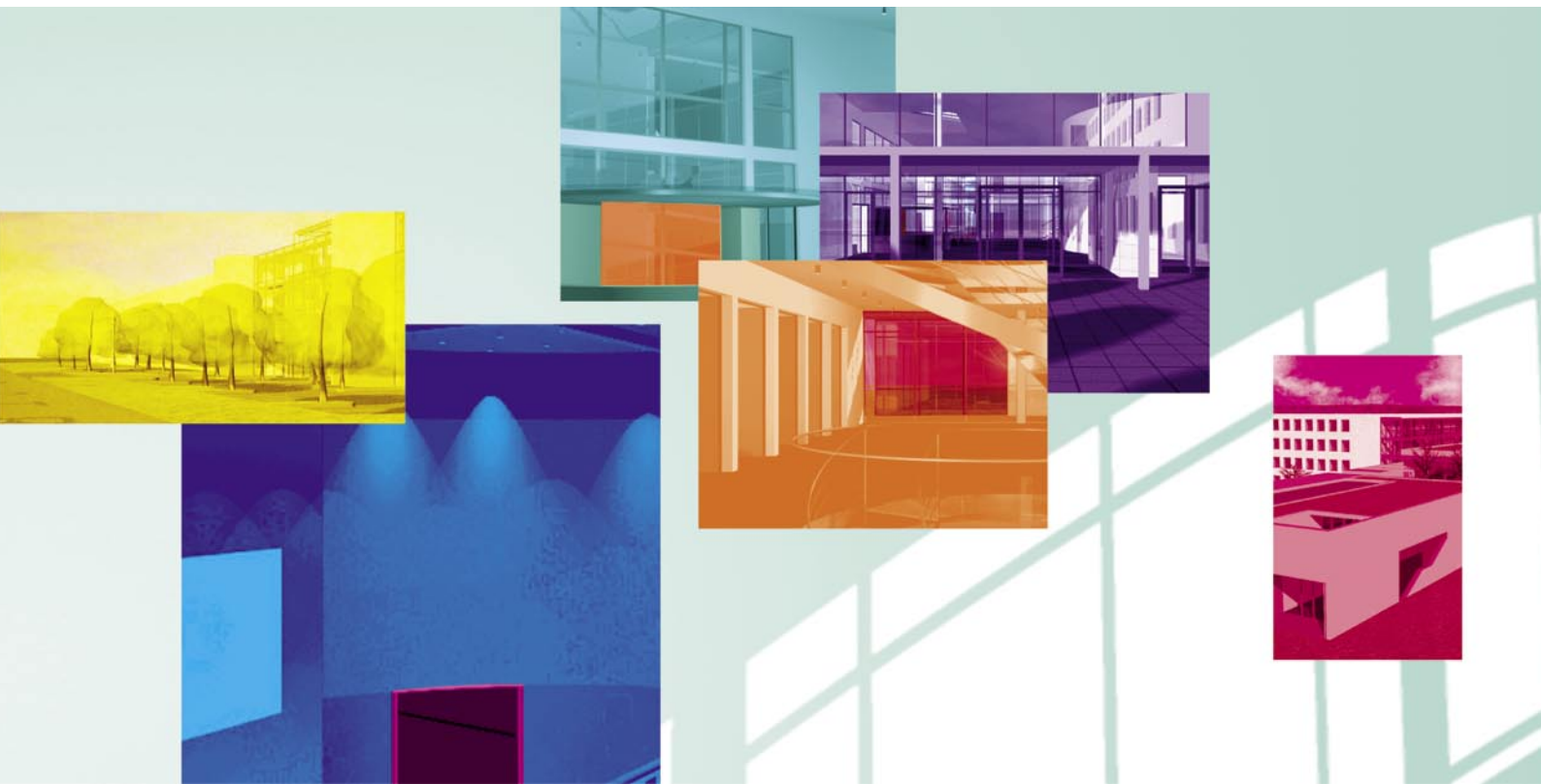




Fraunhofer Institut
Experimentelles
Software Engineering



Annual Report 2003

Fraunhofer Institute for Experimental Software Engineering

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Fraunhofer IESE currently employs more than 140 employees in research and development in the areas of software development approaches, software quality engineering and software process engineering, software architectures and software product lines, continuing improvement and Learning Software Organizations, IT security, and technology-based learning. In cooperation with our sister institute in the U.S., we are developing new technologies, methods, processes, and tools that provide an engineering-style basis for software development. We thus offer methodological instruments that make it possible to predict the outcome of software development projects and thereby make software products more competitive on the market.

Fraunhofer IESE's international customers come from domains where the quality of products and services is co-determined by the software used: automobile production, telecommunications, traffic and transportation, com-

merce, banks and insurance companies as well as software production. Government also plays an important role as a project partner in EU-, federal-, and state-funded projects. In particular, the institute has extensive experience in developing reliable, secure, and flexible software for embedded systems, IT infrastructures and IT service providers, and in providing support for IT-based business processes.

The services we offer range from consulting to building up new structures and processes in software development. They include both the introduction of continuous improvement programs and the selection, adaptation, testing, and implementation of innovative approaches for software development. Companies of all sizes, to include especially small and medium-sized enterprises (SMEs), receive support and assistance in improving their software (development) competence through consulting, contract research, and technology transfer.



From computer simulation to reality:
The new Fraunhofer Center Kaiserslautern is already under construction and will house two institutes. Fraunhofer IESE is expected to move there in 2005.



Office space in the current location of Fraunhofer IESE in Kaiserslautern-Siegelbach is getting scarce. As a temporary solution, additional offices for the expanding institute were leased in neighboring buildings.

Annual Report 2003

Fraunhofer Institute for
Experimental Software
Engineering IESE

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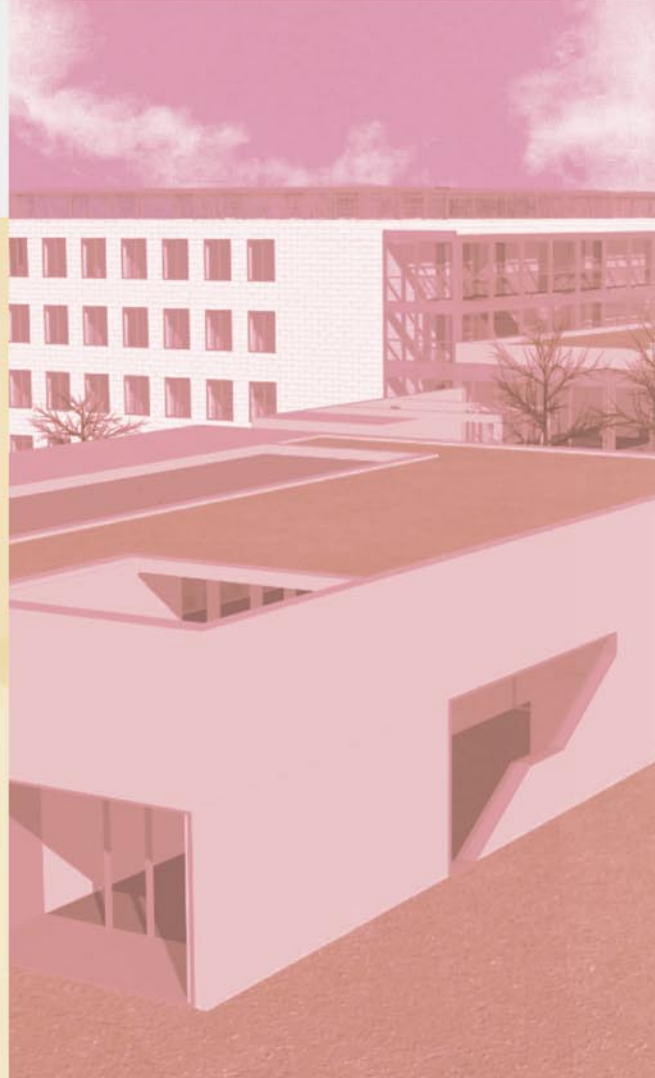
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“In the mechanical engineering sector, we have understood many years ago that investments into processes and methods are very feasible economically. The software industry must also arrive at this understanding if it wants to use the opportunities provided by software while limiting its inherent risks.”

Dr. Thomas Wagner,
Executive Vice President,
Corporate Research and
Development at Robert
Bosch GmbH.

Excerpt from an interview with Dr. Thomas Wagner, Head of the Fraunhofer IESE Advisory Board, on what software engineering means for the automotive industry. The entire interview can be found on page 14.





Once again, top scientific competencies in the area of software engineering and the tireless commitment of highly qualified employees, together with our presence in

international competence networks and successful work on numerous contract research and technology transfer projects have been the pillars that have supported the success of Fraunhofer IESE during the past year.

With a sure feeling for practical feasibility, the more than 140 employees of the Fraunhofer IESE team bundle scientific competencies to support industrial software development according to quality-, cost-/time-, and sustainability criteria, and ensure professional implementation in the everyday operation of organizations of any size and from all domains.

That this tightrope walk between scientific excellence and industrial relevance does not need to be an “either or”, but may also mean “as well as”, is demonstrated by the assessment of an independent expert commission (published in the *Journal of Systems & Software*, 2003). There, based on publications in top international software engineering journals, Fraunhofer IESE is ranked in 6th place among all software & systems engineering research institutions worldwide. Thus, IESE is the only German and best European institute among the Top 15 of this ranking. Furthermore, as in the years before, in 2003 Fraunhofer IESE again earned more than 70% of its budget from external contracts.

The high performance potential of Fraunhofer IESE’s staff is based on their solid education in computer science (many come from the University of Kaiserslautern), on the support and encouragement they receive from the institute, but also on their integration in international networks. Right from the very beginning, our institute has been convinced that top scientific achievements can only be the result of regular competition with “the best of the best (on a global scale) in our field”. It is not enough to show up at a few international conferences. The best scientists worldwide must be tied to Fraunhofer IESE – in our main institute in Kaiserslautern, 17% of the employees currently come from abroad. In addition to being a member of networks with international scientists and institutes (e.g., Fraunhofer IESE is the organizer of the global network ISERN), we also made sure to engage internationally renowned top experts as consultants for our institute.

In accordance with the motto “stopping means going back”, and always true to the motto of Joseph von Fraunhofer, the competencies of the institute are applied and continually evolved with a multitude of partners in cooperation projects in the realm of contract research as well as technology transfer. This report once again presents a wide range of projects that enable a comprehensive, though incomplete, insight into the versatile work of Fraunhofer IESE. You will read about developing and testing innovative methods and architectures, e.g., for embedded systems or wireless systems, and about industrially applied knowledge management, or about the significant increase in productiv-

ity due to systematic reuse in the area of software. Regarding our focus on technology transfer, we will present the Rhineland-Palatinate Research Lab Platform, and we report on current developments in the context of the Virtual Software Engineering Competence Center (ViSEK), which has made a name for itself by now.

In this sense, I hope that you will be excited when you read this annual report –

Dieter Rombach,
Executive Director, Fraunhofer IESE

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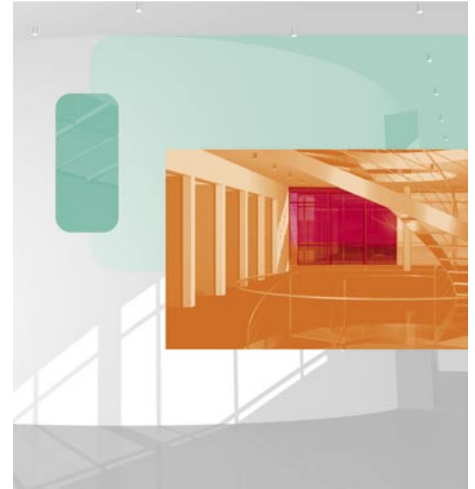
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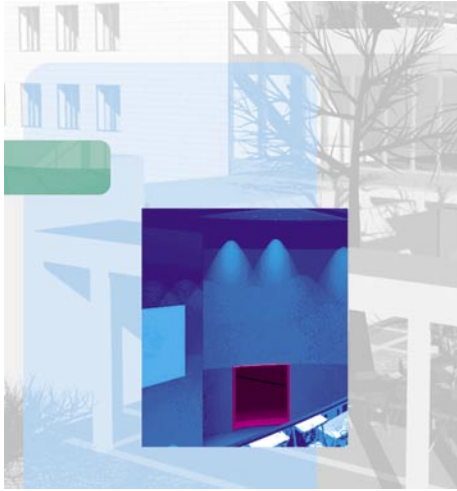
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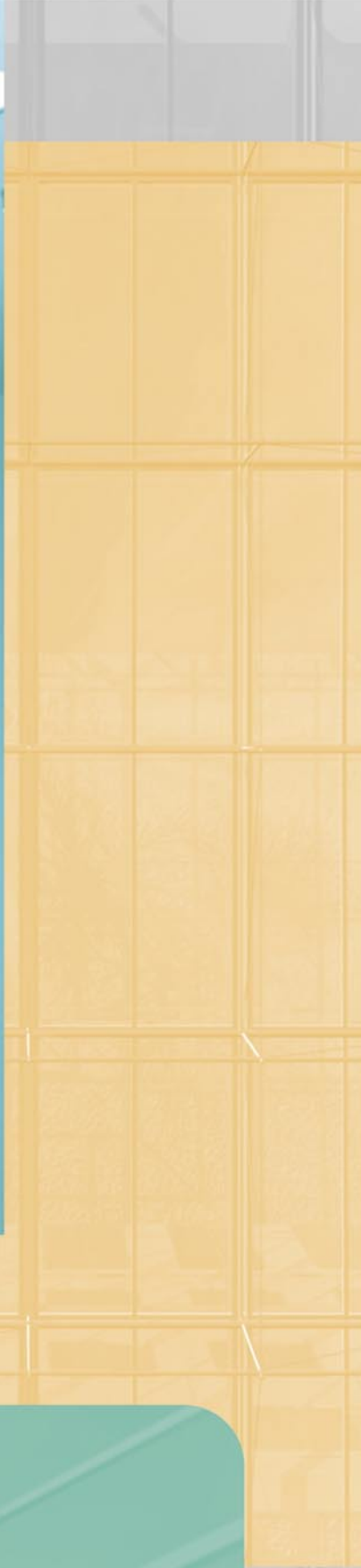
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Into the Future with Software Engineering

Over the course of the last few decades, software has become one of the most important key technologies in those industry domains where high-tech products or services play a central role, and organizations can no longer function without it. The number of product and service features realized as software is also continually increasing. The competitiveness and market success of many domains (e.g., automotive industry, mechanical engineering, telecommunications, telematics, commerce, banks, insurance companies, e-Business, and e-Government) therefore depends directly on software engineering competence – be it in the area of development, procurement, or application.

Our **vision** sees software engineering competence as a key qualification for all high-tech domains. Software competence must be developed, managed, and continually optimized in accordance with clearly defined business goals. Examples from industry show that an experimental method is required for effectively transferring new human-based software development techniques. This experimental transfer approach (i.e., application of the engineering paradigm – plan, implement, test, act – to the development of software) guarantees sustainable improvements and a corresponding “return-on-investment”. More and more organizations are making use of external support to match their software competencies with their strategic business goals. Fraunhofer IESE aims at being recognized by industry as one of the most important partners in the area of contract research and transfer of innovative software and software engineering technologies. Beyond that, we also want to expand our market position as an independent competence center for assessments, studies,

and prognoses of market and technology trends in the area of software engineering. We offer our cooperation to companies from all over the world, regardless of their domain and size.

The primary **mission** of Fraunhofer IESE consists of offering its customers in industry unique, value-adding solutions. This is done through the introduction of software improvement programs, through the transfer of innovative, state-of-the-art software technologies, and through research collaborations to promote such state-of-the-art technologies. Furthermore, we develop programs for improving software competence, conduct studies and assessments, and offer continuing education and training for software professionals. We also promote the dissemination of experimental software engineering as a proven approach for the sustainable introduction of engineering-style rigor into industrial software development. We advance the state of the art of software engineering by experimentally evaluating promising new technologies, by developing new, demand-oriented technologies, by packaging proven new technologies for special customer demands, and by collecting cost-/benefit data as evidence of the benefits of the new technologies in practice.

In order for Fraunhofer IESE to continue to successfully fulfill its mission in the future, the following challenges have to be mastered:

- Strong growth of the institute since its founding
- New scientific and technical challenges to software engineering in a rapidly changing world of applications
- Changed industrial innovation models and constraints

- Homemade constraints of the German scientific community
- Growing expectations towards the role of Fraunhofer IESE for the economic development of the region

The **growth of Fraunhofer IESE** to more than 140 employees today requires that the responsibility for the whole institute be distributed among several individuals, and it also requires more support for the cooperation of individual competence areas in finding industry-relevant solutions. Starting in mid-2004, the institute will have two directors. In addition to the executive director (Prof. Rombach), another colleague will be involved in the leadership of the institute. This colleague will especially increase the competence of Fraunhofer IESE in the area of critical embedded applications (e.g., in automobiles). Furthermore, in addition to the static structures (like competence-based departments and application-based business areas), dynamically defined competence development teams (for the efficient implementation of our competence roadmap) as well as Test Labs (for the implementation of our business area roadmap) will be established. More on that later!

New **scientific and technical challenges** to software engineering stem from the following topics

- Ambient Applications
- Value-based Software Engineering
- IT Security
- e-Government

Ambient Applications deals with applications that provide some service to the user without being instructed to do so – in other words, that react to the user’s behavior and/or to his wishes. As

an example we can use an intelligent personal computer, which determines and continually optimizes its optimal configuration based solely on the usage behavior of its operator. Such Ambient Applications are on the horizon for many application areas such as automobiles and production, but also for living, working, and recreational activities. The challenges to software engineering consist, among other things, of guaranteeing necessary performance characteristics despite constantly changing system configurations, and in providing user-acceptable interfaces between human and machine.

Value-based (also called Dependable) Software Engineering means the use of a software engineering methodology that is appropriate for an application and the necessary performance guarantees related to it. In the past, software engineering has mainly dealt with methods that permit realization of the zero-defect requirements of critical applications such as vehicle control. Development of the remaining applications is currently usually characterized in practice by the use of ad-hoc approaches. These approaches are being increasingly questioned, since these applications are now tied in more and more into value-adding chains (e.g., Internet applications). There is strong interest in “light weight” approaches for the development of such applications. However, these approaches should ensure certain required performance characteristics. The challenges to software engineering thus consist in the development of new methods and process models (keyword: agile methods) as well as in the development of safe prediction models for product quality. To achieve this, we must establish safe process-product relationships – to answer the question of “Which

methods guarantee which results?” In a human-based development environment such as software development, these relationships can only be derived on an empirical basis. This empirical derivation of models represents one of the core competencies of Fraunhofer IESE (Experimental Software Engineering). Many of the models that have been developed already and that can be transferred have been published in a book (Endres/Rombach: A Handbook for Software and Systems Engineering: Empirical Observations, Laws and Theories, Addison Wesley, 2003); they are also available via the portal of the ViSEK project (www.software-kompetenz.de), which is funded by the German Ministry of Education and Research (BMBF). Close cooperation on this topic exists with our Fraunhofer Center in Maryland, USA.

The topic of Security is increasingly becoming a topic across all application domains. One of the competencies of Fraunhofer IESE that is widely recognized by industry is the analysis and correction of security problems in IT systems. The challenge to software engineering here consists of integrating security aspects into the development of new systems – in other words, in proactive security engineering.

E-Government solutions serve the interaction between public administration, industrial suppliers and users as well as private individuals. The range extends from electronic participation of citizens in democratic decision-making processes (e.g., elections) to the use of public services (e.g., submission of building permits, participation in calls for tender) or to public procurement. The challenges to software engineering consist in the complexity of such applications (since in addition to the elec-

tronic portals in general, the general business processes of several suppliers and customers must also be reengineered and integrated in a new way) as well as in the high requirements to the human-machine interface, which must be considered a significant obstacle for widespread acceptance of such solutions.

At Fraunhofer IESE, all four of these challenges are currently being worked on by four interdisciplinary Competence Development Teams.

Changed industrial innovation models and economic constraints such as the pressure to provide faster technical innovation in a global world, the assessment of external research collaborations based on "Return of Investment" as well as the shifting boundaries between suppliers and system integrators require Fraunhofer IESE to reposition itself.

Cycle times for the development of new innovative products have decreased dramatically in the last few years. In many cases, significant innovations take place every 3 to 5 years, at the maximum. In order to handle this challenge, Fraunhofer IESE has established Research Labs as a new form of collaboration. A Research Lab is an organizational unit in which a company's application experts, who are sent there for a limited amount of time, directly collaborate with our scientists at Fraunhofer IESE. Initial results indicate that innovation cycles can be significantly reduced by making research and transfer parallel. The first Research Labs exist with Bosch (D) and Ricoh (Japan). Further Research Labs are currently being prepared.

Even external research and transfer services are today selected solely according to economic criteria. In software engineering, one normally does not sell standard solutions (such as methods or tools); rather, an essential part of technology transfer consists of customizing a product or process for a particular domain or organization. This is exactly what makes it difficult for a company to assess the value before customization has occurred. To deal with this challenge, Fraunhofer IESE has established so-called Test Labs, where domain-specific customization is demonstrated (together with cost-/benefit data) and simple and cost-efficient tests are performed on company problems. These Test Labs exist and will be further expanded for embedded systems in the automotive domain, for telecommunication systems, e-Government solutions as well as for pure software products.

