACTIVE Technologies for Knowledge Management in Microelectronic Engineering Design

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This paper is about using the technologies that are developed in the ACTIVE Integrating Project in an Engineering Design domain for increasing the performance of knowledge workers in their core activities. The knowledge workers in this domain are design project managers, designers, and design support engineers. The focus is therefore on engineering projects and processes in which these categories of knowledge workers are involved. In a nutshell, ACTIVE technologies help solve one of the bottlenecks of engineering design performance management – making the knowledge about design processes effectively articulated and shared. In doing this, the transition is facilitated from the art of handcrafting integrated circuit (IC) designs to a more industrially strong design system with design process knowledge enabled for re-use.

ACTIVE[1] has adopted a service-oriented approach to its architecture; services are defined at a number of levels. At the bottom level are infrastructure services. At the level above this, machine intelligence technology is used. For example the process mining service learns repeated sequences of action executions which constitute running processes and populates the knowledgebase with these. Finally at the top level are the applications.

An ACTIVE case study on managing knowledge and processes in microelectronics and integrated circuits design is lead by Cadence Design Systems GmbH (http://www.cadence-europe.com/), an engineering design services provider in this domain. Cadence attempts the assessment and management of engineering design performance. This work builds on the results of PSI[2] and PRODUKTIV+[3] projects.

A design system is denoted as *a holonic system[4] providing the environment in which design processes are performed*. This environment comprises actors rationally collaborating in design teams, a normative

[1] ACTIVE – **Enabling the Knowledge Powered Enterprise** (http://active-project.eu/) is the EU FP7 Integrating Project. It aims at increasing the productivity of knowledge workers in a pro-active, contextualised, yet easy and unobtrusive way. The approach is to convert tacit and unshared knowledge – the "hidden intelligence" of enterprises – into transferable, interoperable and actionable knowledge to support seamless collaboration and to enable problem solving. A key aspect is the support for informal process knowledge – the informal collaboration and problem-solving tasks that drive much knowledge work in the enterprise.

[2] Performance Simulation Initiative (PSI) is the research and development project of Cadence Design Systems GmbH

[3] Reference System for Measuring Design Productivity of Nanoelectronic Systems (PRODUKTIV+) project has been partially funded by BMBF.

[4] A holon is a system (or phenomenon) that is a whole in itself as well as a part of a larger system (or phenomenon). Source: http://en.wikipedia.org/wiki/Holon_(philosophy)

framework providing regulations and policies, material resources, and tools. A design process executed in this environment and the environment itself are also controlled by the specific cyclic performance management process comprising knowledge acquisition, measurement and assessment, analysis, decision making, and action phases. Provided that there is a software tool facilitating knowledge acquisition, assessment, and analysis, an informed decision based on the results provided by the software can then be made. This decision leads to actions which improve the performance of the design system. The case study focuses on the use and customisation of the ACTIVE technologies of pro-active knowledge process support and knowledge articulation and sharing.

There are many aspects related to engineering design process performance that require optimization [1]. One important facet is the dynamic character and dynamic ramification of a process. Another one closely related to process dynamics is the requirement to seek for the best productive process continuation among the many possible alternative paths. Each execution of such a process is developed and performed by the team of knowledge workers (design engineers, design support engineers, project managers) in a unique fashion. It is not a challenging problem for experienced team members to make follow-up decisions and choose more productive paths because they use their tacit knowledge based on the past experience. However, for those whose experience in designing this or that particular type of a chip or a circuit is limited, an expert adviser may substantially lower the risk of a mistake. It is very similar to using a navigator system for finding a route on a map, but on a map displaying design technology stages. In an ongoing effort in parallel to ACTIVE Cadence is currently developing such a software system for monitoring, evaluating, and simulating design processes in order to suggest project continuations with better performance – the **ProjectNavigator**.

ACTIVE technologies and software components are complementary and facilitating to the **ProjectNavigator** functionality in several important aspects.

At the back-end – by solving the problem of **design process knowledge acquisition**. It is done by incremental collection of the new knowledge about the executions of design processes through monitoring design processes and mining the dataset containing design process execution logs – using the **ACTIVE Process Mining** component.

At the front-end – by solving the problem of design project knowledge articulation and sharing. This is done by visualizing different facets of design project knowledge on Semantic MediaWiki pages – using the **ACTIVE Design Project Visualizer** as a software engine. An illustration for the visualization of a product bound methodology[5] is given in Figure 1. **ACTIVE Design Project Visualizer** is a further refinement of the process visualization software extension to Semantic MediaWiki [3] tailored to the specific requirements of the case study. It comprises a software connector that passes the knowledge stored in the Cadence knowledgebase into the Semantic MediaWiki pages.

[5] A product bound methodology is a superimposition of the chunks of the generic methodologies appropriate for the particular types of functional blocks on the structure of the design artifact.

