Towards MultiMedia Instruction in Safe and Secure Systems – Introduction and Overview

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The aim of the MMiSS project (*MultiMedia instruction in Safe and Secure Systems*), which is supported by the German Ministry for Research and Education, bmb+f, in its programme *"New Media in Education"* from 2001 to 2003, is to set up a multimedia Internet-based adaptive educational system, covering the area of Safe and Secure Systems. Thanks to a consistent integration of hypermedia course materials and formal programming tools, teaching in this area will attain a level hitherto impossible in this form. The system will be as suitable for learning on campus and for distance-learning with its associated management of assignments, as it is for interactive, supervised, or co-operative self-study.

The system is to be introduced step by step, over the duration of the project, into the normal teaching activities of the project partners: Universität Bremen (Krieg-Brückner, Eckert [now at Darmstadt], Gogolla, Kreowski, Lüth, Peleska, Roggenbach, Schlingloff [now at HU Berlin], Schröder, Shi et al.), FernUniversität (Distance-University) Hagen (Poetzsch-Heffter [now at Kaiserslautern], Kraemer et al.), Universität Freiburg (Basin, Wolff et al.), Ludwig-Maximilians-Universität München (Wirsing, Kroeger, Merz et al.), and Universität des Saarlandes (Hutter, Melis, Siekmann, Stephan et al.). However, as the "Open-Source" model is to be used and teaching materials and tools are to be made freely available, a much greater national and international take-up is to be expected. To assist this, a MMiSS Forum is to be founded with German, international, and industrial members, to evaluate the emerging curriculum and assist its development and distribution. The Advisory Board shall advise the project from a scientific as well as an industrial perspective, with a view to future applications.

At the core of the system is the hypermedial adaptation of a series of classes or lectures on the development of Safe and Secure Systems. The lecturers should be able to store various sorts of course material, such as overheads, commentary, bibliographies, books, lecture notes, exercises, animations and so on, and retrieve them again for use in teaching. The system provides a formal framework for the integration of teaching materials based on a *semantic structure (ontology)* and enables fast directed access to individual teaching elements. An initial collection of teaching materials is already available and should be further hypermedially developed as part of the project. It covers the use of *formal* methods in the development of (provably) *correct* software. Highlights include data modelling using algebraic specifications; modelling of distributed reactive systems; handling of real-time with discrete events; and the development of hybrid systems with

continuous technical processes, so-called *safety-critical systems*. The curriculum also covers informal aspects of modelling, and introduces into the management of complex developments and *security* .

The system will also contain a meta-database, containing methodological, ontological and paedagogical knowledge about the contents. The teaching materials should, where possible, be available in several different variants. It should be left to the teachers, or the students, to choose between variants, according to the educational or application context. For example reactive systems could be modelled with either process algebras or Petri-nets.

An important educational aspect is to teach about the possibilities and limits of formal tools. Tools for formal software development should be integrated in the system, to illustrate and intensify the contents to be taught. Thus students doing assignments can use the system to test their own solutions, while gathering experience with non-trivial formal tools. The integration of didactic aspects with formal methods constitutes a new quality of teaching. It will become possible, for the first time in formal methods, both to present a variety of formal tools as a subject for teaching, and to use them as a new medium. Thus an algorithm can for example be simultaneously developed, visualised, and verified.

The goal of applying the new system in as many universities and companies as possible, and the fact that the area of Safe and Secure Systems will continue to develop in future, requires the highest level of *flexibility, extensibility and reusability* of the content. It should be possible to incrementally extend or adapt content and meta-data, to suit the teacher's individual requirements, and to keep them up-to-date.

As the individual parts of the curriculum rely on each other, there is a network of *semantic dependencies*, which the system should be able to administer; thus it must at the least handle version- and configuration-management. The ontology additionally allows better support for orientation and navigation within the content. It should also form the basis for adaptation to the user, for example by learning from exercises which concepts the students have understood, and adapting future assignments accordingly.

The formalisation of semantic dependencies means that the system can help *maintain the consistency* of the content. Definitions must be coordinated to suit each other; the removal or adaptation of part of the material may force the removal or adaptation of all dependent concepts. In formal software development, a similar problem has to be solved: there are also semantic dependencies between different parts of a development, for example between specification and implementation. Some of the project partners have already developed techniques for the administration of such dependencies as things change, and implemented them in development tools. Here we perceive an important *synergy* between expertise in formal software development – and support tools – and the demands of long-term sustainable administration of consistent multimedia materials in an efficient and productive educational system.