In particular in the customer domains of automobile manufacturing and financial services providers, which are important to Fraunhofer IESE, dramatic changes of the interface between suppliers and system integrators are currently taking place. While in the case of the financial service providers, there is a definite trend towards outsourcing IT services, this is still very controversial in the automotive domain. In any case, it leads to new customer orientation and topic focusing at Fraunhofer IESE. In the area of financial service providers, we must concentrate more on external software companies that will provide the systems that the financial service providers have developed themselves internally so far. On the other hand, we must convince banks and insurance companies of the fact that outsourcing without maintaining internal profes-

sional and architecture competence will lead to risky dependencies.

Challenges also result from the fact that the **German scientific community is undergoing major changes** at this time. Here, we must mention mainly the changing role of German universities, the increasing globalization of research as well as the competition with industrial companies for the best brains.

The changed role of the German universities also includes a stronger emphasis on research funded by industry. This may lead to stronger competition for industrial projects between the local university and Fraunhofer IESE. Our experiences with the Fraunhofer Center Maryland and the University of Maryland, however, have shown that if both parties show good will and recognize that Fraunhofer institutes can acquire totally different industrial projects than universities, both sides will profit from each other.

The fact that globally operating companies today select the globally best research partners forces any research institute into a global competition. Only globally leading research institutions are in demand as cooperation partners. Fraunhofer IESE has traditionally had a good position in this respect. A high percentage of foreign staff members, the Fraunhofer Center Maryland, a network of approx. 50 international cooperation partners in all parts of the world, industrial projects with international companies (e.g., Motorola, Nokia, Ricoh), participation in important public international projects (e.g., EU, NSF), as well as an Advisory Board with international members clearly

demonstrate this. In a recently published study (R.L. Glass and T.Y. Chen: An Assessment of Systems and Software Engineering Scholars and Institutions, The Journal of Systems and Software, 10/2003), Fraunhofer IESE was evaluated as the only German and best European research institute in software & systems engineering. We interpret this external appreciation as a reward and as a challenge for the future.

We are confident that in the future, we will be able to fulfill our industry-related tasks with increased political flexibility, and we welcome in this context the introduction of the new pay scale model for scientists, which has been under discussion for a long time already as an important factor for staying competitive.

Cities and regions have high expectations regarding the effect of Fraunhofer institutes as **regional drivers for economic development and for the creation of jobs**. This is even more true in an economic environment like the one in Kaiserslautern, which is characterized mainly by SMEs. Fraunhofer IESE therefore concentrates especially on the needs of small and medium-sized companies. In the Competence Center for Software Technology and Continuing Education and Training (KSTW), regional companies receive technological support and qualification. KSTW is directly located in the regional technology park PRE-Park and has played a major role in creating 2 500 IT jobs so far. Currently, the concept of Research Labs, which has been successful in cooperation with large companies, is also being practiced in collaboration with SMEs. In order to perform such collaborations with these companies despite

their lower staff levels and lesser funds, the state has funded the Rhineland-Palatinate Research Lab, a cooperation platform where ready-made solutions are offered. This offer has received a very positive response by the regional companies. The region's prospects for establishing itself in the IT sector on a long-term basis are very good according to the magazine DMEURO „Die internetteste Stadt“ (Cover story: Internet in Figures, in DMEuro 12/2003, pp. 22). The article identifies Kaiserslautern as the German city with the second-best innovation potential in the area of IT/Internet. With the move of Fraunhofer IESE into the Fraunhofer Center in the immediate vicinity of the university in the year 2005, these services offered to SMEs will be improved even more.

In conclusion, it can be stated that Fraunhofer IESE reacts to the listed challenges with scientific and organizational measures and with the commitment of its entire staff. This will enable us to continue fulfilling our mission in the future.



Computers instead of Mechanics

Engineering-style methods in software development are increasingly gaining importance, particularly in times of economic difficulties. Systematic Software Engineering helps to utilize the great innovation potential of software-based solutions, while at the same time assuring the required quality and limiting development risks. For this annual report, Dr. Thomas Wagner, Executive Vice President, Corporate Research and Development, at Robert Bosch GmbH, and chairman of Fraunhofer IESE's Advisory Board since 2003, answered questions about the increasing computerization of modern mass production automobiles.

? Performing research that is closer to the demands of the software industry and developing solutions were the goals of a redefinition of the business areas of the Fraunhofer Institute for Experimental Software Engineering one year ago. At that time, you, Dr. Wagner, became chairman of the Advisory Board, succeeding your predecessor, Prof. Denert. How do you assess the situation today? Has Fraunhofer IESE sharpened its profile by orienting itself towards software engineering for the development of embedded systems, for security solutions, for process improvement, and for software-based products and services?

! Fraunhofer IESE has made the first, important step in that direction. All of the topics mentioned, each of them by itself, are of fundamental importance for German industry. A majority of our industries lives on products that can be called "embedded". Security issues are becoming increasingly important, not only in the automotive industry. When we think about security, we often think of systems that have a potential for being jeopardized, in other words, we think of "safety", but we must not forget the "security" aspects. The entire mechanical engi-

neering domain is built on reliability; here, the economic relevance of functioning machinery is obvious. A second step must follow. I think that here we are entering a relatively uncharted area: It is not enough for the business areas of Fraunhofer IESE to merely coexist. Making the relationships among these topics and the solution models understandable will be a very meritorious achievement. It requires application-related research, which, I believe, ideally suits the Fraunhofer model.

? In the software developing industry, costs are tightly calculated today. Investment costs should bring rapid return on investment. In light of this situation, how do you rate the willingness of organizations to elevate their processes, methods, and technologies to a higher level? We all know that fundamental innovations only provide a return on investment in the medium or long term.

! Indeed – and sometimes a dramatic situation arises on a very short notice, which may even jeopardize an organization's very existence. Just imagine if the federal government had negotiated different contracts with "TollCollect", the German consortium for the truck toll, e.g., by taking into account the experience of the U.S. Department of Defense in the 1980s ... In the mechanical engineering sector, we have understood many years ago that investments into processes and methods are very feasible economically. The software industry must also arrive at this understanding if it wants to use the opportunities provided by software while limiting its inherent risks. The problem will be that for software, we will not have as much time available as we had in mechanical engineering. For this, the speed of innovation is just too great.



Dr. Thomas Wagner is Executive Vice President, Corporate Research and Development, at Robert Bosch GmbH.

? The company in which you are responsible for research and development is the trailblazer of many essentially software-based innovations in today's automobiles. The antilock brake system, the airbag, electronic stabilization programs (ESP), and navigation systems are inconceivable without software. Today, developers are working on more intelligent automotive solutions, such as automatic driver recognition, active theft detectors, and the integration of multimedia devices as well as mobile phone services into the vehicle. This multitude of software components can only be produced both reliably and cost-efficiently if it is done on the basis of an open and hardware-independent system architecture. Robert Bosch GmbH has therefore decided to use the innovative approaches of model-based development and product line development. Have you thereby taken over a leadership role as an important supplier for the automobile industry? Will the automobile become the model case for integrative system development?

! We want to arrive at joint solutions with our partners in the automotive industry. Therefore, we are getting involved in the development of the overlapping electronic platform "AUTOSAR". Suppliers could hardly continue to fund and control anything else. Otherwise, we would have to individually adapt to between seven and ten different platforms of the respective groups of manufacturers, and perform totally specific developments for each of these platforms. In the face of the foreseeable further shift of value

creation to the suppliers, however, this would also become a problem for the manufacturers themselves. Since the challenge will first become pressing for the large suppliers, we are, of course, in the forefront of this development. In the long term, the result will be integrative system development. Organizations in the automotive industry are now trying to take the first steps in this direction.

? Upper class vehicles are well equipped with lots of electronics and software. Their owners, however, often complain about sudden and inexplicable loss of functions. Should these be considered childhood diseases, or are these indicators showing that the current limits of controlling complex systems with a reasonable amount of effort have been reached?

! Our development methods must keep pace with the challenges of increasing system complexity. This perception is general and nothing new. The automotive industry is by now well on its way to transfer this realization into procedures. Your first question aims exactly at what needs to be done. Besides, we are not so bad after all. Vehicles have failed in the past, too. The proportion of electronic failures, however, has continually risen during the past few years – but not as dramatically as the extent of the electronic systems used has increased. Regarding software, this means: During the last 10 years of exponential growth of the amount of software in vehicles (which has doubled approximately every two years), we have managed to still keep the problems under control. But: Among the manufacturers and suppliers, everyone is aware of the issue of quality, since every failure is one too many.

? The more important software development becomes for technical innovations, and the more

software gets integrated into technical equipment, the more important it gets to rationalize this process. Which technologies and methods do you expect to bring progress in saving costs and increasing quality? What do you think is the significance of empirically based models for process-product relationships?

! Regarding the first question: The first milestone is called process discipline. Building on that, reuse can be systemized. We know from our own experience that this is the right way. Models for process-product relationships are important building blocks for continuing to elevate the level of our product creation processes. To do this, we will not be able to simply use generally applicable models like the Capability Maturity Model (CMM). We will need models that satisfy the specific requirements of our products, their typical characteristics. You certainly mention this issue because you know that our understanding of such relationships, the capability to develop such models, and to beneficially apply them, are still very limited. This is the reason why I consider this to be one of the urgent topics for Fraunhofer IESE.

? With Cartronic, Bosch has developed a function- and software architecture with open and standardized interfaces, enabling an orderly sharing of software between automobile manufacturers and suppliers. Do you see this as a model example for the redesign of relationships between suppliers and OEM (Original Equipment Manufacturer)? Will new chances for software suppliers arise based on such a model?

! The automotive industry landscape will experience change in several dimensions. When the suppliers' part in the creation of value increases, new opportunities will arise, of course. On the other hand, pure software

suppliers, which have already existed for some time, are nowadays limited to partial functionalities. This will not change in the near future. Without an intensive understanding of the system context – and this includes cooperation with mechanical engineering –, suppliers will remain in the second row or even farther back.

? Software developers who provide services in the context of a product strategy defined by the customer, will thus, on the one hand, get more freedom through model-based development technologies, and more planning reliability on the other hand. For the gears between developers and customers to mesh together, though, the processes should be in harmony on both sides. What are the consequences of this necessity for the research activities and consulting services of an institute such as the Fraunhofer Institute for Experimental Software Engineering, especially in the area of process engineering?

! It will be important that not only a single organization decides to make its software development more professional. The interfaces between customer processes and supplier processes must be matched. This must also include the product-relevant interfaces. This understanding has increasingly spread within the automotive industry. We are thus on the right track. It is up to a research institute such as Fraunhofer IESE to identify the research relevant issues and initiate research in them. We are not talking about “daily business” here, i.e., how companies should be supported in CMM-based improvement – this is where the strength of classical consulting companies lies. We expect Fraunhofer IESE to look beyond this horizon and help package issues that we do not need on a broad basis yet, but rather in our most progressive sub-organizations.

Dr. Wagner, we thank you for the interview.

Highlights in 2003

Learntec 2003

At the Learntec educational fair in Karlsruhe from 4 to 7 February, Fraunhofer IESE showed what quality means for e-Learning. The e-Learning course "UML interactive for Design Engineers", an online tutorial that teaches the basics of modern software development, served as an example. The course documented the high level attainable by educational institutions and content developers if they develop their offers with the help of Fraunhofer IESE's IntView methodology, and if they realize top-modern didactical and technological approaches.

IntView is a methodology for the systematic creation of e-Learning courses, which enables a holistic approach. It takes into account such things as the learners' qualification profiles, organizational goals and objectives, technical constraints, and cost factors. On the basis of such an integrated view, modular e-Learning systems and qualification plans can be created that are custom-tailored and adapted to current requirements. This includes the possibility to obtain additional knowledge on the job "just-in-time".

The Fraunhofer IESE approach of meeting today's requirements for continuing education and training in an organization by developing a modular qualification system was received very well by the fair's visitors. "Just-in-Time" is also an imperative gaining increasing importance in the face of the costs involved in continuing education and training. This, together with the necessary personalization of educational courses offered, can only be achieved with a sophisticated methodology like the one developed by Fraunhofer IESE, namely IntView.



IntView stands for a method that can be used to develop learning software systematically – according to the motto "plan first, then program", explains Ines Grütznier (photo) at the Fraunhofer booth at Learntec 2003.



Jörg Dörr uses model robots to demonstrate the benefits of component-based software development to the members of the Rhineland-Palatinate Multimedia Committee.

CeBIT 2003

Five products were presented by Fraunhofer IESE at the world's largest IT fair in Hanover. The main attraction for visitors was the presentation of a programmable Lego robot. Institute experts demonstrated with this model how different variants of a software family can be produced with component-based development technology. It was made clear that this technology is not only suitable for manufacturers of information-processing systems, but that it can also be profitably used in programming equipment controls.

The benefits of the product line methodology PuLSE® were the topic of the second presentation. On the basis of a web-based financial information system, which was developed by the software company MARKET MAKER with the help of PuLSE®, it was proven that it is possible to generate different variants of a software product from one generic software model, and thus save development costs through reuse.

The "Qualification Kit Object-oriented Software Development" turned out to be interesting not only for programmers. Continuing education and training specialists from companies of various domains received information on how the modern didactical approach of Blended Learning has been realized in this qualification method. Even political decision-makers showed interest in continuing education and training technology "made by Fraunhofer IESE", including the Minister for State Development in Western Australia, the Honorary Clive Brown, and the Labor Minister of Jordan, Mzahim Muhaisin.

Fraunhofer IESE in Kaiserslautern is World Class

In the international ranking of software engineering research groups, the Fraunhofer Institute for Experimental Software Engineering (IESE) achieved an excellent 6th place.

Ranking is done on the basis of the number of publications in internationally leading professional journals. In the study, publications between 1998 and 2002 were examined. IESE is the only German organization among the Top 15, and, at the same time, the highest ranked one in Europe. After last year, when IESE first managed to make it into the ranking in seventh place, it managed to improve its position again this year. The ranking of the top-ranked institutes was made for the tenth time. The research ranking 2003 was published in the October issue of the renowned professional journal "The Journal of Systems and Software".

The range of Fraunhofer IESE products was complemented by products from the research and development focus area security. NIXE®, an award-winning tool for checking the security settings of UNIX-based computer systems, attracted the attention of system administrators. They obtained extensive information about NIXE®'s range of performance and about its benefits: cost savings, parameterization, automation, reliability, and a large number of pre-configured evaluation criteria.

CROCODILE® was presented as the currently most powerful analysis tool for Cisco router configurations that automatically detects security defects in IP networks. Booth visitors were mainly interested in application experiences with CROCODILE® in maintaining and auditing IP networks. With the help of usage examples from major telecommunications companies, it was possible to demonstrate that CROCODILE® is able to detect numerous vulnerabilities that are easily overlooked by a human inspector. Service providers and consul-

itants also recognized the high usage value of this tool, which can be used for performing security audits more effectively. Representatives of smaller companies reacted with interest to the performance of cost-efficient security audits with CROCODILE® offered by Fraunhofer IESE.

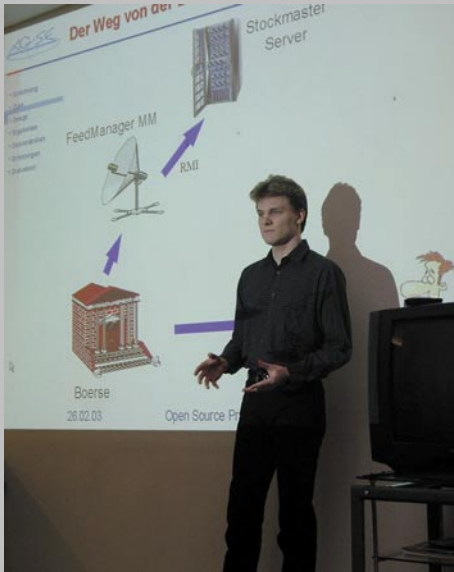
Further products that received attention from government and industrial representatives were the Internet portal ViSEK, a platform for knowledge exchange on software engineering topics, and the Virtual ICT Academy Rhineland-Palatinate, via-it. Hans-Arthur Bauckhage, Minister of Economy, Transportation, Agriculture, and Viniculture of the state of Rhineland-Palatinate, and prominent visitor at the Fraunhofer IESE booth, expressed his approval of the institute's initiatives and stressed the great importance of Fraunhofer IESE in the area of technology transfer, in particular in Rhineland-Palatinate.



CeBIT 2003: Dr. Dirk Muthig (l.) in a conversation with Hans-Arthur Bauckhage (r.), Minister of Economy, Transportation, Agriculture, and Viniculture of the state of Rhineland-Palatinate.



At CeBIT 2003, the institute's executive director, Prof. Dieter Rombach, explains the Fraunhofer IESE exhibits to visitors.



Just like in real projects: David Hopfenzitz, in the role of the design engineer, presents the architecture of the overall system developed by him together with other students in the context of his industry internship.



The Rhineland-Palatinate state government wants to re-structure conditions on the market for IT continuing education and training and take measures to improve the quality of the educational courses offered, according to the Rhineland-Palatinate Minister for Science, Continuing Education, Research, and Culture, Prof. E. Jürgen Zöllner, speaking at an information event at the conclusion of the ZITA project.

Internship at an Industrial Partner's Site

In the winter semester 2002/2003, students from Prof. Dieter Rombach's software engineering lecture again had the opportunity to gain practical experience in a special kind of software development project. This was already the second time that Dieter Rombach and Theo Härder, both professors at the Department of Computer Science at the University of Kaiserslautern, managed to get an industrial partner for their innovative concept of an industry internship. After the system company Maxess, this time the partner was MARKET MAKER Software AG, producer of financial software. Dr. Martin Verlage, Director Data & Services at MARKET MAKER, had a challenging task for the students.

"Develop a client/server system that actively informs investors about prices and news!", was the task. A big challenge for the students; a suitable target definition for the internship's initiators, since the main issue in an internship is not to develop some software that can be used as is, but rather, in Dieter Rombach's words: "It is important that in such an internship, the students learn how important it is to adjust to the contractor".

It depends on the cooperation of regional software organizations whether this concept will survive, whether the students will continue to get a chance to prepare themselves for practical professional life in a realistic manner. After the successful conclusion of the second industry internship, Rombach and Härder were confident. The two industry internships had proven that

industry-oriented education is feasible, for the mutual benefit of organizations and students. Verlage agreed: "As a software organization, we are, of course, interested in getting well trained computer science graduates."

Presentation of the Study "Certification of Continuing Education and Training in the area of IT in Rhineland-Palatinate"

A study (ZITA*) performed on behalf of the Ministry of Science of the state of Rhineland-Palatinate was the focus of an information event on 19 May. Minister Zöllner stated that the study had revealed serious defects in the area of continuing education and training in IT. All those involved are now called upon to ensure more transparency and efficiency by cooperating more closely and systematizing the educational courses offered.

Details of the study were presented by Maud Schlich, the project leader at the time, and project members Silke Steinbach-Nordmann and Eric Ras. Their task had included, among other things, capturing the current status of those continuing education and training courses offered in the area of IT jobs that were available on the Internet. The authors of the study drew far-reaching conclusions from the results of this survey. They recommended weeding out the courses offered in order to increase transparency, for example, by making the names of the courses more uniform. The current situation is characterized by a Babylonian multitude of more than 4000 names. It is also necessary to create a continuing education and certification system for IT education that is

*) Certification of Continuing Education and Training in the area of IT in Rhineland-Palatinate

consistent in itself and that is in accordance with regulated measures all over Germany. An initial and important step could consist of developing a generally recognized, objective process for evaluating existing education courses and, eventually, putting it into operation. Basic principles of such a process were presented for discussion by the project members.

In a final round of discussions, Dr. Peter Krug, the department head in charge at the Ministry of Science in Mainz, expressed his hope that educational service providers and organizers would use the government's initiative and collaborate in a constructive manner in the re-design of the continuing education and training system in the area of IT.

Book series focusing on "Empirical Procedures in Software Engineering"

The Fraunhofer IESE book series "Software Engineering" has started with the "Handbook of Software and Systems Engineering" by Albert Endres and Dieter Rombach.

This book is intended to be the first one in a series that shall represent the fundamental findings of system and software engineering on the basis of empirically provable facts. Unique in this form, this handbook targets both students and professional users, and, following the development cycle of modern software systems, systematically presents software engineering rules and laws. The topics range from requirements definition and system design via implementation and test to the maintenance of complete systems. All of the presented findings are based

on many years of software engineering research and were empirically derived from a large amount of experiences.