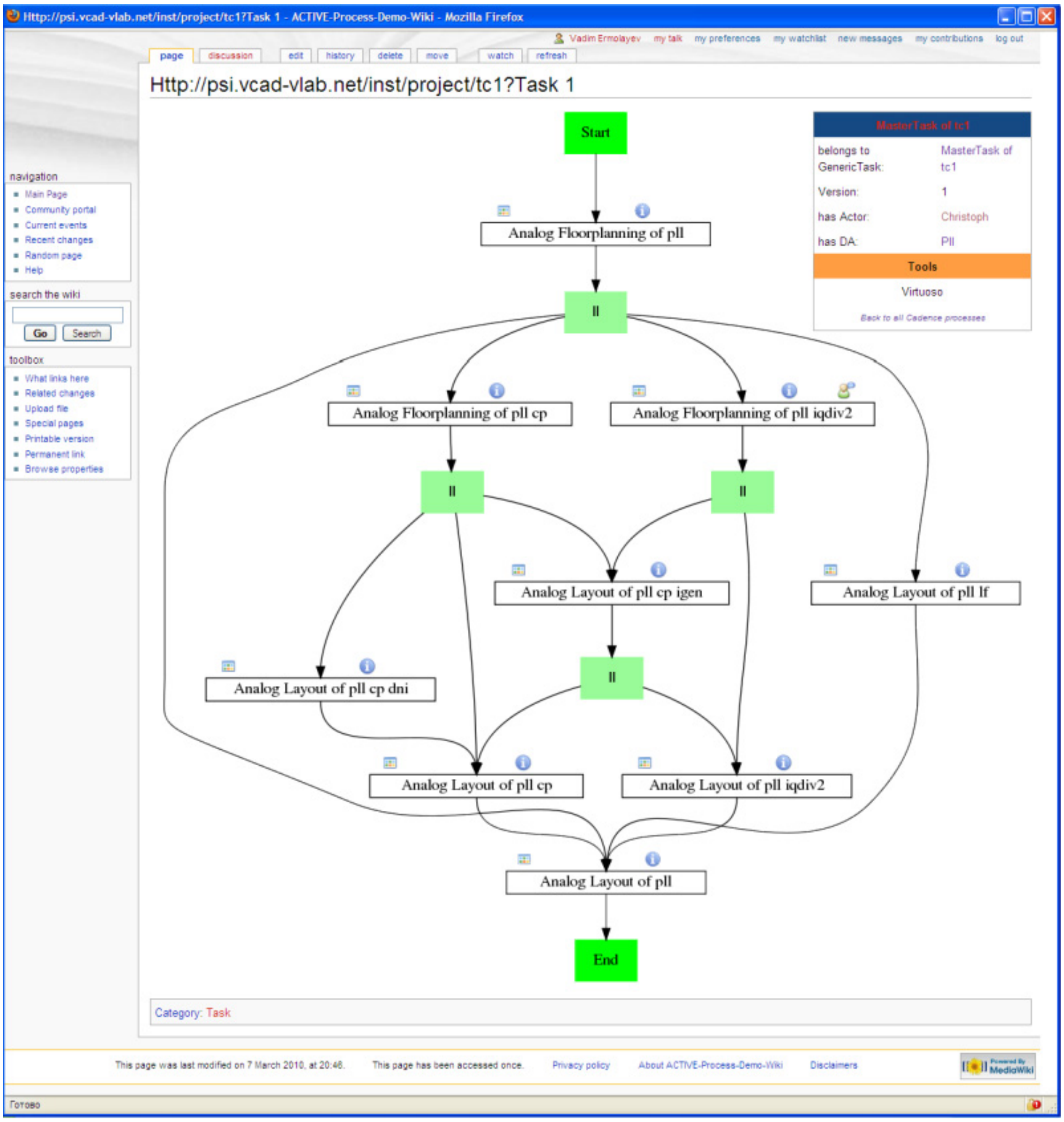

Figure 1: An example of a product bound methodology representation in **ACTIVE Design Project Visualizer**..

The knowledge is taken from the Cadence design project knowledgebase that is the repository of instances of the PSI Suite of Ontologies (e.g. [2]). The knowledgebase is populated from a number of different sources. Static assertions: IP library, methodology, tool, and designer skill descriptions, are entered by human users via **ProjectNavigator** interfaces. Process execution knowledge for the parts of the processes that have already been accomplished comes from **ACTIVE process mining** components. Predictions about possible continuations of the processes are generated by the **ProjectNavigator** simulator functionality.

The static knowledge, when articulated in the wiki pages, forms the basic map of the design system "terrain". The knowledge about the executed part of a process that comes from the process miner marks the track on the "terrain" that the project has passed already. The simulated variants of prediction knowledge, when superimposed on the map, are in fact the suggestions of possible continuations.

Knowledge workers in IC design may be facilitated by using such an expert navigator in a variety of ways.

One important use case is for making optimized project plans by exploiting the experience of the other teams in their accomplished projects. A project manager at the project planning phase is challenged by the necessity of making numerous choices of: the functional blocks from the available IP libraries to be reused; a particular sequence of technological operations that best suits the type of the developed design artifact; a most efficient and effective tool for a particular activity; the constellation of designers with matching skill sets. These choices can be made based on the analysis of the choices made in the successfully accomplished projects, especially those best practice cases performed by experienced “alpha teams”. For helping in that the **Design Project Visualizer**: (i) presents the knowledge about the frequency of use of the reused IP, the technological path, the tool in the past projects; and (ii) provides the functionality for moderated team discussions around the alternative possibilities.

Another use case may exploit the synergy of the ACTIVated software and the **ProjectNavigator** simulation functionality. Once the project plan is drafted and detailed down to the level of a Work Breakdown Structure, it may be fed back to the **ProjectNavigator** simulator for exploring how it would be executed. The simulation results used in the **Design Project Visualizer** may provide proofs of the quality of the developed project plan.

Currently the case study is in the demonstrator software validation phase. Dry run and preliminary usability validation iterations have been performed. The results indicate that the development is consistent with the planned roadmap [4]. The software in its current revision demonstrates reasonable conformance to the specified requirements. User perception of the demonstrator as the tool for performing their representative tasks is satisfactory.

References

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