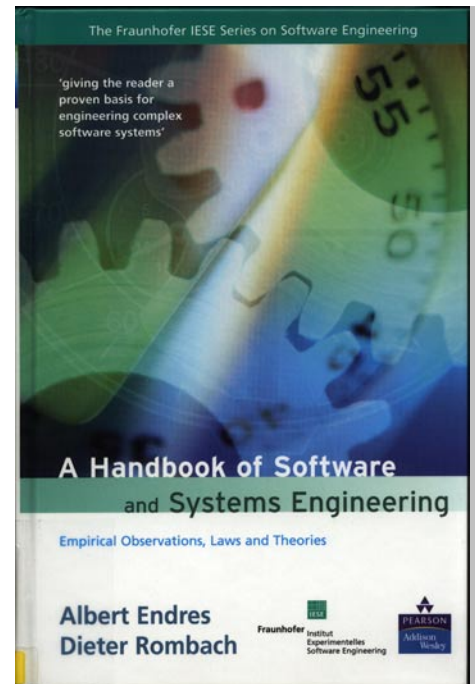
During the course of many years, both authors have made a name for themselves in the area of software engineering. For many years, Albert Endres worked at IBM Germany, in the areas of software development, operating systems, and compiler construction, and did research and finally taught computer science as a full professor at the University of Munich, Germany.

Dieter Rombach holds the chair for software engineering at the department of computer science at the University of Kaiserslautern. Since 1996, he has also been executive director of the Fraunhofer Institute for Experimental Software Engineering IESE.

Renowned scientists could also be recruited for the editorial board of the new book series. They include, among others, David Parnas, Karl Reed, Ian Sommerville, and Marvin Zelkowitz.

Expansion of the Virtual Software Competence Center

The expansion of the Internet portal established in the context of the ViSEK project continued in 2003. This platform for software engineers and software developers was enriched with new functionalities and contents. Since the beginning of 2003, it does not only offer current software know-how provided by the partners involved, but also enables users to add comments to existing information material and provide their own experience reports to the software community.



Profound and competent: Fundamental rules and laws of software development are the topic of "A Handbook of Software and Systems Engineering", the first volume of the new book series "The Fraunhofer IESE Series on Software Engineering".



Drawing the winners: ViSEK project manager Ralf Kalmar and the researcher in charge of the ViSEK user survey, Dr. Teade Punter, are drawing the five winners of one copy each of "A Handbook of Software and Systems Engineering – Empirical Observations, Laws and Theories", by A. Endres and D. Rombach.

In addition to already published articles on topics such as Model-Driven Architecture (MDA), Unified Modeling Language UML, product line engineering, model creation, and development of user-friendly software, the visitor to the site www.software-kompetenz.de will also find basic information about testing software, about quality assurance in software development, or about the V-model. The site also lists regional and national/international events organized by ViSEK project partners on various topics of software engineering – especially for small and medium-sized enterprises.

Project coordinator Ralf Kalmar from the Fraunhofer Institute for Experimental Software Engineering is sure that the continuing expansion of ViSEK will convince the software community of the great benefit of the portal. According to the computer scientist, ViSEK is on the best way towards establishing itself as virtual competence center for software engineering in the German-speaking world. The number of visitors to the website has risen to the sizable amount of approx. 23,000 per month.

CeBIT America 2003

With their joint presentation at CeBIT America in New York City from 18 to 20 June, the Fraunhofer software engineering centers in Kaiserslautern and Maryland intensified their contacts to the North American software industry. The Fraunhofer Institute for Experimental Software Engineering and the Fraunhofer Center Maryland presented solutions that contribute to the reduction of risks in the use of software products developed by third parties.

These solutions make it easier for industrial software users to integrate so-called COTS (Commercial-off-the-shelf)

software – in other words, pre-confectioned solutions – into their own processes and systems. Organizations are able to better control the unavoidable difficulties and error sources if they systematically discover, capture, and assess risks and are then supported in making a safe decision based on the information available. For the various aspects of integration of code, architecture, and user interfaces, the corresponding solutions were offered with the building kit BUY-IT. Great interest was also generated by the software tools NIXE® and CROCODILE®, which complemented the offers of the Fraunhofer institutes with their functions for automatic vulnerability analysis of IT networks with regard to security.

On her tour of CeBIT America, the German Federal Minister of Education and Research, Edelgard Bulmahn, also paid a visit to the joint booth of Fraunhofer IESE and Fraunhofer Maryland. Like the Bavarian Minister of State Erwin Huber, who had Fraunhofer experts inform him extensively on the issue of network security, the federal minister exhibited great interest in the functioning of software tools that can be used to avert the danger presented by hackers and computer criminals. Our experts Frank Herman, Mikael Lindvall (both Maryland), and Michael Ochs (Kaiserslautern) were on hand to answer the visitors' questions.

New Building Gradually Takes Shape

Kaiserslautern-Siegelbach – this was yesterday, this is still today. The future: That is the PRE-Uni-Park. Fraunhofer IESE anticipates celebrating its 10-year anniversary in the new location already, after moving there in the year 2005.

Perfect Timing, one could say. At any rate, this is an example of how a vi-



The German pavilion at CeBIT America – the American edition of the world's largest computer fair.



VIP visit: The German Federal Minister of Education and Research, Edelgard Bulmahn, getting information about the newest trends at the Fraunhofer IESE booth at CeBIT America 2003.

sion has materialized into reality. At the beginning, there was the idea of clearing the way for transferring software engineering knowledge into practice. In the meantime, the spirit of applied software engineering has not only moved and inspired people, but has even moved construction machinery.

The groundbreaking ceremony took place on 27 October. Since then, construction engineers, construction workers, excavator operators, and truck drivers have taken over the area of the former railroad shunting yard at Trippstadter Straße. They are building the foundations for a second high-tech center in Kaiserslautern. The PRE-Uni-Park should give new impulses to the development of Kaiserslautern as an industrial site. Here, applied research will drive the economic development even more than at PRE-Park on Mainzer Straße. This will be ensured by the Fraunhofer Institutes for Experimental Software Engineering IESE and for Industrial Mathematics ITWM, which will form the physical and scientific center of this area.

Next to Fraunhofer IESE and Fraunhofer ITWM, a third Fraunhofer institute with a matching research focus is to be established later – that is the plan. Synergy effects, which so far had been partially impeded by the physical separation of the applied, industry-oriented research from the university research, can then evolve undisturbed. A lively exchange of ideas, of knowledge and people between science and business.

The course for all this is already being set now at Fraunhofer IESE. Research laboratories are being established where scientists and specially appointed experts from practice work together on joint topics. Demo Centers are being designed, which are especially directed at small and medium-sized enterprises, and which provide neutral as well as

objective information on state-of-the-art software technologies. Future plans include establishing a center for the transfer of research results and for continuing education and training, in order to support regional software organizations, in particular.

Ideas grow with communication – and communication needs space. The renowned architecture company AS Plan (Kaiserslautern) has designed structures for the building complex of the Fraunhofer center that enable a symbiosis between rationality and intellectual freedom. A generously sized canopy, for example, will signalize the visitors of Fraunhofer IESE that this institute sees itself as a liaison between science and practice. Although it is often called a “Think Tank”, the outside of the institute will not inspire any martial associations. Large window façades and clear skylights, which allow a lot of brightness to enter the building, will create an inviting atmosphere.

Glass, aluminum, sand-lime brick, and exposed concrete are the construction materials that will form the skin of the building. The extensive greenery areas are a contrast to the soberness emanating from these substances. They will not only relax the eyes, but also serve as climate buffers in those parts where they extend into the building and end on the rooftops.

Openness to the inside and to the outside is one of the main characteristics of the new building complex. General institutions such as the dining room, the cafeteria, the central presentation room, and the seminar rooms are already recognizable from the outside. Low energy consumption is ensured by an earth heating/cooling system, which pre-heats the air in the winter and reduces the interior temperatures in the summer to a bearable degree.



Heavy machinery digging up the red soil: excavation work started in 2003.



Kick-off: Construction on the third Fraunhofer Center in Germany officially started on 27 October 2003.



Studying the plans: Final details are discussed between the architect, Prof. Ermel, the institute's executive director, Prof. D. Rombach, Lord Mayor B. Deubig, and the director of the Department of Building Regulations, Günther Schnitzer (from left to right).

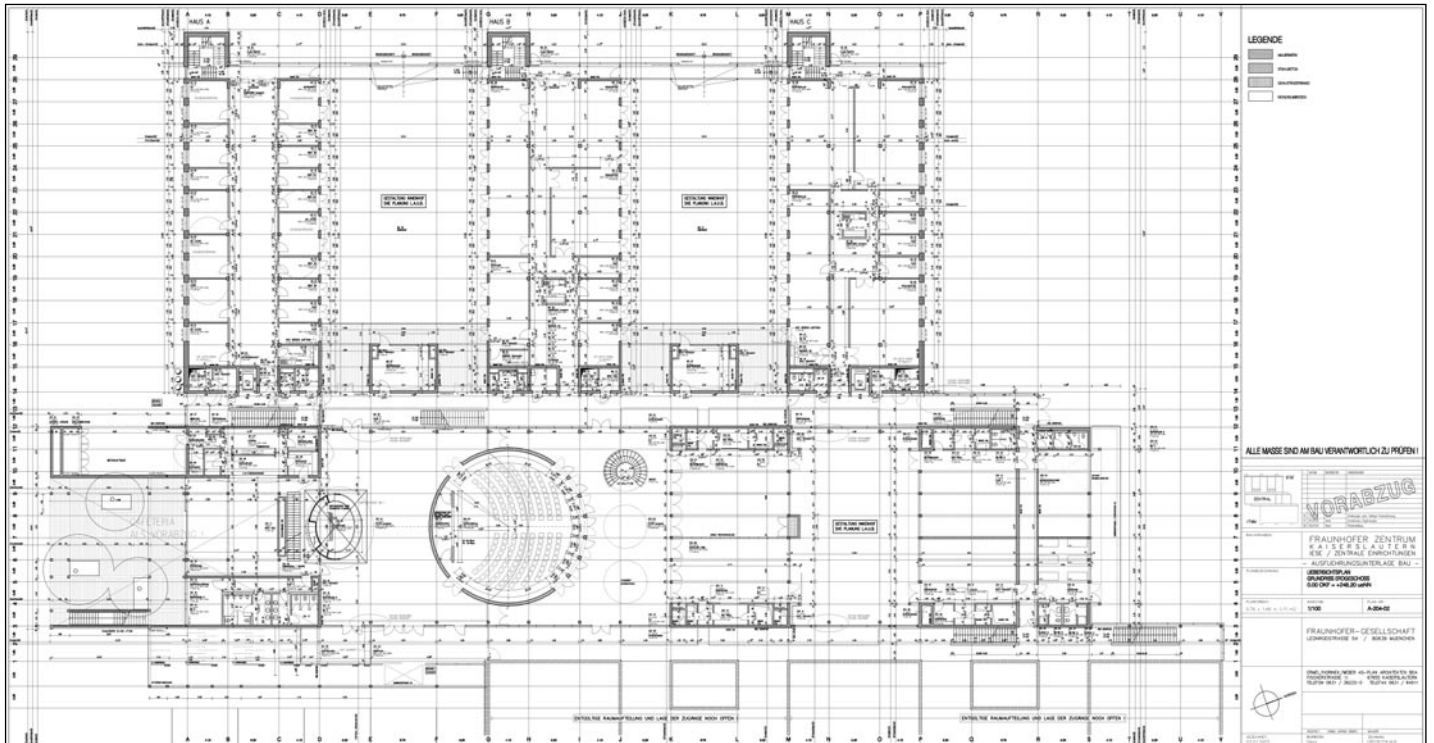


Only bits and bytes so far: The representative main entrance of the new institute center will soon become reality.

The Fraunhofer Institute for Experimental Software Engineering, which began as a newcomer in the year 1996, has by now “grown up” in every respect. This is also visible by looking at the age structure of its employees. Whereas during the first years, the majority of employees were single, family fathers and working mothers with children are not rare any more today. Not only optimal working conditions, but also social institutions prove that the Fraunhofer center is headed towards the future. When the institute will move in a few years, the little ones will also be taken care of. A day care center will then accept up to 30 children.

Competence Center “Virtual Office of the Future” Opened

As a research platform for software engineering and document management that is unique in the whole world, the new competence center Virtual Office of the Future opened today in Kaiserslautern, with the Japanese IT giant RICOH as its first cooperation partner. The Japanese company with 75,000 employees is one of the worldwide leading suppliers of office communication systems. The goal of the new competence center is to perform research and development collaboration with companies and to develop innovative products in the area of “Intelligent Of-



Everything according to plan: In the foreground of this blueprint, the lobby area and the large auditorium can be seen; the offices in the upper part of the blueprint are interspaced with atriums to break up their monotony.

Office Applications". Regional small and medium-sized enterprises (SMEs) may also become a part of this with their complementary competencies. The new competence center is currently being established at the German Research Center for Artificial Intelligence (DFKI) and at the Fraunhofer Institute for Experimental Software Engineering (IESE). RICOH wants to use the vicinity to the Technical University and to the planned technology park PRE-Uni-Park for developing innovative solutions for the office of the future in cooperation with DFKI and Fraunhofer IESE.

After careful analysis of more than fifteen potential sites in Europe (including five sites in Germany), Ricoh has decided on Kaiserslautern as the preferred site for its European Research Lab. The main reasons for that were that the competence center "Virtual Office of the Future", which was recently founded with the support of the state of Rhineland-Palatinate, offers an ideal environment for RICOH's planned research in the areas of software engineering and document management. According to Dr. Kunii, one of the Senior Vice Presidents of RICOH, Kaiserslautern is the European site that offers the highest competence in these research areas, which are important for the future of RICOH. Furthermore, the

city of Kaiserslautern offers the ideal prerequisites for a fruitful collaboration due to its partnership with Bunkyo-ku, the seat of RICOH's central software research and development group ("Software R&D Group"), which has been in existence for many years, and due to its renowned Technical University.

After DFKI was initially given the task in March of this year, and with the signing of the cooperation contract by Prof. Rombach for Fraunhofer IESE in Tokyo on 7 November, the preliminary phase of the planned research collaboration was successfully concluded. Only three days after the contract was signed, the first RICOH employees arrived in Kaiserslautern on 10 November 2003 in order to start preparations for their project work at Fraunhofer IESE. Soon RICOH will establish a central administrative office at PRE-Park, which is the premier address for high-tech companies in Kaiserslautern. In two initial projects under the umbrella of the new competence center, the future strategic cooperation is to be prepared. The project groups will each be staffed with three employees sent by RICOH and three scientists from the Kaiserslautern research centers. The two projects will be located at Fraunhofer IESE in Siegelbach and at DFKI on the campus of the University of Kaiserslautern.



Kick-off: Dr. H. Kunii, Senior Vice President of the project partner RICOH, came all the way from Japan to attend the official opening of the "Virtual Office of the Future".



The new competence center "Virtual Office of the Future" is currently being established at the German Research Center for Artificial Intelligence, DFKI (represented by Prof. A. Dengel, at the podium) and at Fraunhofer IESE (represented by Prof. D. Rombach).

IESE and its Network Partners



Collaborations

Fraunhofer IESE cooperates with technology providers, technology transfer customers, and strategic partners in national and international collaborations with the purpose of promoting the development of software engineering technology and transferring it into industrial practice.

International Research Networks

Fraunhofer IESE is a member in several international research networks. The International Software Engineering Research Network (ISERN) with about 35 scientific and industrial members plays a significant part in IESE's international research cooperation. ISERN is a forum for applied software engineering researchers to exchange the latest insights and findings in Software Engineering. Leading research institutions within ISERN include: the University of New South Wales, Australia; the Fraunhofer Center for Experimental Software Engineering, Maryland (FC-UM), Maryland, USA; Lund University, Sweden; Tor Vergata University, Rome; the University of Bari, Italy; the University of Strathclyde, Scotland; the University of Hawaii; the University of Maryland; the Nara Institute of Science and Technology, Japan; and VTT in Oulu, Finland. Fraunhofer IESE coordinates the ISERN network. In addition, IESE is affiliated with the Center for Empirically Based Software Engineering (CeBASE), a project of the National Science Foundation (NSF), USA. Other CeBASE members include FC-UM, the University of Maryland, the University of Southern California, Mississippi State University, and the University of Nebraska-Lincoln.

Bilateral research and exchange programs for students and scientists exist with renowned institutions, such as the University of Maryland's Experimental Software Engineering Group; the University of Southern California's Center for Software Engineering; the Software Engineering Institute (SEI) at Carnegie Mellon University, Pittsburgh; Carleton University in Toronto; the University of Calgary, Canada; the National ICT Australia Ltd (NICTA), Sydney; and the Software Quality Institute at Griffith University in Australia.

Publicly-funded Collaborations

Fraunhofer IESE coordinates the national Virtual Software Engineering Competence Center (VISEK), a project funded by the German Federal Ministry of Education and Research. VISEK partners are

- Brandenburgische Technische Universität Cottbus ("Brandenburg University of Technology Cottbus"), Cottbus
- Fraunhofer-Institut für Rechnerarchitektur und Softwaretechnik FIRST ("Fraunhofer Institute for Computer Architecture and Software Technology"), Berlin
- Fraunhofer-Institut für angewandte Informationstechnik FIT ("Fraunhofer Institute for Applied Information Technology"), St. Augustin
- Fraunhofer Institute for Experimental Software Engineering IESE, Kaiserslautern
- Fraunhofer-Institut für Informations- und Datenverarbeitung IITB ("Fraunhofer Institute for Information and Data Processing"), Karlsruhe

- Fraunhofer-Institut für Software und Systemtechnik ISST (“Fraunhofer Institute for Software and Systems Engineering”), Berlin
- Oldenburger Forschungs- und Entwicklungsinstitut für Informatik-Werkzeuge und -Systeme OFFIS (“Oldenburg Research and Development Institute for Computer Science Tools and Systems”), Oldenburg
- Institute for Computer Science, Technical University of Munich, Munich

The mission of ViSEK is to provide German software developing companies with fast and simple access to the latest and most appropriate methods for developing software according to engineering principles. Its primary goals are to build up a community of software engineering experts and professional users as well as to create an Internet portal through which the expert knowledge of ViSEK partners will be made accessible to the more than 20,000 software developing companies in Germany. The portal or virtual competence center thus represents a basis for successful knowledge transfer between research and industry and vice versa.

On the European level, Fraunhofer IESE coordinates the Experimental Software Engineering Research Network (ESERNET). The main objective of ESERNET is to establish and maintain a European leadership in experimental software engineering as an essential catalyst for fast and sustained improvement of European software competencies. It is funded by the European Commission in the context of the 5th Framework’s IST program.

In addition, collaborations within several other publicly-funded consortia exist. These aim either at software engineering technology advancement

or dissemination of best practices and technology transfer. Bilateral industrially-funded collaboration often result from these projects. Public project sponsors include the Government of the State of Rhineland-Palatinate, the Federal Government of Germany, and the European Commission.

Industrially-funded Collaborations

The industrial cooperation partners of Fraunhofer IESE range from large global players to small regional companies. They can be roughly grouped into four categories:

- Large national and international companies that seek help in their mid- to long-term endeavor of quality improvement in software development.
- Large national and international companies that can afford their own R & D departments and that search for competent research partners.
- Medium-size companies that want to set up improvement programs or have to implement technology changes under very tight budget and schedule constraints.
- Small companies that need ready-to-use, proven technology that yields short-term return on investment.

In addition to bilateral collaborations, Fraunhofer IESE and FC-UM organize a multinational consortium of international companies - the Software Experience Center (SEC). In SEC, member companies team up to advance their software engineering competencies on a global scale, i.e., across different sites and business units and in collaboration with other leading companies in the field as well as in other application domains.

Specialized Services for SMEs

The Competence Center for Software Technology and Training (KSTW) offers services specifically tailored to small and medium-sized companies. The core offering is focused on base practices in software engineering such as requirements engineering, systematic testing, inspections, etc. KSTW’s Software Competence Kit (“Baukasten Software Kompetenz”) allows tailored consulting services including the following elements: moderated self-assessment workshops, systematic business process modeling, problem analysis based on ISO 15504/SPICE, and tailored staff qualification.

The recently founded research lab for SMEs (funded by the State of Rhineland-Palatinate and the European Commission/EFRE) offers the possibility for a cluster of SMEs to jointly work on software engineering research topics. The focus is on setting up an infrastructure for tailoring software engineering topics to the specific needs of SMEs and includes preparations for the transfer of such topics to SMEs.

The Fraunhofer-Gesellschaft

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The Fraunhofer-Gesellschaft undertakes applied research of direct utility to private and public enterprise and of wide benefit to society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration. The organization also accepts commissions and funding from German federal and Länder ministries and government departments to participate in future-oriented research projects with the aim of finding innovative solutions to issues concerning the industrial economy and demands faced by society in general.

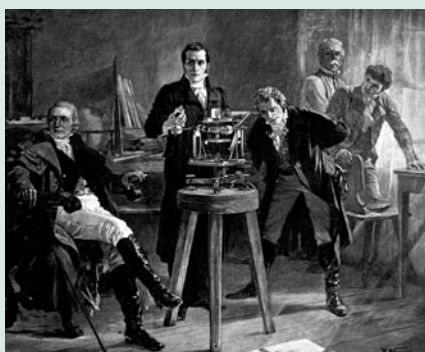
By developing technological innovations and novel systems solutions for their customers, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. Through their work, they aim to promote the economic development of industrial society, paying particular regard to social and environmental concerns.

As an employer, the Fraunhofer-Gesellschaft offers a platform that enables its staff to acquire the necessary professional and personal qualifications to assume positions of responsibility within their Institute, in industry and in other scientific domains.

At present, the Fraunhofer-Gesellschaft maintains roughly 80 research units, including 57 Fraunhofer Institutes, at over 40 different locations in Germany. A staff of some 12,700, predominantly qualified scientists and engineers, work with an annual research budget of around one billion euros. Of this sum, approximately €927 million is generated through contract research. Roughly two thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. The remaining one third is contributed by the German federal and Länder governments, as a means of enabling the Institutes to pursue more fundamental research in areas that are likely to become relevant to industry and society in five or ten years' time.

Affiliated Research Centers and Liaison Offices in Europe, the USA and Asia provide contact with the regions of greatest importance to future scientific progress and economic development.

The Fraunhofer-Gesellschaft was founded in 1949 and is a recognized non-profit organization. Its members include well-known companies and private patrons who help to shape the Fraunhofer-Gesellschaft's research policy and strategic development.



The man behind the name:

Joseph von Fraunhofer

The Fraunhofer-Gesellschaft owes its name to Joseph von Fraunhofer (1787-1826), the successful Munich researcher, inventor and entrepreneur.

Born of a family of modest means, the glass-grinding apprentice Joseph von Fraunhofer joined the institute for optics headed by privy councillor Joseph von Utzschneider, who put the young researcher in charge of glass manufacturing at the early age of 22. Joseph von Fraunhofer's major developments include new methods of glass production and processing.

The optical instruments he himself developed, such as the spectrometer and the diffraction grid, enabled Fraunhofer to conduct fundamental research in the fields of light and optics. He was the first scientist to measure the spectrum of sunlight and characterize the appearance of the dark absorption strips: the "Fraunhofer lines".

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(as of December 31, 2003)

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Fraunhofer eGovernment Center

The Fraunhofer eGovernment Center consists of eight Fraunhofer institutes offering services for e-Government in Germany and Europe on the basis of the synergies of their individual competencies, which range from application knowledge and technology know-how to solution development.

Each institute involved has many years of experience in the areas of technology and application, and collaborates in various e-Government application projects. As regional representative of the eGovernment Center in Rhineland-Palatinate, Fraunhofer IESE supports government agencies as well as software developing organizations in establishing, expanding, and improving their e-Government services. In particular, the following services are offered: support in strategy determination and execution of feasibility analyses, quality assurance and support of realization projects (with special consideration of system architecture, usability, and IT security issues) as well as support in establishing e-Government know-how. In order to guarantee optimal coverage of the technological and application-related issues, the projects are performed in cooperation with other institutes of the Fraunhofer eGovernment Center on a case-by-case basis.

The Fraunhofer eGovernment Center is manufacturer-independent. The services offered range from consulting and assessment services to technology evaluation, re-organization of business processes, software development and implementation, evaluation and development of security solutions, to project

performance, quality assurance, standardization support, and know-how transfer.

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www.eGov-Zentrum.fraunhofer.de

Fraunhofer Group Information and Communication Technology

The Fraunhofer Group Information & Communication Technology consists of fourteen Fraunhofer institutes with more than 3,000 employees, and has an annual budget of over 190 million €. This makes it the largest research association for information and communication technology in Europe and one of the largest in the world.

The value-creating chain of the Information and Communication Technology domain is covered broadly by the complementary foci of the member institutes (New Generation Internet, multi-modal dialogs and new media, knowledge and content engineering, IT security, computing and biology, simulation and virtual engineering, innovative applications and I&C-based services).

Within the Fraunhofer Group Information & Communication Technology, Fraunhofer IESE is particularly active in the areas of e-Government, IT security and software engineering (systematization of requirements; modeling and design of distributed, parallel, and embedded systems; development of methods and tools, structural assessment of



organizations regarding I&C). In addition, Fraunhofer IESE, together with the Virtual Software Engineering Competence Center (which can be accessed on the Internet via www.software-kompetenz.de), bundles the know-how of more than 500 experts who implement new technologies in practice in a sustainable manner.

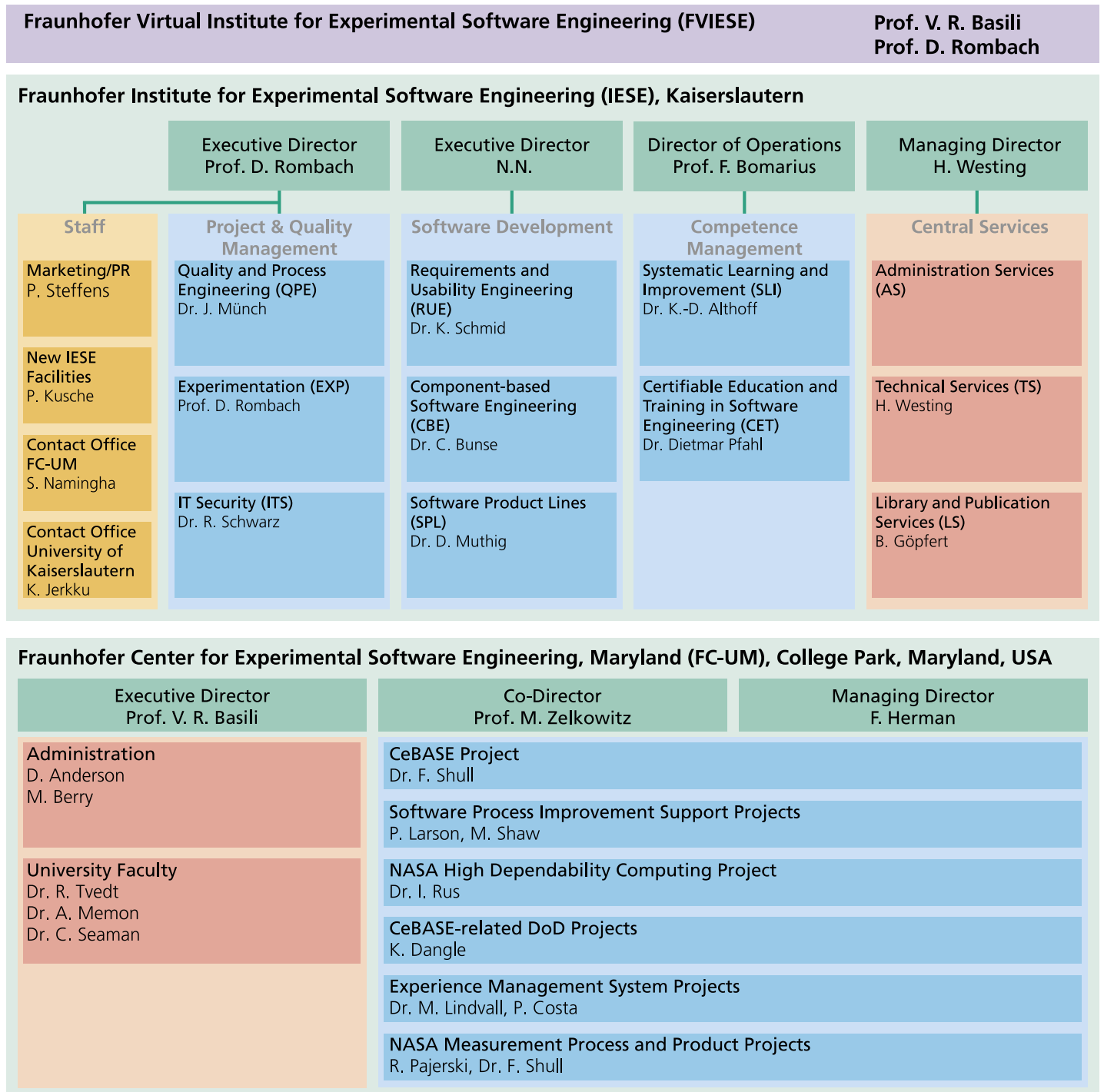
The Fraunhofer Group Information & Communication Technology makes its competence portfolio available to partners from industry and government. The range of services offered includes custom-tailored IT solutions, competent technology consulting as well as advance research for new products and services. Through international research programs, the member institutes are part of a worldwide network of business and research organizations in Information & Communication Technology domain.

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Organizational Structure



The Fraunhofer Virtual Institute for Experimental Software Engineering

The Fraunhofer Virtual Institute for Experimental Software Engineering, FVIESE, includes two partner institutions: the Fraunhofer Institute for Experimental Software Engineering (IESE) in Kaiserslautern and the Fraunhofer Center for Experimental Software Engineering, Maryland (FC-UM) in College Park, Maryland, USA. Both institutions are legally independent units of the Fraunhofer-Gesellschaft e.V. and Fraunhofer USA, Inc., respectively. The institute directors, Prof. Dieter Rombach and Prof. Victor R. Basili, coordinate FVIESE.

Core Competencies and Business Areas

To ensure efficient execution of daily operations, the FVIESE institutes – Fraunhofer IESE and FC-UM – are organized into several departmental units and staff groups, which constitute the institutes’ line structures. The Fraunhofer IESE line structure is complemented by a two-dimensional matrix structure. One dimension is assigned to so-called “Core Competencies”, each of which focuses on a cluster of research themes. The other dimension of the matrix is allocated to so-called “Business Areas”, each of which is motivated by a group of related customer

problems. The Core Competencies are dedicated to developing innovative software engineering methods, technologies, and tools, to proving their benefit, and to systematically packaging their research results. Research is typically carried out within public or Fraunhofer base-funded projects. While the Core Competencies thus prepare the ground for technology transfer, the Business Areas are devoted to applying the technologies in industrial practice and to initiating their large-scale roll-out. Business Areas are thus responsible for acquiring, setting up, and monitoring industrial projects, for continuously observing and analyzing market needs, for spotting new business opportunities, and for feeding market require-

ments back to the Core Competencies. Each Fraunhofer IESE scientist belongs to one Core Competence and is dynamically assigned to Business Area projects. Business Areas are thus virtual units with no personnel resources of their own (apart from the Business Area Managers), which draw upon the Core Competencies for staffing customer projects. One member of the IESE Advisory Board is assigned to each Core Competence and to each Business Area, in order to provide continuous advice and guidance on strategic research and market-related issues.

Core Competencies

Experimentation

- Design of Empirical Studies
- Data Analysis
- Result Packaging

Manager: Prof. Dieter Rombach

Advisory Board Member: Prof. Victor Basili

Requirements and Usability Engineering

- Requirements Engineering
- Software Design
- Inspections and Testing

Manager: Dr. Klaus Schmid

Advisory Board Member: Prof. Dr. Manfred Broy

Component-based Software Engineering

- Component-based Design
- Software Engineering for Embedded Systems
- MARMOT Method for Real-Time Systems

Manager: Dr. Christian Bunse

Advisory Board Member: Prof. Dr. Paul C. Clements

Software Product Lines

- Value-based Product Line Development
- Model-driven Product Line Architectures
- Reengineering-driven Product Line Development

Manager: Dr. Dirk Muthig

Advisory Board Member: Dr. Paul C. Clements

Business Areas

Reliable Software for Embedded Systems

- Automotive (Dr. Peter Kaiser)
- Industrial Machines (Ralf Kalmar)
- Aerospace and Defense (Dr. Klaus Schmid)

Advisory Board Member: Dr. Thomas Wagner, Dr. Matthias Berg

Secure Software for Infrastructure Facilities and Services

- Telecommunication (Dr. Volker Hübsch)
- Telematics (Dr. Klaus Schmid)
- Infrastructure Services (Provider) (Dr. Volker Hübsch)

Advisory Board Members: Dr. Michael Strugala, Wolfgang Jung

Quality and Process Engineering

- Goal-oriented Assessment and Measurement
- Process Engineering and Technology
- Cost and Quality Engineering

Manager: Dr. Jürgen Münch

Advisory Board Member: Prof. Victor Basili

Systematic Learning and Improvement

- Experience Factory and Organizational Learning
- Systematic Improvement
- Software Experience and Knowledge Management

Manager: Dr. Klaus-Dieter Althoff

Advisory Board Member: Prof. Werner Mellis

Certifiable Education and Training in Software Engineering

- Evaluation and Certification
- Technology-enabled Learning
- Simulation-based Learning and Decision Support

Manager: Dr. Dietmar Pfahl

Advisory Board Member: Prof. Mary Shaw

IT Security

- Vulnerability Assessments
- Standards Compliance Certification
- Tool Support for Security Checking

Manager: Dr. Reinhard Schwarz

Advisory Board Member: Prof. Jürgen Nehmer

Flexible Software for IT-based Business Processes

- E-Business (Andreas Jedlitschka)
- Banking and Insurance (Michael Ochs)
- E-Government (Petra Steffens)

Advisory Board Member: Dr. Rudolf Bülesbach

Software-based Products and Services

- Software Companies (Andreas Jedlitschka)
- Consulting Companies (Dr. Frank Bomarius)
- Training and Further Education Providers (Maud Schlich)

Advisory Board Members: Prof. Michael A. Cusumano, Dr. Martin Verlage

The Fraunhofer IESE Advisory Board

The Advisory Board consists of representatives of research, industry, and government. The board members support the Institute Directors with advice and counsel.

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Director, Department of Research,
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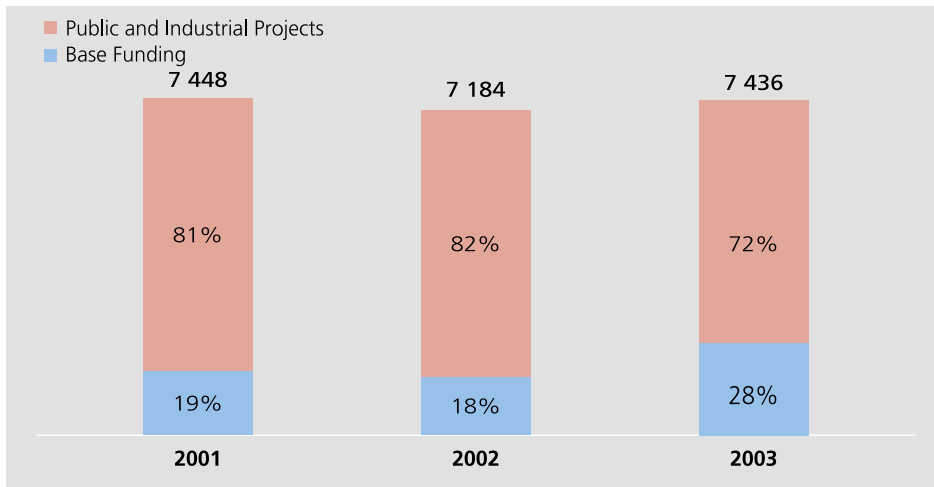
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The members of the IESE Advisory Board at their Annual Meeting in September 2003.

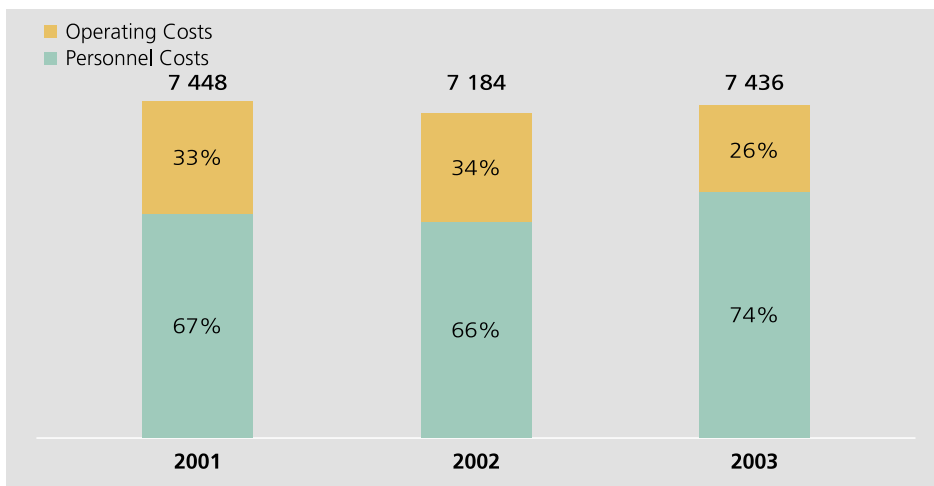
Development of Personnel and Budget



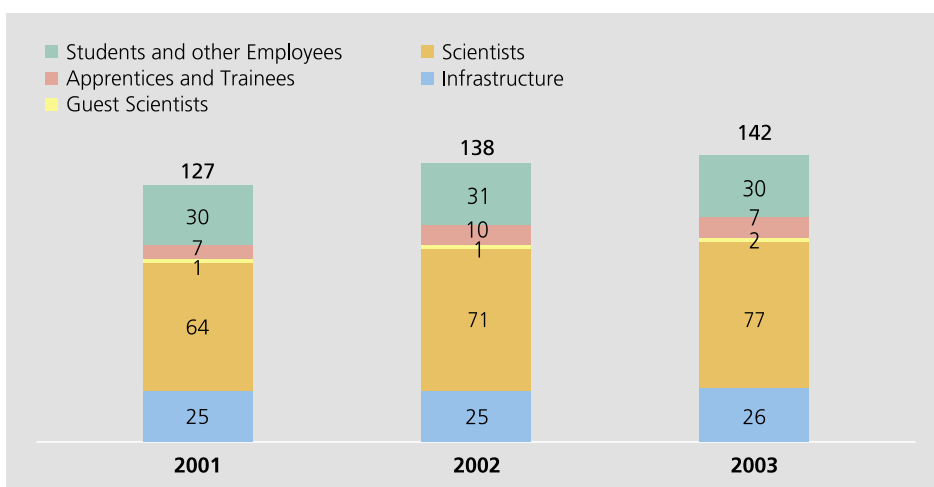
Personnel and Budget Development

In the year 2003, IESE continued to pursue the strategy of moderate personnel growth regarding scientist positions. At the end of 2003, IESE employed 142 people, including 107 scientists, 2 guest scientists as well as 7 trainees and interns, with 17% of the employees coming from abroad. In 2003, the percentage of female employees was 32%.

In 2004, the institute plans to further increase its scientific personnel.



In view of the 2005 move to the new institute building, which is already under construction, operating costs were reduced even more, making approx. three-fourths of the total costs personnel costs. In order to continue the increase in personnel, which is necessary for future strategic development in the scientific area, and against the background of a tight national economic situation, IESE increased basic funding for 2004 from its own reserve funds.





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Experimentation (EXP)

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Prof. Dieter Rombach

How software development methods and processes influence product quality, costs, and time depends on a multitude of human and organizational factors, which include experience, motivation, and the specific product life cycle. Empirical studies – from controlled experiments in research environments to case studies in industrial practice – are necessary for building reliable models of the mutual dependency of processes and products. Such models make it possible to select suitable methods and processes for a given project context. In addition, explicit process-product models can be optimized on the basis of project feedback that is based on measurement data. Numerous software engineering projects have benefited from such a data-based approach: examples include NASA's Software Engineering Laboratory (50% reduction in costs, 5% prediction precision and zero defect delivery quality), Allianz and Bosch, where significant quality improvements were achieved. There are, however, also examples from small and medium-sized companies, such as MARKET MAKER Software AG, where the application of product line technology helped to significantly shorten development cycles.

The empirical work conducted at Fraunhofer IESE is based on central approaches: the "Goal/Question/Metric" method (GQM) for measurement, the "Quality Improvement" method (QIP) for project-based learning and improvement, as well as the "Experience Factory" method (EF) for experience

management. All of these methods were originally developed together with our sister institute, the Fraunhofer Center Maryland. Later, the methods were refined and supporting tools and domain-specific technology transfer plans were added. In the meantime, the Fraunhofer IESE approach has evolved into the de facto standard for the introduction of innovative software engineering methods in industry. One of two current projects that aim at acquiring and disseminating empirical knowledge about software engineering methods is the IMPACT project (funded in part by the U.S. National Science Foundation), which focuses on the causal relationships between empirical studies and practical success in industry. Set against the same background, the ViSEK project (which is funded in part by the German Ministry for Education and Research, BMBF) bundles the software engineering knowledge available in Germany and makes it easily accessible via an Internet-based portal. The competence team "Experimentation" cooperates with all other competence areas in preliminary empirical testing of innovative software engineering methods as well as their transfer into industrial practice. Fraunhofer IESE's internationally renowned experimental competence is also reflected in the fact that it is in charge of the ISERN competence network, which consists of 50 globally leading research institutions, and which aims at furthering empirical methods and promoting empirical studies.

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Dr. Klaus Schmid

In today's competitive business world, corporations succeed or fail depending on how well they meet their customers' expectations. Low investment in the requirements phase causes problems later when users' or customers' expectations are not met. Correcting these failures in a delivered system costs 10 to 100 times more than correcting them in the requirements phase.

The competence area Requirements and Usability Engineering (RUE) develops and transfers solutions in the area of requirements, usability, and quality assurance, focusing on both human needs and technological innovations to increase our customers' competitiveness. RUE helps companies to increase the satisfaction of all product and process stakeholders, while at the same time decreasing costs for development and rework as well as user support and training.

IESE's requirements engineering method RE-KIT (Requirements Engineering with emphasis on Knowledge Management, Interface Specification, and Traceability) supports communication and knowledge management for projects and products. It provides proven techniques for elicitation, negotiation, specification, validation, and management of functional and non-functional requirements as well as a tailorable procedure for assessment and improvement of requirements processes.

Early quality assurance is supported by the world leading inspection method FINE (Fraunhofer Software Inspection). Blended with techniques for test planning, test case derivation, and document metrics, FINE allows to build product quality early on.

For achieving user satisfaction, RUE offers specific usability engineering techniques integrated with software engineering. Particular emphasis is put on the elicitation and definition of usage-adequate processes and tasks.

Customized variants of all these techniques have been successfully applied in different domains and in companies of various sizes.

Examples include projects in the area of e-Government, automotive systems, and telecommunications. Another focus are innovative areas such as ambient intelligence. In addition, RUE evaluates, improves, and packages experiences and techniques with new software engineering trends such as agile processes.

Further Information:

RE-KIT

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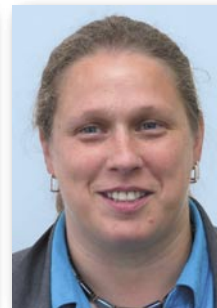
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Dr. Christian Bunse

The functionality of technical products depends increasingly upon control software embedded in these products, which is completely responsible for the behavior of these products. In addition to functional requirements, embedded control systems must fulfill stringent non-functional requirements such as performance, security, or reliability.

The competence area Component-based Software Engineering (CBE) offers a portfolio of synergistic software engineering techniques that individually, or collectively, help to systematically develop component-based software systems, with a specific focus on embedded and real-time systems.

The Kobra method developed at IESE supports a model-driven, UML-based representation of components, and a Product Line approach to their application and deployment. This enables the benefits of component-based development to be realized throughout the entire software life cycle, and allows the reusability of components to be significantly enhanced. Based on Kobra and the principles of component-based software engineering, the goal of CBE is to support IT organizations in systematically building embedded and real-time systems with respect to strategic, organizational, managerial, methodological, and implementation aspects.

CBE has developed the MARMOT approach for embedded system development. MARMOT is completely

based upon the Kobra method, and fully subsumes all Kobra principles and artifacts. However, MARMOT places strong emphasis on embedded and real-time concepts in object and component technologies, such as software/hardware integration, response-time requirements, safety, and efficiency. Furthermore, MARMOT allows such systems to be developed in an aspect-oriented way, with non-functional characteristics such as timing or performance being regarded as aspects.

Systematic quality assurance is needed for ensuring high-quality, reliable components. Therefore, MARMOT provides state-of-the-art inspection- and testing techniques. Examples are 'Architecture Centric Inspections' (ACI), 'Built-In Testing' (BIT-Composite), and evolutionary and genetic algorithms (timing analysis).

To demonstrate the practical applicability of its technology portfolio, CBE has started an embedded system laboratory, which allows students and practitioners to develop embedded systems (both hard- and software) in a realistic manner.

Further Information:

MARMOT

www.marmot-project.de/

Kobra Method

www.iese.fraunhofer.de/Kobra_Method/

The CBE Team



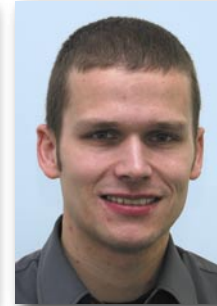
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Dr. Dirk Muthig

Product line development is currently seen as the most efficient answer to the challenges faced by many companies that develop software-intensive products: They must bring more and more products to market in increasingly shorter time intervals, with increasing complexity and at decreasing costs. Product line development enables an organization to make optimal use of its resources by establishing a strategic platform for software development. Such a platform deals with those properties that are common to several products, and offers a means for systematically managing product-specific characteristics. Therefore, product line development allows efficient development and maintenance of a large variety of products. This has proven to be extremely successful in many companies of various sizes and in various application domains.

The transition from single system development to product line development makes it necessary to change various aspects of the software life cycle. The solutions offered by the competence area Software Product Lines (SPL) at Fraunhofer IESE is PuLSE® (Product Line Software Engineering) – an approach that supports all product line-related activities, including all introductory transfer activities.

PuLSE® supports three orthogonal perspectives:

- Optimization of the product line with regard to an organization's economic goals
- Selection and implementation of suitable methods, techniques, and tools for implementing, using, and maintaining a product line platform
- Systematic transfer and integration of existing values into a product line organization

During the design of PuLSE®, attention was paid to developing the approach in an adaptable and modular way, in order to deal with various organizational contexts and constraints. Thus, the introduction and application of product line technology can be done in the right places at the right times – flexibility as the result of five years of experience.

Fraunhofer IESE supports organizations in migrating their single system development to an optimal product line approach, i.e., suitable organizational and technical measures are identified and planned, and active support is provided for implementing them.

Further Information:

PuLSE®

www.iese.fraunhofer.de/PuLSE/

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Dr. Jürgen Münch

The Competence Area “Quality and Process Engineering” (QPE) offers comprehensive support for goal-oriented improvement of software development processes and for data-driven project and quality management. With the help of Fraunhofer IESE, customers can coordinate their projects more precisely with regard to time, costs, and product quality, and achieve sustainable improvements.

Goal-oriented process and product assessments permit a “Health Check” for software development projects and organizations, and identify potential areas in which companies can improve their products and processes. For process assessments, the ISO 15504 Standard (SPICE) is used. Product assessments correspond to the ISO 9126 and ISO 14598 standards, among others. Furthermore, the QPE Competence Area also systematically supports companies in getting ready for external and internal assessments (e.g., in accordance with CMMI).

The effective implementation of process improvements is supported by descriptive process modeling techniques and process management services. Technical processes are systematically elicited by competence area experts, then analyzed, optimized, and documented. One important result is high-quality process documentation that can be efficiently maintained, and which is generated by means of the “Electronic Process Guide” technology.

With the use of the SEV simulation approach, predictions about the effects of improvement measures are already possible before they are implemented, meaning that the risks inherent in process changes can be drastically reduced before these changes are actually implemented in practice.

Exact measurements of important characteristics within a software development process are a major decision-making factor for its continuing improvement and for data-driven project and quality management. The services provided by Fraunhofer IESE in the QPE competence area include the establishment of measurement programs and ratio systems, the implementation of measurement infrastructures as well as the analysis and interpretation of the results. In addition, we combine measurement with integrated quality modeling in order to specify, control, and predict a multitude of quality criteria. We support our customers in the definition of an integrated QA strategy that enables quality assurance in parallel to the project right from the beginning, and optimally matches software testing procedures.

Early recognition of project risks, management of contract development, and easier integration of COTS-type software into one’s own systems are some of the other important tasks for which Fraunhofer IESE offers proven solutions and which it adapts to customer requirements.

The “Electronic Process Guide” is an integral part of the product Spearmint/EPG® by Fraunhofer IESE.

Further Information:

Process Assessments / FAME®

www.iese.fraunhofer.de/fame/

Process Management / SPEARMINT®

www.iese.fraunhofer.de/Spearmint_EPG/

Process Simulation / SEV

www.sev-fraunhofer.de/

Cost Estimation, Risk Analysis / COBRA

www.iese.fraunhofer.de/COBRA/

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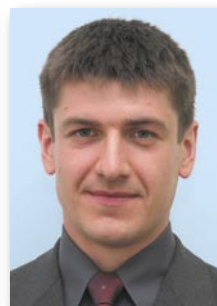
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Dr. Klaus-Dieter Althoff

Knowledge is a resource that is gaining increasing importance. Solving challenging tasks in a competent manner and making the best possible decisions requires relevant knowledge to be easily available. Often, however, the person responsible for a project does not have sufficient knowledge of all the details required for a task. One common strategy to compensate a lack of knowledge is to delegate sub-tasks or to involve experts. This is not always a feasible method, since the necessary knowledge carriers are not always actually available. A very promising way for escaping from this dilemma are so-called knowledge systems, which can be sub-divided into knowledge-based systems and knowledge management systems. These are the focus of research and development of the competence area "Systematic Learning and Improvement" (SLI) at Fraunhofer IESE.

An example of a knowledge system could be a decision support system, where the various alternatives are automatically assessed (considering both prerequisites and consequences), and proposed to the user; this can also include additional constraints such as experiences or a special decision-making context. Such a system would combine aspects of a knowledge-based system and a knowledge management system. For a knowledge management system, the user-oriented exchange of knowledge and experiences is typical, whereas the automatic processing of knowledge through intelligent algorithms represents a domain of knowledge-based systems.

The SLI competence area supports customers of Fraunhofer IESE in the systematic development of

- knowledge management systems and knowledge-based systems that provide support for important tasks within the software development and business processes, as well as
- knowledge-based (sub-)systems that provide software products with the necessary "intelligence" for being able to stand up in competition.

We provide support in establishing and controlling the necessary knowledge processes for capturing, packaging, developing, maintaining, evaluating, and using knowledge. For this, Fraunhofer IESE has developed the DISER methodology, which has by now proven itself in more than two dozen industrial and public projects. DISER is based on the experience factory approach providing that the knowledge system developed at the customer organization is realized as an integral part of the respective software development or business process, and/or that the knowledge-based system that was developed is implemented together with the required knowledge processes.

Our many years of experience enable us to provide competent consulting on

- which parts of a knowledge system should best be realized as a knowledge-based system in order to optimize usage through the resulting (semi-) automatic support and/or
- which parts of a (e.g., embedded) software product it would make sense to equip with more "intelligence" in order to increase such things as functions, flexibility, adaptability, and user acceptance

Further Information:

www.iese.fhg.de/experience_management/

DISER: Design and Implementation of Software Engineering Repositories.

The SLI Team



Gabi Klein
Secretary



Björn Decker
Knowledge Management



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Dr. Dietmar Pfahl

Although software is extremely important for market success in all high-tech and service domains, competence development in the area of Software Engineering (SE) is often neglected. Concurrently, however, the demand for on-the-job- and on-demand qualification of people working in the area of SE is rising constantly, due to the increasingly shorter innovation cycles of software technology. One way of meeting this challenge is the establishment of effective and efficient SE learning systems that combine innovative e-Learning techniques with traditional ways of teaching ("Blended Learning"). In order to improve their effectiveness, SE learning systems must be tailored to the business processes, software application domains, individual SE competence profiles, and qualification requirements of a software organization. For controlling the efficiency of SE learning systems, measures must be taken for evaluating the success of e-Learning, assuring the quality of e-Learning products, and systematically reusing continuing education content. Furthermore, the integration of e-Learning processes and infrastructures with current knowledge management solutions are a necessity if sustainable success is desired. With the support of its e-Learning laboratory, which was established last year, the department "Certifiable Education and Training" (CET) performs research in several of these important areas and offers related services to software development organizations, providers of continuing education courses in the area of SE, and providers of SE content in general, for example in the context of the CET products IntView and QUALISEM.

The IntView product offers methods, techniques, and tools for efficiently developing high-quality learning software. What makes IntView special is the systematic, comprehensive, and continuous interweaving of relevant professional knowledge from the area of media didactics and media pedagogics with engineering-style processes in the development of software. In addition to the introduction of an integrated learning software development methodology, IntView also includes individual services such as the analysis and custom-tailored adaptation of methods, techniques, and tools already in use, as well as support in requirements engineering and quality assurance.

With the QUALISEM product, the CET department offers a package of coordinated methods and techniques for efficiently analyzing the demand for continuing education in the area of SE, for evaluating learning software and learning infrastructures, as well as for assessing planned or previously introduced e-Learning and/or Blended Learning solutions.

Based on the methods of the products IntView and QUALISEM, CET will, in the future, offer comprehensive support for all issues concerning the generation, representation, consistency upkeep, maintenance, and evaluation of documents necessary for handling or using software products. This includes instruction and installation manuals, help texts, mini-tutorials as well as all types of contents appearing on the monitor.

Further Information:

UML Course
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Dr. Reinhard Schwarz

IT security is an important issue for anyone who depends on information technology (IT). The competence area "IT Security" (ITS) of Fraunhofer IESE supports organizations in determining their long-term security strategy, in finding and closing their security gaps, and in keeping up a secure IT operation. The ITS competence area offers methodologies, tool support, and technical expertise all aimed at fulfilling customer-specific security requirements.

Making IT infrastructures secure is a complex, time-consuming task - and experienced security personnel are rare. Fraunhofer IESE provides suitable tool support for improving the efficiency and effectiveness of security analyses and for using existing resources in an optimal manner.

One of the tools developed at Fraunhofer IESE is NIXE® (Non-intrusive UNIX Evaluation), a flexible tool for performing cost-effective security audits on UNIX systems. The audit criteria can be individually set. If necessary, the tool can also derive these automatically from a secure reference system.

An innovative tool for the systematic checking and improvement ("hardening") of router configurations is CROCODILE®. Further development of this interactive tool continues in close cooperation with our customers, such as Deutsche Telekom. CROCODILE® possesses a series of analysis and representation capabilities that are unique so far. The tool is also suitable for larger evaluation campaigns in batch processing mode in accordance with freely configurable evaluation criteria.

Fraunhofer IESE supports its customers in the development of security-sensitive software by providing Secure Software Engineering methods and best practices. These allow developers to systematically capture security requirements and implement them in a reliable manner. Our test and audit methods contribute to quality assurance and help to recognize security risks and correct defects early on, before they can become a threat.

Fraunhofer IESE helps organizations in product areas where conformity with mandatory safety standards is essential, such as in the food or pharmaceutical industry. For instance, we support our customers in performing computer validation in accordance with relevant laboratory standards, or in dealing correctly with electronic records and signatures in accordance with FDA regulations.

One general focus of our research is on reducing dependency on the implicit knowledge and intuitive skills of a small number of security experts. Fraunhofer IESE is working on providing decision-making support in key areas such as e-Government security or baseline IT protection. The goal is to use techniques from the area of knowledge management to make security know-how available to a larger group of employees. Regarding this issue, the ITS competence area is working on developing system solutions for large municipalities.

Further Information:

NIXE®
www.iese.fraunhofer.de/NiXE/

CROCODILE®
www.iese.fraunhofer.de/crocodile/

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CROCODILE® (Cisco Router Configuration Diligent Evaluator) is a registered trademark of Fraunhofer-Gesellschaft.

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Reliable Software for Embedded Systems

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Dr. Peter Kaiser



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Dr. Klaus Schmid

Advanced, high-quality software for embedded systems is one of the strengths of both German and European industry. Today, the use of software for competitive products is indispensable in many traditional engineering disciplines. By now, this secondary software market has become larger than that of the classical software industry. Quality, reliability, and economic feasibility, in particular, are important quality aspects in this area.

These aspects are a special focus of the Business Area "Reliable Software for Embedded Systems", whose activities center around the special requirements of the following application domains:

- Automobile industry
- Mechanical engineering and industrial machines
- Aerospace and defense industries

Furthermore, this Business Area also offers support to customers from the areas of

- Industrial and consumer electronics
- Chemical and pharmaceutical industry
- Medical technology

All these domains are characterized by their need for high-quality software embedded in large heterogeneous systems. Standard conformant and cost efficient methods are necessary for producing secure, reliable, and easily expandable and/or adaptable software components.

The Business Area provides customer-specific solutions from the IESE portfolio for typical problems. This includes the following services:

- Introduction of product line software engineering. This makes it possible to shorten release cycles and reduce costs by improving the reuse of software components across the products of a product family. Furthermore, better synchronization of software and hardware development is facilitated.
- Component-based development of embedded systems for improving maintainability and mastering complex safety-critical software. Model-driven generation of software also enables major reduction of development costs.
- Performance of software engineering process assessments (e.g., in accordance with ISO 15504) addressing the trend towards quality certificates for an organization's capability to develop and maintain its software.
- Preparation for external assessments according to the CMMI standard by means of document and process analysis, as well as support in necessary adaptations.
- Technical support for subcontractor management and integration of current technologies such as Web Services, enabling an organization to concentrate on its core competencies, and facilitating time- and cost-optimized product development.
- Introduction of data-driven product and project monitoring in order to reach the projected quality goals for processes and products.

Further Information:

www.iese.fraunhofer.de/Business_Areas/

Secure Software for IT Infrastructures and Service Providers

Today, almost all organizations are critically dependent on the availability and correct functioning of their IT infrastructure. Flawless information processing has become vital for the fast, smooth progress of business and production processes. The increasing use of telecommunication services and the growing importance of e-Commerce will increase this dependency on IT even more in the future. Against this background, the Business Area "Secure Software for IT Infrastructures and Service Providers" deals with the special requirements of the following application domains:

- Telecommunications
- Telematics
- Infrastructure Services (Provider)

One of the characteristics of these domains is that they require a system environment that is not only highly scaleable, available, and flexible, but also extremely secure. For some of the

typical problems encountered in connection with these high-level requirements, the Business Area offers customer-specific solutions from the IESE portfolio, such as:

- Comprehensive support for Requirements Engineering. This includes all activities dealing with elicitation and coordination, documentation, modeling, validation as well as development of requirements for a system.
- Performance of IT security audits for identifying security vulnerabilities and threats, for closing existing security gaps, defining adequate security goals, and implementing the respective security measures.
- Introduction of risk management for continuous checking of possible risks and implementation of suitable strategies and counter-measures.

Further Information:

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Flexible Software for IT-supported Business Processes

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The Business Area “Flexible Software for IT-based Business Processes” mainly addresses three business domains:

- Banks and insurance companies, who want to enforce higher cost efficiency, maintain and improve product quality, and shorten development cycles, e.g., by harmonizing heterogeneous IT landscapes and architectures;
- Suppliers and their business partners, who want to optimize their work flow processes along the supply chain by making full use of the potential of Internet-based technologies (e-Business);
- Public and government institutions and their development partners, who want to optimize the efficiency and quality of administrative processes as well as the government services offered by using modern IT technologies (e-Government).

The services offered by Fraunhofer IESE include support for owners, developers, and users of software for banks and insurance companies as well as for e-Business and e-Government solutions in the following areas: IT security, usability engineering, process optimization, reuse-based software design and architecture, software project manage-

ment, competence management, quality assurance, software acquisition, and business strategies.

The services of the Business Area include:

- IT security audits and design of security strategies; architecture-centric software design, combining the benefits of software product line technology, model-driven architectures, and component-based development;
- Design and implementation of technology-based learning environments and sustainable competence management;
- Consulting with regard to outsourcing strategies as well as analysis and improvement of outsourcing scenarios;
- Support in subcontractor management and COTS acquisition;
- Integrated software project risk management; software process optimization;
- Assessments and improvement of user interfaces.

Further Information:

www.iese.fraunhofer.de/Business_Areas/



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Software-based Products and Services

The Business Area “Software-based Products and Services” handles the special concerns of software organizations that develop software products or offer customized software solutions. This includes companies that provide IT consulting as well as continuing education and training providers.

The customers in this Business Area are mostly small and medium-sized enterprises who do not maintain their own research departments, but expect an immediate return-on-investment at the same time. IESE offers its innovation and research services to such companies. Beyond that, IESE cooperates with these companies and serves as a technology partner in joint customer projects.

The following topic areas are included:

- Requirements analysis
- Usability Engineering; with special focus on utility
- Quality management, control and assurance

- Techniques and methods for verification and validation of software
- Assessment and improvement of software processes
- Assessment and improvement of software products
- Expert reports, certifications, evaluation of tools and technologies
- Project management through risk management and knowledge management
- Methods and techniques for technology-based learning (e-Learning, Blended Learning)
- Content Engineering for multimedia learning modules
- Evaluation of learning modules and learning platforms
- Skill analysis and demand-controlled established of curricula for “On-the-Job” and “Near-the-Job” continuing education

Further Information:

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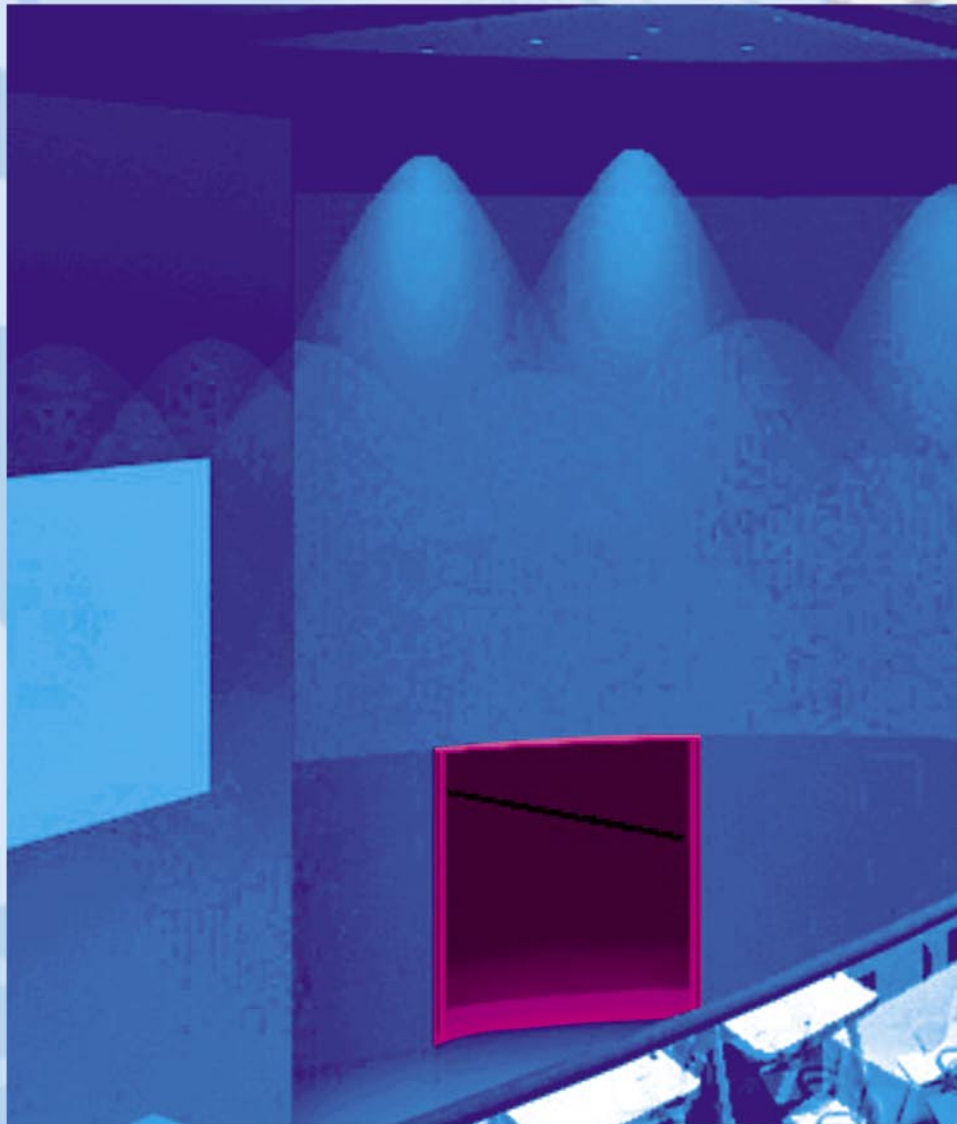
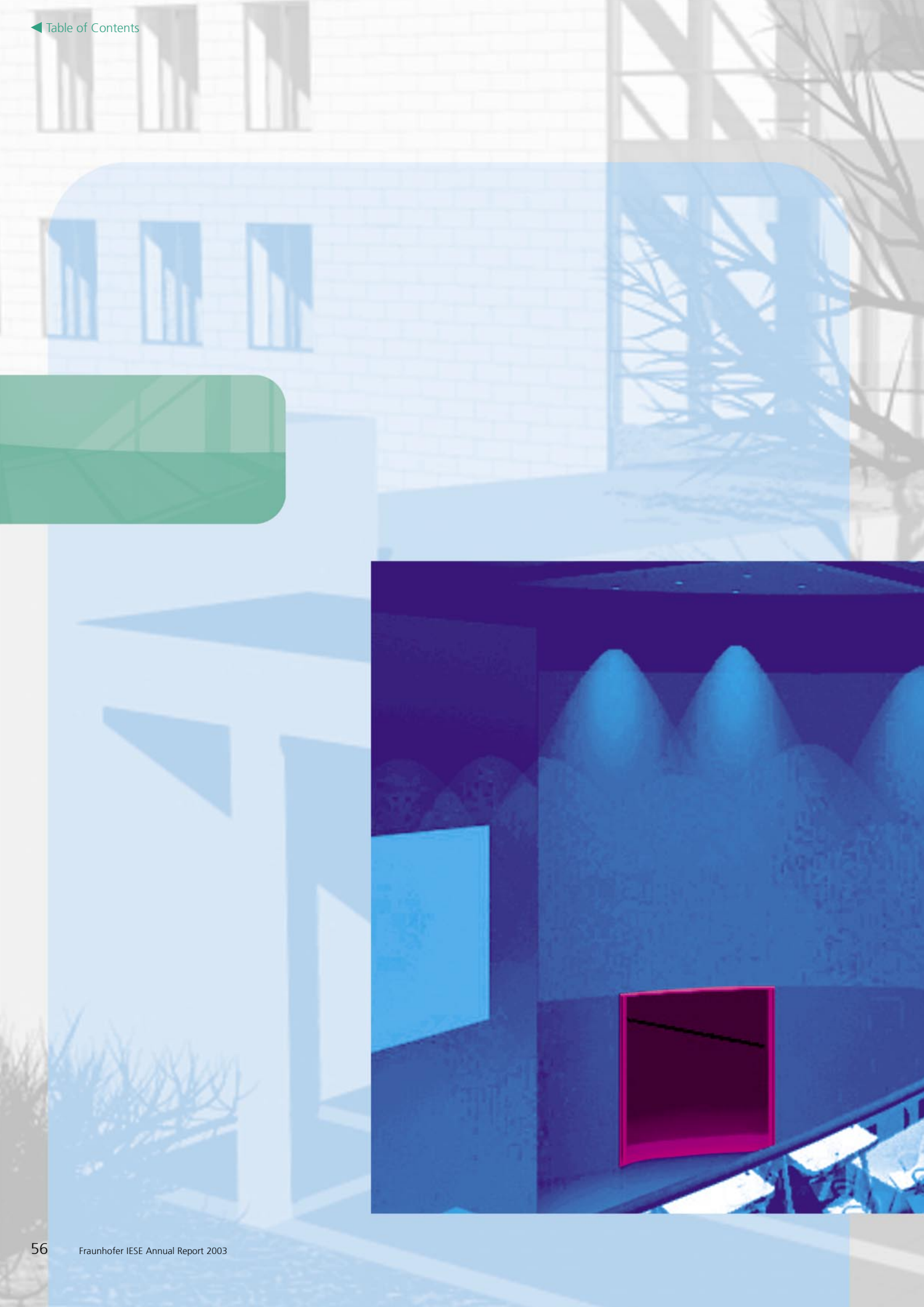
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EMPRESS – Evolution Management and Process for Real-Time Embedded Software Systems

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Dr. Peter Kaiser

The goal of the European ITEA project EMPRESS is to strengthen Europe's leading position in the area of information and communication technology and expand it to other areas. In the context of this project, which ran through the end of 2003, methods are made available to better take into account the evolution of software for real-time embedded systems during development already. EMPRESS deals with both security-sensitive systems from the aerospace or automobile industry and less security-relevant applications from the areas of consumer electronics or mechanical engineering. The security-sensitive systems have the highest demand for reliability and availability, since lives might be endangered if they malfunction (as when brakes fail due to a software defect). Demands by the other applications are also quite high, since especially in the case of embedded systems, failure can cause high costs, e.g., if a manufacturer has to recall a product – not to mention the resulting damage to the image of a brand or a company.

In the case of embedded systems, new ideas are usually implemented in small steps, but in short product cycles. Against the background of an increasingly intensive competition, it is thus

important to integrate this evolution into the design and development of software for embedded systems very early by using suitable methods.

In the face of the clearly visible expansion of the market for embedded systems (today, 98% of all microprocessors and microcontrollers produced are already used in embedded systems), the problems of evolution and thus the solutions developed within EMPRESS will become increasingly important in the future.

In EMPRESS, a multitude of reasons are given that require evolution of the software of embedded systems: functions are changed or added, customer requirements or other environmental constraints require variants of a product. Even a change of the system architecture or of the hardware platform invariably leads to adaptations of the software. Despite all this innovation, the non-functional requirements such as security and reliability must not be disregarded.

In EMPRESS, Fraunhofer IESE collaborates with 15 industrial and research partners from five nations in order to develop a process and suitable methods for making the evolution of software for embedded systems manageable.

The solutions developed in EMPRESS for all relevant application domains (automotive industry, mechanical engineering, space and aerospace industry, consumer electronics as well as telecommunications) are not only presented in theory, but are also practically validated with industry-oriented demonstrators, and they are continually improved.



The EMPRESS process, which is based on the Rational Unified Process (RUP), comprises a framework that integrates the methods and techniques developed. In those disciplines that are important for the management of evolution, activities are defined that were either expanded by EMPRESS or that are new, and appropriate methods are selected, adapted, or developed.

The reference architecture in EMPRESS is based on components. This makes it easier to localize changes and – by simply exchanging the software components, which have clearly defined interfaces – implement them fast and without errors.

The work of Fraunhofer IESE in the context of the EMPRESS project was concentrated on dealing with non-functional requirements to the software for embedded systems. Work centered on a quality model developed by Fraunhofer IESE, which is being evolved in synchrony with the system and/or the product. Requirements are elicited systematically, (non-functional) qualities are determined, analyzed, described unambiguously and – if possible – quantitatively, and traced and documented during development through configuration and change management technologies. This allows exact assessments of the changes to a software with regard to their effects on the system, but also with regard to their economic feasibility.

Software product lines, one of the core competencies of Fraunhofer IESE, offer an important opportunity to address certain evolution problems. In the course of the work within EMPRESS, Fraunhofer IESE first determines the



In multifunctional displays for the aerospace industry, embedded systems must fulfill the highest requirements. (Photo courtesy of BARCO GmbH.)

(product line) requirements from existing documentation on the particular software. By integrating potential requirements – to include especially non-functional ones – for future products into current development, a reference architecture can be derived that enables pre-planning of the evolution of the software to a certain extent.

As mentioned before, verification and validation are particularly significant for all embedded systems. With incremental procedures tested in practice, and limiting itself to those components that were actually changed, Fraunhofer IESE uses the EMPRESS project to contribute to saving effort and creating trust in the correct implementation of requirements, in particular that of the often-neglected non-functional requirements (such as security, reliability, extensibility) on the software of an embedded system. At the end, fulfillment of these qualities is checked with suitable met-

rics and models; parallel realization of test environment and software component to be tested allows performing this important check already in early stages of development.

Further Information:

EMPRESS
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Technical Writer IT – Documentation Specialist in the area of Software

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With its department “Certifiable Continuing Education and Training in Software Engineering”, Fraunhofer IESE has been active in the area of web-based learning for quite some time already – either by providing tutor-assisted solutions for self-learners, or in connection with classroom teaching and specialized tests in the context of complete Blended Learning offers. In doing so, Fraunhofer IESE consistently builds on teaching IT professionals software engineering-related special knowledge as a continuing qualification measure, since this allows making optimal use of the internal synergies of the institute through the interaction of content experts, multimedia instructional designers, and implementers. After various target group-specific offers on the Unified Modeling Language (UML) and the learning course on the Kobra methodology, published at www.iese.fraunhofer.de/Products_Services/kobra_online, work on the project “Development and testing of modularized learning units for the profile ‘Technical Writer IT – Documentation Specialist in the area of Software’” has already progressed quite far by now. The project has been receiving funds from the program “New Media in Education” of the German Federal Ministry of Education and Research (BMBF) since November 2002. The learning software modules are to be used in qualification measures to be performed according to the methodology of work process-oriented continuing education and training. This methodology had first been developed and disseminated under the leadership

of the Fraunhofer Institute for Software and System Technology ISST in the course of reorganizing IT continuing education and training in the context of the BMBF research project “Work process-oriented Continuing Education and Training in the IT Domain (APO)”.

The job profile “IT Technical Writer”, which had also been developed in the context of the APO project, describes the activities and qualification of a specialized occupation that is already very much in demand, namely that of an IT-oriented specialist for technical documentation in the widest sense. This profile had been created before by Fraunhofer IESE in close cooperation with external industry experts from the field of technical writing. Learning content and learning goals are geared towards real work processes documented in the form of reference processes and sub-processes. By the beginning of 2004, Fraunhofer IESE and its partner, the Software-Akademie AG Kaiserslautern (SWA AG), will design and implement at least 13 web-based learning units of 15 minutes online learning time each. These learning units will then be evaluated by SWA AG in the context of learning courses offered and will be optimized on the basis of those results.

One of the central goals of this project is the adaptation of the learning units to use for on-the-job learning. Therefore, the contents to be taught were, for example, divided into a relatively large number of modules, and the required online learning time per learning

unit was strictly limited – this takes into account internal and external studies of online learning courses, according to which individual sessions should not last for more than 30 minutes maximum, if they are to be integrated without problems into the learners' job environment. The learning contents are embedded into a realistic scenario with numerous work instructions that the learners can directly transfer into their everyday work. This is complemented by interactive exercises that allow the learners to assess and expand their knowledge. In this context, special emphasis was placed on the concept of "detailed feedback", which has proven itself in similar projects. This means that in case of an error, the learner will not only get the (required) negative feedback, but is given the background of the error in a context-sensitive way. In addition, the learning units contain extensive real examples from the field of technical writing as well as further information on how to study relevant topics on one's own.

The learning units are designed, implemented, and evaluated in close cooperation between Fraunhofer IESE and SWA AG according to the integrative method IntView for the development of systematic learning software, which was developed at Fraunhofer IESE. IntView takes into account technical, didactical, design-oriented, and organizational aspects of such an endeavor to the same extent, and is thus able, in particular, to correctly implement the dependencies that exist between these sub-areas.



In a comprehensive training course, Technical Writer IT – Documentation Specialists in the area of software learn how to professionally "wield their pen".

In the design and implementation of the learning modules for the profile "IT Technical Writer", Fraunhofer IESE assumes the role of the contractor who develops the learning units according to the requirements and needs of SWA AG and those of the participants of the continuing education course it offers. SWA AG as the customer is involved in the creation of an extensive requirements analysis and in the design of the learning units, and provides the actual contents of the learning units. In addition, the participants of the current continuing education measure of SWA AG are actively involved in the project regarding this issue. For example, they take part in an evaluation of a design prototype of the learning units in the

form of a usability test during which minutes are recorded.

The technical realization of the learning software with standard web programming technologies such as HTML, JavaScript, and Flash (as far as needed) guarantees trouble-free use of the resulting continuing education courses by learners, tutors, and professional consultants, without requiring special computer or data network equipment. For interactive simulations and exercises, freely available standard plug-ins are used, such as Macromedia Flash; the decision not to use components that require a license makes the resulting learning software cheaper and increases its flexibility.

Further Information:

IntView
www.iese.fraunhofer.de/IntView/

IT Technical Writer
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The Future is Wireless – Wireless Internet Service Engineering (WISE)

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Dr. Jürgen Münch

Since its beginnings (in analog technology), wireless communication has played a highly visible role in modern times. Despite the fact that by now, transmission has been completely digitalized (even the last analog radio network, the so-called C-Net, was finally taken offline), and notwithstanding the already existing offers regarding mobile Internet usage, mobile Internet services are still waiting for their final breakthrough. Applications such as mobile online trading (stock exchange business) or mobile multi-client-capable games often already reach their limits with the traditional Internet regarding stability, bandwidth, and response time of the necessary online connection – thus it is obvious how difficult implementation of the so-called wireless Internet is. Although certain technical solutions from the traditional Internet can be reused for developing software for wireless Internet applications, numerous new problems appear. Regarding organizational aspects, these problems are, for example, a result of the desired mobility and newly emerging business models, but even regarding technical aspects, several obstacles must be overcome due to the limited bandwidth and the variety of equipment with various functions to be addressed. From a methodological point of view, in many cases software development in this domain is just barely in a beginning stage: Despite short development cycles and tight budgets, development times as well as development costs cannot be planned with a sufficient degree of preciseness. So far, very few critical services are offered (i.e., those with special non-functional requirements such as reliability or security), since important quality aspects have not been sufficiently studied yet. Furthermore, there is hardly any experience about the effects of available development techniques with

regard to development costs or reliability, to name just a few.

The goal of the WISE project is to develop an engineering-style method and a generic architecture for the realization of wireless Internet services and to test it in industrial environments. It was initiated at the beginning of 2002 and will be concluded by October 2004. The industrial partners in the project are InvestNet (Italy), Motorola Global Software Group (Italy), Sodalìa (Italy), Solid (Finland), and Sonera (Finland). The research partners collaborating with Fraunhofer IESE are Politecnico di Torino (Italy) and VTT Electronics (Finland).

The task of Fraunhofer IESE in the context of the WISE project is to make available and evaluate a development methodology for software for various wireless services. By applying methodology and architecture, we seek to reduce the currently still disproportionately high software development costs (compared to traditional Internet services) and the time to market for these services.

Both the design of the methods and the creation of the architecture, as well as the testing of these are based on the observation of suitable pilot projects of the involved industrial partners regarding the development of prototype wireless services. The evaluation of the procedure is done qualitatively and – if possible – quantitatively through the use of measurement programs.

The pilot projects are being observed by Fraunhofer IESE in three iterations each; the number of requirements to be fulfilled is expanded after each iteration. In addition, during each iteration different standards, such as GPRS (General Packet Radio Service), UMTS (Universal

Mobile Telecommunications System), and diverse technologies, such as the Wireless Markup Language (WML) and Java 2 Platform Micro Edition (J2ME), are looked at. Even though these projects are of a prototype nature, involving the industrial partners ensures that the results of the emerging methods and architectures are relevant for the everyday operation of the service providers. The formal description of the procedure used is supported by a rotational systematic survey among the developers. The results of these interviews are recorded with the tool SPEARMINT®, which was developed at Fraunhofer IESE.

SPEARMINT® is used for descriptive modeling of a development process, i.e., for describing the necessary process in its real context. The tool's intuitive graphical notation permits immediate monitoring of the models by the industrial partners. The explicit representation of the development process is again the indispensable prerequisite for planning measurement programs to evaluate the prototype wireless service under the two aspects of "process" and "technology" with regard to costs, development time, and quality. The measurement programs are planned and performed, and the gained measurement programs are evaluated with the help of the Goal-Question-Metric paradigm (GQM), in whose development Fraunhofer IESE was also involved. Unnecessary costs and later insecurity regarding the evaluation of the captured data are thus prevented.

At the end of each iteration, the data are summarized in accordance with the goals defined at the beginning of the iteration, and are then presented to the participating industrial partners in feedback sessions. During the course



Wireless communication is "in" – software engineering ensures reliable services. (Photo courtesy of Siemens AG.).

of these feedback sessions, a body of experiences and improvement possibilities for future software development is built up successively. Through this process, which was introduced by Fraunhofer IESE, a valuable, continually growing experience base of reusable knowledge packets is created in the form of flexible, customizable process and quality models, lessons learned, as well as knowledge regarding usage and problem potential of the available technologies. Considering the aspect of quantitative description of the abstract term "quality", in particular, the quality models are a novelty in the relatively new domain of wireless Internet services.

In the end, the gained experiences are stored in context and packaged for future projects. Fraunhofer IESE's industri-

al partners use the acquired knowledge to improve their software development processes. Other research in the areas of customizable reference process models, customizable documentation of processes, formalization, maintenance, and administration of software know-how receive important motivation and strong impulses from this project.

This project is funded by the European Commission (no. IST-2000-30028).

Further Information:

SPEARMINT®
www.iese.fraunhofer.de/SpearMint_EPG/

WISE
<https://softeng.polito.it/WiseWeb/home.htm>

Teaching Knowledge – Sharing Experiences: Virtual Software Engineering Competence Center

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More than 20,000 companies are currently producing software in Germany – but only about 30% of them use engineering-style methods. Every computer science student learns that software is to be developed according to engineering principles, similar to other high-tech products. Yet, quality guidelines, such as those set down in the ISO standards, are often not followed in actual development. This “deficit in the methods” is very evident especially among small and medium-sized enterprises.

The capability of developing high quality software within a short period of time is a factor that determines success for many companies. In practice, however, it is often difficult to quickly get the necessary overview, select the appropriate technology for a project, and adapt it to the development situation at hand. Thus, similar issues are worked on again and again, instead of using already existing experience. This was one of the reasons why in December of 2000, a study performed by the German Federal Ministry of Education and Research (BMBF) demanded that software know-how that is distributed across numerous individual institutes be bundled in a special competence center and be made centrally available.

Set against the background of this problem, the publicly funded project ViSEK has established a virtual software engineering competence center, which aims at more intensive networking between IT professionals and researchers.

Project Goals

The project pursues two main goals:

- Establishing and taking care of a community for professional software engineering that unifies industry and research and promotes technology transfer between and within both groups.
- Offering products and services that support the transfer of technology from research into industry resp. from one industrial partner to another.

Project Partner

There are mainly eight research institutions building up this competence center on behalf of BMBF. They largely cover Germany geographically and are characterized by application-oriented research in a wide range of professional topics:

- Brandenburgische Technische Universität Cottbus, Forschungsgruppe Software-Systemtechnik (“Brandenburg University of Technology Cottbus, Software Systems Engineering Research Group”)
- Fraunhofer-Institut für Rechnerarchitektur und Softwaretechnik FIRST (“Fraunhofer Institute for Computer Architecture and Software Technology”), Berlin
- Fraunhofer-Institut für angewandte Informationstechnik FIT (“Fraunhofer Institute for Applied Information Technology”), St. Augustin
- Fraunhofer-Institut für Experimentelles Software-Engineering IESE (“Fraunhofer Institute for Experimental Software Engineering”), Kaiserslautern

- Fraunhofer-Institut für Informations- und Datenverarbeitung IITB (“Fraunhofer Institute for Information and Data Processing”), Karlsruhe
- Fraunhofer-Institut für Software- und Systemtechnik ISST (“Fraunhofer Institute for Software and Systems Engineering”), Berlin.
- Oldenburger Forschungs- und Entwicklungsinstitut für Informatikwerkzeuge und -systeme OFFIS (“Oldenburg Research and Development Institute for Computer Science Tools and Systems”)
- Technische Universität München, Institut für Informatik IV (“Technical University of Munich, Institute for Computer Science IV”)

Approach

An Internet portal was created as a virtual meeting point for the exchange of experiences and contents, which can be accessed via <http://www.software-kompetenz.de>. This portal makes it possible to easily and quickly access information and is thus geared particularly towards smaller companies. In addition, regional and national events are organized to enable representatives of research and industry to personally exchange experiences.

Results

The Internet portal offers the infrastructure for a software engineering knowledge database as well as community services such as discussion forums or an event calendar. The central element of the portal is a repository, where the project partners deposit know-how and experiences on technologies, methods,

and tools in software engineering. In order to achieve a certain amount of completeness after only a short time, the ViSEK project first focuses on the two domains of e-Business and Critical Systems.

The contents of the knowledge database are packaged by the platform and directly integrated into the portal as HTML pages – thus interested companies need not fulfill any particular technical access requirements. At this time, approx. 1,800 such contributions by more than 50 authors are stored in the database (as of October 2003). The database-supported presentation enables versatile navigation from various entry points. Even context-specific connections to entries resulting from the relations stored in the knowledge database can be shown (like related literature references, for example).

As one important characteristic that differentiates this portal from other technology descriptions on the Internet, the individual experience contributions on individual scenarios that are stored in the knowledge database largely contribute to enabling evaluation of the usefulness of a technology in one's own context. This includes, on the one hand, empirical studies performed by Fraunhofer IESE, for example – but also observations or experiences from practice. Within the project, more than twenty new studies were performed to complement the software engineering knowledge and, in particular, to document effects on practical usage – all of them are available on the portal of the competence center.

Any Internet user can him-/herself enter experience contributions into the portal without a time-consuming and complex

registration process. Two instruments are available for evaluating the contents of the competence center, i.e., whether the contents are considered useful, and to which extent they reach the target group “software developers and software decision makers”: On the one hand, any entry can be evaluated regarding its usefulness by other users of the portal. On the other hand, users can comment on existing entries and thus make their own contribution to expanding the knowledge database.

Community Building

To promote the use of software engineering methods especially in SMEs, the competence center presents the topic at publicly visible events that include the relevant industrial associations and interest groups. In addition to the national activities in Germany, the scientific partners also organize local meetings.

Future

The competence center and the portal www.software-kompetenz.de are to be established as the primary contact point for software engineering issues in Germany. For the future, non-commercial operation is envisioned, which will be funded mainly by contributions of a group of institutions.

The ViSEK project is funded by the German Federal Ministry of Education and Research (BMBF) under grant number 01 IS A02.

Further Information:

Virtual Software Engineering
Competence Center
www.software-kompetenz.de/

From Project-specific Development of Single Systems to the Reuse of Generic Components – Experiences with Software Product Lines at Robert Bosch GmbH

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The control units for automobile manufacturing developed by Robert Bosch GmbH consist to a large extent of software, so-called embedded systems. Just like the entire software developing industry, Robert Bosch GmbH can also only continue to keep up its competitiveness in the long term if they manage to further reduce costs, efforts, and time-to-market in software development. At the same time, equipment becomes more and more complex, since it fulfills increasingly complex tasks in modern automobiles – with continuously high quality requirements. Matters are made worse by the increasing demand for customized products: More and more variants of the embedded systems must be produced for different control units. In order to be able to face these challenges, Robert Bosch GmbH has decided on using a product line approach.

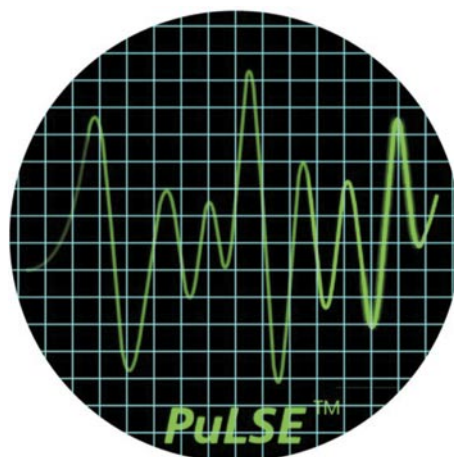
Switching from project-specific development of single systems to product line development can normally not be done in a single step. Therefore, Bosch pursued a step-wise migration strategy.

After a reference architecture for control units had been developed together with experts from the various project

teams, the migration towards product line-oriented software development was performed. This included three steps: selection of suitable components, determination of the extent of the product line (“scoping”) as well as modeling and implementation of the selected components according to the product line method PuLSE® developed at Fraunhofer IESE. In this process, the selected components were viewed sequentially and adaptations of the PuLSE® method to the specific development situation at Bosch were performed if needed.

In order to keep the necessary application knowledge as low as possible, two components were selected that are required for all types of equipment and hardware platforms. Variability was thus motivated by technical as well as by application-specific aspects. Another advantage of the selected components was the fact that they consisted of a relatively small amount of code, and that they were well understood.

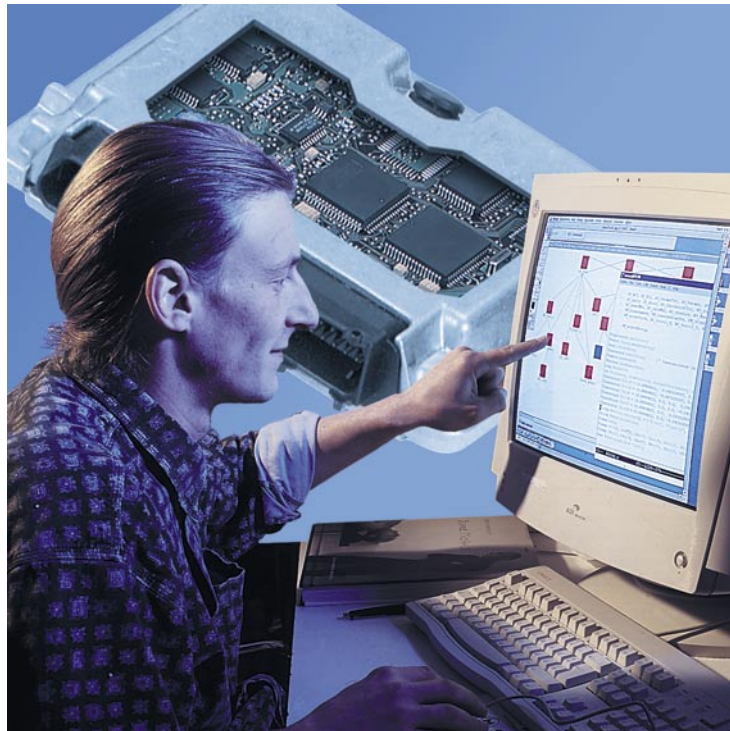
Concentrating on particularly common and manageable components made it possible to demonstrate the use of product line technology realistically, in all its different aspects, to investigate the potential of the product line approach in the organization, and to get as many employees as possible into contact with product line technology. The long-term goal is to establish a component-based product line that covers most variants and components of the reference architecture.



Scoping determined which “members” the product line should comprise and which properties the individual variants would have. In this particular project, a lot of existing variants of the two components, which were being used in already existing products, were analyzed. On the basis of this analysis, the software components of the planned product line were modeled and implemented in accordance with the product line method PuLSE® developed at Fraunhofer IESE. The components were designed generically, i.e., they contained explicit variation points according to the variable properties that had been identified. The resulting software variants did not only include code, but also a variant-specific specification and a matching software design.

This planning and implementation of a product line based on two components was the first step towards product line-oriented development. It was shown that all variants demanded by the project partner could be generated, which proves the success of this project.

In addition to demonstrating technical feasibility, the adaptation of the PuLSE® method to the specific requirements of the organization was also validated. This was done in the following manner: In parallel to the implementation work at Fraunhofer IESE, software variants were also realized at Bosch on the basis of the generic specifications generated by Fraunhofer IESE, and the resulting artifacts and implementations were compared. In both cases, the



Efficient: The product line approach makes it much easier to develop software for the multitude of modern control units.

specific product line components had been realized correctly. However, there was a difference in the quality of the technical implementation of the different solutions. Thus it seems advisable to improve the technical product line capabilities in the customer organization in the context of further migration towards product line-oriented software development.

Further Information:

PuLSE®
www.iese.fraunhofer.de/PuLSE/

Managing Experiences in the Telecommunications Domain – The Case Base of T-Com Security

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From a customer's point of view, reliability and security of a telecommunications network are essential criteria for the quality of the service used. It is thus very important to recognize emerging critical incidents early during running operations, and to react as fast and as effectively as possible in case of a crisis. Furthermore, the data saved during operation are often security-sensitive, e.g., regarding privacy aspects, but also with regard to solving premeditated attacks. Maintaining the given quality standards requires effective processes for recognizing, collecting, and analyzing critical incidents with the objective of being able to react appropriately.

This project, which builds on T-Com Security's case base for the structured capturing and processing of critical incidents in running operations (which is already in its build-up phase) consisted of two sub-aspects. One part dealt with adding a knowledge base component to the case base, in order to provide optimal support to the case specialists working on critical cases in their experience intensive activity. On the other hand, a technical security concept for the case base was developed, which fulfills privacy act requirements while also taking into account such matters as tactical requirements with regard to resolving security incidents. For both sub-aspects, prototype implementation of the developed concepts was performed by Fraunhofer IESE before they were actually tied into T-Com Security's case base. The project, initiated in mid-2002, was performed in the context of the work group "Network Security" (AKNS). AKNS is an association of several universities and research institutions under the leadership of T-Com Security, Deutsche Telekom Darmstadt.

Knowledge Base Component

The treatment and solution of the named incidents is an experience-intensive activity, whose success depends on the experience of the respective case specialist with that particular type of incident. A knowledge base component is thus intended to complement the case base, in order to be able to exchange casework experience between the case specialists. This helps to access the experience of colleagues regarding the effectiveness of prior measures and to partially standardize casework by reusing experiences.

In order to determine the current state of the case base with regard to experience management, its concept was first evaluated to identify points for integrating various knowledge sub-processes into the current case processing. Evaluation was based on Fraunhofer IESE's DISER methodology as well as on a reference model for experience-based systems in IT security. Such an evaluation aims at identifying balanced experience feedback loops, i.e., experience is reused in the same process or work procedure where it was gained. These experience feedback loops must be tied into "lived", i.e., actually performed processes (or work procedures) in order to achieve the desired success in practice.

Among others, the "solution path" of the critical incidents, as a process that is particularly experience-intensive, was identified as a promising complement to the knowledge base. Supporting this problem solution path through experience required overcoming some obstacles, since here, the commonalities and

differences in the case processing of the individual areas at T-Com Security became particularly evident.

Systematic information on suitable measures for reducing, resp. avoiding security gaps and the resulting damage costs were considered to be of particular importance by T-Com Security. Of course, a warning about unsuitable measures should also be given at the same time. This means, however, that regarding the solution path, both positive and negative experiences have to be administered. Whereas positive experiences are often typical contents of knowledge-based systems, negative experiences present a special challenge. A high degree of maturity of an organization is required for employees to not only have the courage to mention negative experiences, but to even go one step further and document such experiences in writing with the objective of avoiding them in the future. Thus, for the whole process to be accepted in the organization, it was necessary to “package” these negative experiences in such a way that is not only not incriminating to the experience author (i.e., the case specialist), but even lets him appear in a positive light (which is justified merely by the future usefulness of this normally very helpful type of experience). In order to achieve this, Fraunhofer IESE developed suitable modeling and a presentation adapted to the special needs of the case specialists at T-Com Security.

Acceptance controls of the selected modeling and presentation were finally performed with empirical methods. The critical technical aspects of the overall concept were checked by means of a

prototype realization prior to final implementation. For this, the prerequisite for low-risk implementation of a knowledge base component for the case base was developed for T-Com Security.

Technical Security Concept for the Case Base

Furthermore, the content of a case base is extremely security sensitive. This generally applies to all data it contains, since these contain information on potentially vulnerable areas of the telecom infrastructure or personal data that can be related to the persons or users listed as case participants. Privacy requirements play an equally important role, as do tactical considerations with regard to resolving security incidents, e.g., in case of suspicions held against the organization’s own employees. Generally, it must be ensured that all data can only be read and written by authorized users, and only to the extent required by their respective task. The group of authorized users and the type of authorization may change during the course of working on a critical incident – possibly several times. This authorization concept therefore had to be integrated into the system environment of the case base (e.g., authentication server, application server), taking into account given and sometimes even contradictory constraints of this environment.

Fraunhofer IESE has therefore developed a technical security concept for the case base of T-Com Security, which is sufficiently flexible to fulfill the different requirements. At the same time, it

- does not obstruct the functional main requirements of the case base in operation,
- is easy to use in everyday operations, and
- is integrated into the given IT system environment without security gaps.

A final prototype implementation of the concept proved its practical usability and demonstrated that it is indeed possible to integrate complex security functions into an existing case base environment.

The reference model was developed in the context of the SKe project with the collaboration of Fraunhofer IESE.

Further Information:

SKe
www.ske-projekt.de/

DISER
www.iese.fraunhofer.de/erfahrungsmanagement/

DISER: Design and Implementation of Software Engineering Repositories.

Rhineland-Palatinate Research Lab Platform

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The economic structure in Rhineland-Palatinate is strongly shaped by small and medium-sized enterprises (SMEs). More and more of these companies are turning into service companies and making their money from software-intensive services. Others produce products with a value adding proportion of embedded software of 50% and more – not counting those organizations that produce application programs for the primary software market. Faced with intensive competition, only companies using the newest methods, technologies, and tools in software engineering can operate with economic efficiency. But SMEs, in particular, generally lack the financial and personnel resources to adapt state-of-the-art research results to their own requirements and use them – let alone perform their own research activities. The personnel required for these activities would have to be withdrawn from current projects, or newly hired and trained – neither is feasible considering the high project pressure, tense financial situation, and low staffing levels of many companies in the region. Essentially concentrated in the universities and in application-oriented research institutes, the knowledge so urgently needed by IT SMEs often does not find its way into these companies' everyday operations.

In order to accelerate and intensify transfer into these organizations and thus eliminate the competitive disadvantage of regional SMEs, the Ministry of Economy, Transportation, Agriculture, and Viniculture (MWVLW) of the state of Rhineland-Palatinate and the European Fund for Regional Development (EFRE) have made funds available for building the infrastructure of a regional research platform for small and

medium-sized enterprises in the western Palatinate region, in the context of the Goal 2 Program 2000 - 2006. This research laboratory platform, which is to be created by the end of 2004, provides the physical and technical infrastructure, including the necessary personnel, for paving the way for quick, cost-efficient, and sustainable technology transfer within a limited topic area, ahead of future economic use. In such a research lab, employees from different companies collaborate closely with Fraunhofer IESE researchers. The company representatives contribute the necessary application knowledge, while the software experts from Fraunhofer IESE contribute the technological know-how. Via the research lab platform, the knowledge from the research institutions that is needed for the technology transfer is made available for the development of innovative and marketable solutions in an uncomplicated manner, and in a way that is very cost efficient for the companies.

The platform will consist of several research labs, each dealing with one concrete problem from the area of software engineering in long-term collaborations with regional companies. The results achieved will also be made available via a Web portal. Thus, even organizations that did not directly collaborate in the labs will also benefit from the possibilities of technology transfer.

One research lab that already exists deals with the issue of "Software product line development and usability".

Software product lines – in other words, generic reference architec-

tures for the effort-saving derivation of software variants – have proven in the past to be an important approach to efficiently developing software. So far, this is being used mainly by larger organizations wanting to realize potential savings of the product portfolios they offer. Unlike major corporations, however, small and medium-sized enterprises must react to market requirements much faster and are only able to a limited extent to do long-term portfolio planning. In many cases they also act as subcontractors, resp. contract developers, for other companies. This makes it harder to systematically implement product line methods across various projects.

Product line development in small and medium-sized enterprises must therefore be guided by their specific requirements:

- Particularly flexible adaptability of the products to be developed to the requirements of various customer groups
- Implementation of the product line approach within the shortest possible time, also with agile methods
- Taking into account the possible “prior history” of a customer project when establishing a software product line

The variety of wishes and requirements from customers of many diverse domains also provides the software developing SMEs with the challenge of guaranteeing uniform and intuitive usage of the systems created in different variants (usability). On the one hand, the interactive design of the programs must be adapted to the domain-specific

culture of the customers. On the other hand, with regard to the intended use of product line technologies, the need arises to ensure an easy-to-understand and consistently usable monitor layout across all variants of the software of one product line.

The industrial partners collaborating on this issue include DCON Software & Service AG, Kaiserslautern, a3 systems GmbH, Zweibrücken as well as KLin-form KG, Kaiserslautern.

Another lab that is currently being built up will be dedicated to the vast area of software testing. The possible bandwidth of this lab ranges from the improvement of existing testing methods to the design of new, innovative testing methods in light of test automation. This is another area where Fraunhofer IESE is negotiating with top-class industrial SMEs. The third lab in the context of the Rhineland-Palatinate research lab platform is currently in its design phase; the topic area to be dealt with has not been determined yet. Representatives of regional organizations can contact the project office with topic proposals.

(Funding registration number: MWVLW; Az.: 8315 38 51 04 IESE; chapter 0877 title 892 02).

ZITA – Certification of IT Continuing Education and Training in Rhineland-Palatinate

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Professional qualification measures must satisfy the requirements of professional practice, the demands of the job market, and the demands of the learners. Organizations in the IT domain, in particular, with its extremely short innovation cycles, have traditionally depended heavily on lifelong learning by their employees. In the IT domain, a major part of the skills and knowledge acquired during primary education and training is already out of date after a few years, and thus not usable as qualification on the job market. The high demand for qualification and the relatively good hiring chances in this domain have led to a large and very diverse variety of educational courses, seminars, and training courses. Faced with this enormous variety, those interested in educational courses find it very difficult to compare the individual courses offered with regard to their content, price, or type of certificate. Thus, the decision for or against a particular course has so far been made more or less arbitrarily. Systematically planning a personal continuing education path is also made difficult because it is so hard to compare the contents of courses and the certificates attainable.

Fraunhofer IESE has taken up the job of contributing to more transparency, comparability, and awareness of quality on the Rhineland-Palatinate market for IT education and training. Essentially, this ambitious objective is to be achieved through the establishment of the virtual Information & Communications Technology (ICT) academy for Rhineland-Palatinate ("via-it") and the introduction of a statewide certificate for high-quality IT education and training in the context of the ZITA project.

The virtual ICT academy Rhineland-Palatinate "via-it", funded by the Ministry of Economy, Transportation, Agriculture, and Viniculture, bundles the Internet courses for professional ICT continuing education and training offered in the state of Rhineland-Palatinate via a central portal and acts as a broker for quality-assured IT continuing education and training courses offered in the area of e-Learning / Blended Learning. The portal is intended to be a marketplace for education and training suppliers and customers, and offers information, infrastructure, and quality assurance all at the same time.

The ZITA project aims at creating mandatory quality standards through the introduction of a statewide certificate for IT education and training courses offered in the classroom in order to give consumers a means to help them make an informed decision. A recognized certificate will also give organizations offering such courses the opportunity to obtain a publicly visible position on the market. Last but not least, the certificate aims at increasing the awareness of quality among consumers and suppliers, and give necessary impulses for direct improvement of quality within the educational institutions by initiating discussions about the quality of IT education and training and its monitoring.

The first step of this two-step project was funded by the Rhineland-Palatinate Ministry for Science, Research and Culture. It covered a period of ten months and was concluded in February 2003. At the beginning, a representative inventory of the Rhineland-Palatinate IT education and training courses offered was taken. For this, more than 6500 offers were analyzed and categorized

according to various criteria. The results can be summarized as follows:

- A veritable “jungle of terms” makes it hard to look for courses and to compare courses, since different terms are used for courses with similar or identical contents.
- Missing or imprecise information about the target group addressed by the course makes it impossible, for example, for members of a certain profession to select specific courses.
- Information on access requirements, based on either content or form, are missing in more than one third of the courses offered.
- Two thirds of the courses conclude with a certificate of participation. However, only less than 4% of these are so-called recognized certificates (e.g., IHK certificates, ECDL, Comp-tia, various product certificates).

These results strengthened the resolve of Fraunhofer IESE to create more transparency and orientation for those interested in education and training, and to ensure standards for adequate and sufficient information of participants, for an unambiguous course naming convention, and for expressive, comparable certificates by introducing the “Rhineland-Palatinate IT Certificate”.

The assessment of the courses offered was followed by comprehensive quality criteria being worked out for IT education and training, and by the design of a process for certifying individual education and training courses. The quality criteria refer to organizational aspects, but also, in particular, to learning contents being job-oriented and up-to-

date, to the organization and support of the learning process as well as to continuing internal quality assurance of the courses offered. The result was a catalog with more than one hundred indicators for high quality IT education and training.

During the entire course of the project until now, close contact with experts from educational practice, from software companies and software education and training centers was an important part of the conceptual work. One important result of this collaboration was the desire for a mandatory “curriculum for IT education and training”. Such a curriculum was finally implemented in a job profile-related, step-wise reference model that maps existing continuing education and training paths and contents in the form of modules. This leads to an overview of possible (continuing) education and training paths for a specific job profile. In addition, the model provides the option of combining individual competencies acquired at different educational institutions and leading to recognized certificates. The prerequisite for this is comparability of contents and performance records as well as the mutual recognition of partial certificates by the different educational institutions. For the reference model, a first prototype of a service tool was developed: The ZITA IT qualification planner aims at supporting individuals interested in education and training in planning their individual continuing education and training paths.

After presentation of the results gained from the first step in May 2003, Fraunhofer IESE continued to participate actively in the public discussion about the introduction of an IT cer-

tificate. Since all concepts that were designed are mere recommendations, the central task consists of achieving the necessary acceptance from education and training suppliers and government institutions. For this purpose, one of the measures performed in September 2003 was an online survey among suppliers of continuing education and training courses that explicitly asked questions about their assessment of the plan, possible concerns, and about their willingness to cooperate in the practical realization of the certification method. The results of the acceptance study were again presented to a group of educators, businesspeople, and scientists in December, and formed the basis for a discussion on the organizational and economic design of the certification process.

The second step of the project provides for the design of the certification method and the preparation of the actual certification operation. Due to the related objectives, it is intended to intertwine the projects ZITA and virtual ICT academy Rhineland-Palatinate, “via-it”, more than before. One possible perspective would be presentation of the independent certification authority ZITA as part of the virtual academy. The independent certification authority could, on the one hand, certify the classroom courses. On the other hand, ZITA could perform accreditation and certification of the e-Learning and Blended Learning courses available and bookable on via-it as a subcontractor of the group that operates via-it. In this way, two projects whose motivation and objectives are aimed in a similar direction would collaborate in a reasonable manner.

Further Information:

ZITA
www.iese.fraunhofer.de/zita/

via-it
www.via-it.de



Fraunhofer Center for Experimental Software Engineering, Maryland (FC-UM)

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Profile of Fraunhofer Center Maryland (FC-UM)

Mission and Vision

In 1994, Fraunhofer-Gesellschaft e.V. (FhG) established Fraunhofer USA (FUSA), headquartered in Plymouth, Michigan, to foster collaboration between research institutions and industries in the United States. The Fraunhofer Center for Experimental Software Engineering, Maryland (FC-UM), is the only FUSA center to specialize in software and related engineering fields, focusing on the use of experimental approaches to introduce innovative techniques into industry.

FC-UM is an applied research and technology transfer organization and is affiliated with the University of Maryland (UM) and the Fraunhofer Institute for Experimental Software Engineering (IESE) in Kaiserslautern, Germany.

FC-UM's mission is to advance the state of the practice in software engineering by applying the scientific method to software engineering, utilizing past results to guide development choices and using organizational learning as the key to improvement.

FC-UM understands that technology organizations will face an ever-increasing need to better understand software and the role that it plays in their business strategies. Competitive organizations must continually search for ways to better control, manage, predict, improve, and evaluate their software development efforts. FC-UM's vision is to act as a recognized contributor and leader in helping organizations to customize solutions for these problems and to understand their effect on the organization's product or business.

Business Areas and Competencies

FC-UM emphasizes software engineering, software development practices, and software processes using application development, feedback, and learning to improve its client organizations' software development technologies. Through this proven approach, FC-UM makes its clients more competitive in critical information technology fields. Global, national, and regional organizations benefit from FC-UM services.

FC-UM supports research and development in the discipline of software engineering and its enabling technology. It facilitates collaboration between private-sector companies, government agencies, and academic institutions, in order to develop innovative, actionable approaches. The Core Competencies of FC-UM lie in the areas of technology transfer and process and product improvement.

The Core Competencies that FC-UM offers are founded on the Experience Factory concept developed by Dr. Victor Basili. The Experience Factory approach defines a framework for Experience Management that has been successfully applied to software development at NASA for more than 25 years and recently at other organizations. The Experience Factory enables Organizational Learning and acknowledges the need for a separate support organization that enables the project organization to manage and learn from its own experience. The support organization

- helps the project organization observe and collect data about itself.
- builds models and draws conclusions based on that data.
- packages the experience for further reuse.
- reports these experiences back to the project organization.

Core Competencies

Software Technology Evaluation

- Experimenting with various technologies
- Determining their suitability for use in specific environments

Customers

- National Aeronautics and Space Administration (NASA)
- Defense Advanced Research Projects Agency (DARPA)
- Department of Defense (DoD)

Project Focus

- High Dependability Computing Project
- National Science Foundation Center for Empirically Based Software Engineering (CeBASE)

Risk Management

- Using existing risk management techniques and tools on projects
- Applying risk management to the development of secure systems

Customers

- DoD
- DARPA

Project Focus

- Acquisition Risk Management

Experience Management Services

- Developing experience bases and tools – knowledge management, building learning organizations
- Analyzing and synthesizing information
- Experience Base/Experience Factory tools, Visual Query Interface, Frequently Asked Questions, eWorkshop, Lessons Learned Experience Base

Customers

- National Science Foundation
- DoD
- DARPA

Project Focus

- CeBASE
- Software Process Improvement Implementation Support

Measurement

- Decision support system for goals and metrics
- Integrating corporate goals down to software project goals
- Integrating Goal Question Metric, Balanced Scorecard, Practical Software and Systems Management, etc.

Customers

- NASA
- DoD

Project Focus

- Software Process Improvement Implementation Support
- NASA Metrics
- Acquisition Risk Management

Reading Techniques

- Defining and experimenting with various reading techniques to catch errors at early stages of development
- Determining their suitability for use in specific environments

Customers

- NASA Goddard Space Flight Center
- Jet Propulsion Laboratory
- NASA Ames Research Center

Project Focus

- State-of-the-Art Inspections
- Reading/Inspection Technologies
- High Dependability Computing Project

Implementation Practices

- Experimenting with various Agile Technologies to reduce the cost of software development
- Developing Graphic User Interface testing techniques compatible with Agile development

Customers

- Industry Partners
- SEC
- DoD

Project Focus

- Agile Methods
- GUI Testing
- SEC
- Acquisition Risk Management

Software Process Improvement

– **Capability Maturity Model (I)**

- Assisting companies in achieving their software process improvement goals
- Assisting organizations in improving the quality of their software related products and services
- Assisting organizations in their software acquisition practices.

Customers

- Principally government contractors
- DoD

Project Focus

- Software Process Implementation Support
- Software Industry Consortia
- Military Health Systems

COTS

- Conducting empirical research to understand COTS-based systems and develop models
- Applying technologies for detecting defects in COTS-based systems

Customers

- NASA
- National Science Foundation

Project Focus

- High Dependability Computing Project
- CeBASE

Projects in Progress

Agile Methods

Agile Software Development Methods are software development practices designed to efficiently produce software and reduce overhead costs. Although interest in Agile Methods is increasing, very little empirical evidence exists to support anecdotal evidence about its usefulness and effectiveness. FC-UM collaborates with experts and practitioners to characterize Agile practices by

- conducting a series of eWorkshops
- designing and conducting experiments
- developing a measurement framework to help practitioners and experimenters collect metrics and better understand these practices.

The testing practices of Agile Methods are of particular interest to us. In Agile Methods, testing occurs early and forms one of the cornerstones of the development process. One of the main principles of Agile Methods is to embrace change, even late in the development cycle, in order to improve the customer's competitive advantage. In environments applying this principle, testing and retesting become crucial to assure the system's quality as it evolves.

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Acquisition Risk Management

The U.S. Army is aggressively pursuing emerging technologies in numerous areas (including software) to apply to the construction of an unprecedented, very large system-of-systems. Although federal agencies continue to outsource functions to contractors, including accountability for lead systems integration, the responsibility for organizational success still lies with the acquiring agency. Agencies must practice aggressive risk management; for complex software-intensive systems, this requires software engineering risk management. In collaboration with the University of Southern California's Center for Software Engineering and Carnegie Mellon University's Software Engineering Institute, FC-UM provides an integrated solution to the Army's program support and risk management needs. With a combination of facilitated workshops, industry-recognized experts, best-of-breed software engineering practices, and day-to-day interaction, FC-UM reduces program risks and also adds program value through collaborative solution-building. FC-UM applies the experience factory concepts to support the specific programmatic needs of the U.S. Army and to leverage these experiences for the benefit of the Department of Defense overall.

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Architecture Evaluation

Programmers under time and budget pressures sometimes add and change code without fully understanding the system's architecture. This behavior is often accelerated when developers who were not part of the original design alter the system. Once a system is damaged by architectural mismatches, significant effort may be required to stop and reverse this degeneration. Re-engineering is costly and time consuming and also delays the implementation of new features.

Architecture evaluation is a form of defect reduction that addresses this problem and makes maintenance and evolution easier by detecting unnecessary complexity, incorrectly implemented software solutions, and dead code. FC-UM's process for architecture evaluation reveals architecture violations in a clear, systemic way, making it easier to address problems and incorporate implementation according to the original architecture. This also helps preserve the system's maintainability over time.

The FC-UM approach actively and systematically detects and corrects deviations based on the analysis of couplings between components. Visual inspection of the architecture might not be systematic enough to detect deviations. Our systematic process, supported by a software tool, is flexible, cost-efficient, and can be tailored to meet different levels of design constraints.

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COTS-based Development Lessons Learned Repository

Part of the Center for Empirically-Based Software Engineering (CeBASE), the COTS Lesson Learned Repository (CLLR) provides uniquely planned support for the software development community. Allowing practitioners to share insights and solutions that can reduce risk and improve the industry’s quality and productivity, the CLLR grows organically and is based on the premise that new knowledge is always in demand. It contains descriptions of the lesson (summary, risk, or issue addressed, type of data supplied – qualitative or quantitative), recommended audience (program or project manager, developer), and the story behind the lesson. The context where the lesson was learned is also incorporated, with reference to details regarding the type of system, organization, number and types of COTS products, and life cycle plans. To date, the CLLR offers:

- A chat tool for knowledge elicitation through “electronic workshops” (eWorkshops) where participants meet online to discuss a given topic.
- Repositories of experience and lessons learned from COTS-based projects and empirical studies.
- A FAQ mechanism based on an evolving knowledge base which supports use of the system and connects users with experts.
- A Visual Query Interface (VQI) that graphically displays the repository’s content for knowledge analysis and discovery issues related to users’ specific topics of interest.

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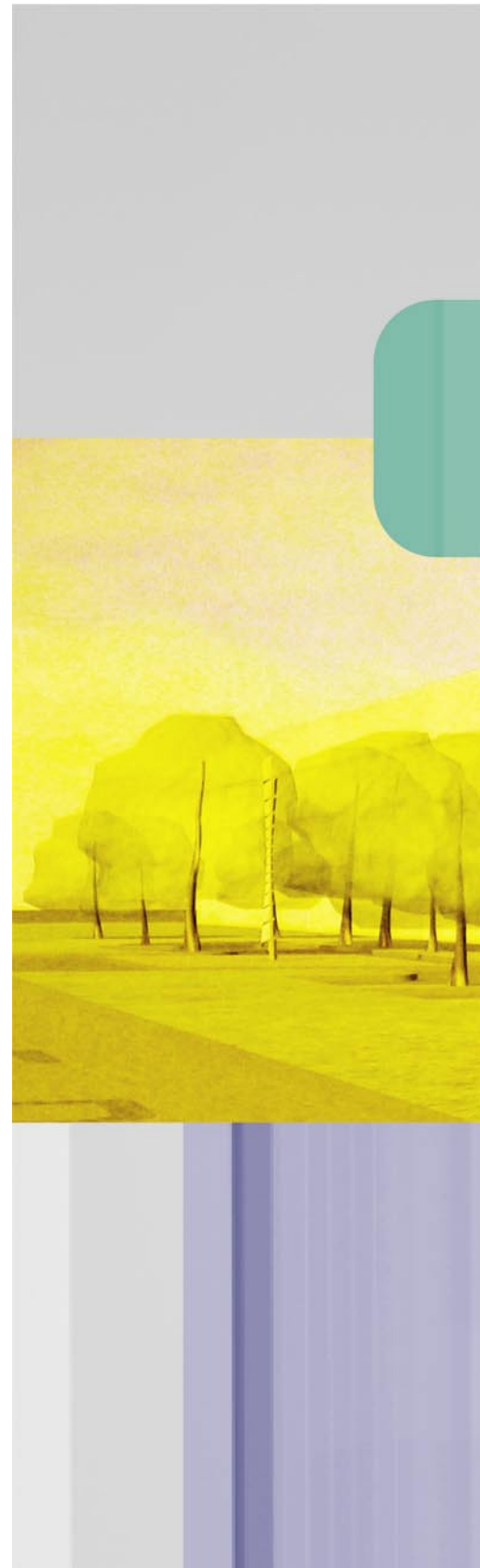
GUI Testing

Agile Development typically features frequent code releases that must be successfully tested, creating an obvious need for rapid and regular testing. Tools and techniques must be convenient and efficient so that testing does not burden programmers, particularly those testing graphical user interfaces (GUIs).

The GUITAR model (Graphical User Interface Testing Framework) created by FC-UM automates some of the crucial aspects of testing a GUI more logically and thoroughly than current tools that employ capture and replay functionality. GUITAR enables developers to create ‘projects’ for each GUI application under test, consisting of artifacts (files/folders) that are produced or consumed by tools and implemented as GUITAR’s plug-ins. The test designer can implement new tools and integrate them with GUITAR via plug-ins.

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High Dependability Computing Project

The High Dependability Computing Project (HDCCP) investigates the use of experimental methods to evaluate new design and development approaches and technologies in order to improve NASA's capability to create highly dependable software. The incremental, five-year, cooperative agreement is part of a broad strategy for dependable computing that links NASA, corporate partners, universities, and research centers.

FC-UM has developed a methodology for characterizing software system dependability that it has prototyped for a small-size system. This methodology takes into account the multiple facets of dependability and the system's different stakeholders. We are developing an experience base of models that describe, assess, and predict software's dependability properties. We have also analyzed the dependability of operational NASA systems such as the Mars Science Laboratory and the Center-TRACON Automation System (CTAS).

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MHS Information Management/ Information Technology Process Improvement Project

The Military Health System (MHS) has begun an effort to improve its software acquisition (SA) practices in a measurable manner. FC-UM support for this program is to define the measures and quantify both the short-term and long-term levels of success for their CMM-

based process improvement initiative, including progress, program effectiveness, and return on investment. To do this, FC-UM will assist the MHS IM/IT Process Improvement Program to effectively identify, collect, and analyze SA and other project-related measures.

Utilizing the experience factory approach, FC-UM is working with the organization to develop a measurement program based on MHS IM/IT business goals, processes and projects. Tools and techniques are being developed to support analysis and feedback needs specific to the goals of MHS IM/IT organization. In the next phase of work, the measures are being applied to several pilot projects in order to validate the approach with the acquisition project teams.

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NASA Metrics Support

NASA is currently implementing an agency-wide metrics program to understand and improve its software systems. Implementing this program requires the development of focused guidance for NASA project managers. In order to establish this guidance, common goals across NASA centers and system domains as well as project-specific goals and risk areas need to be considered. The creation of an agency-wide metrics program is a key objective within the NASA Software Engineering Initiative Implementation Plan. However, for a broad-based program like this to succeed, it must be perceived as valuable by project managers and program offices and also minimize any impact on projects. The methodology is being

piloted on several projects at several NASA centers. The resultant goal-metric sets will be categorized into classes of metrics and usage scenarios that provide metrics selection guidance at the project level. Reporting examples are being developed that will assist both project and agency-level analysis. Since motivation is vital, a key task will be to show project managers both the short-term benefit of using data to effectively manage their projects and the longer-term benefits of measuring improvements in their software products and processes. Tying performance measures to internal and external goals provides strong motivation for managers to rely on data to understand project performance.

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Reading/Inspection Technologies

Software inspections ensure that software artifacts, created during the software life cycle, possess the required quality characteristics. For instance, inspections improve design and code quality by increasing defect removal during development in a cost efficient manner, thus ensuring that the software artifacts necessary for its construction correctly reflect the needs of stakeholders.

FC-UM has continued its work on the research and application of “software reading techniques,” which increase the effectiveness of software inspections by providing guidelines that inspectors can use to examine (or “read”) a given software artifact and identify defects. Empirical evidence demonstrates that software reading is a prom-

ising technique for increasing software quality for different situations and document types and is not just limited to source code. Software reading can be performed on all documents associated with the software process and is an especially useful method for detecting defects, since it can be applied as soon as documents are written. FC-UM is engaged in a number of collaborations for the purpose of refining reading techniques for different stages of the life cycle.

FC-UM has developed FOREST inspections (Fraunhofer Optimized Reviews Eliminating Stakeholder Troubles). Unlike other inspection methods, the FOREST methodology analyzes the stakeholders in the software product and provides each reviewer with a targeted quality focus. This analysis makes FOREST inspections possible even during early phases of software development (for example, requirements and high-level design creation), where the cost savings from avoiding defects is highest.

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Software Measurement Service

Software Measurement provides a means of interpreting and preserving data in a form that facilitates making decisions and recognizing goal achievement. It also allows more useful data integration and enables data to be consolidated and used to fulfill long and short-term measurement goals. For example, most organizations utilize measurement data to manage productivity performance. Typically, the software component of an organization

does a poor job relating their performance to business goals.

FC-UM’s software measurement framework is based on the following components:

- Method: The FC-UM method draws the best components from existing approaches, including our own Goal-Question-Metrics™ approach.
- Experience Base: Effective software measurement programs are based on experience. An experience base helps select the best metrics for any given situation.
- Experts: FC-UM measurement experts rely on our method and experience base to analyze an organization’s needs and design effective measurement programs.

Software Measurement is implemented in stages. First, goals and currently collected data are analyzed to build an individualized measurement program. The program lays the groundwork by starting with selected key metrics that can be incrementally complemented with additional metrics over time, to create an immediately useful program that gradually matures measurement capability.

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Software Process Improvement Implementation Support

FC-UM helps private industry companies to achieve their software process improvement goals through baseline assessments, action planning assistance, periodic consulting support, and auditing services. Staff expertise in lessons learned for process improvement in small organizations and non-traditional software environments plays a significant role in the delivery of these projects. Staff are certified by the Software Engineering Institute in performing Software Capability Evaluations and are experienced in assisting organizations to achieve compliance with the Capability Maturity Model® (CMM) and Capability Maturity Model-Integration® (CMMI).

Organizations served include: Creative Computing Solutions, Inc., Bethesda, Maryland; DataStream Conversion Services, LLC, College Park, Maryland; Global TechPro, Falls Church, Virginia; ManTech Systems Engineering Corporation, Lexington Park, Maryland; QSS Group, Inc., Lanham, Maryland.

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Software Process Simulation

Software Process Simulation provides a level of confidence in the planning and control of the technical and human factors involved with software development. It enables users to simulate parameters factoring in different decisions and strategies along the way. Process simulation enables users to:

- Match the best technologies and strategies for a specific project.
- Estimate the effect of technology infusion and process changes before implementation.
- Increase understanding and communication throughout development.
- Examine process structure, relations and behavior that affect engineering and management decisions.
- Use customized experimentation tools.
- Predict trends in the dynamic evolution of project parameters, including defect prediction, dynamic control, and more.

FC-UM's project simulation models are calibrated specifically to meet the needs of different organizations and their projects, taking into account their specific problems, questions, and decisions. By focusing on relevant variables that must be monitored and controlled, FC-UM identifies significant factors inherent in the development process and tailors metrics collections to improve tracking and planning.

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State-of-the-Art Software Inspections

FC-UM is working with NASA's Goddard Space Flight Center (GSFC) and Jet Propulsion Lab (JPL) to improve their processes for inspecting software work products for defects. A unique outcome of this research will be an assessment of advanced reading techniques that promise to detect a greater number of faults in a more cost effective manner, and the integration of a well-proven process for inspections across the software engineering life cycle.

The final product of this work will be an updated inspection process, supported by a training course and train-the-trainer materials developed with input from NASA developers and based upon the constraints faced by typical NASA projects. The development of this process will build upon previous results obtained, including:

- recent experiences elicited from across NASA with regards to inspections
- an existing and effective set of inspection training materials that have been updated and tailored for use in particular NASA development environments
- results of pilot applications and case studies with NASA projects showing the effectiveness of the updated inspection approach.

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Consortia

The Center for Empirically Based Software Engineering (CeBASE)

One necessary step towards the goal of building more reliable software systems, on time and within budget, is the establishment of an institutionalized empirical discipline for understanding causal relationships among the processes, components, and technologies that affect the building of systems. As in the physical and natural sciences, experimentation in software engineering requires a community in which

- proposed experimental designs can be critiqued by multiple researchers
- experimenters access the resources they need to perform experiments
- the results of experiments replicated at different locations can be analyzed for what they say about the "big picture."

For these reasons, FC-UM cooperates with four universities across the country in the development of CeBASE. Through CeBASE, FC-UM undertakes original empirical research and is de-

veloping a prototype system for sharing and evolving the results of such research with a community of affiliated researchers and practitioners. CeBASE develops and refines techniques to increase the descriptive and predictive power of empirical models, and studies specific software development technologies to enable industrial organizations to understand the benefits and disadvantages of those technologies in their specific context. FC-UM also provides courses and symposia on empirical methodologies and results, and encourages the use of empirical knowledge in software engineering education.

On its website, www.cebase.org, CeBASE maintains a repository of tools, reports, data, and experimental results related to empirical studies, for use by empirical researchers and practitioners. Some examples include:

- Links to publicly available tools that can be downloaded to assist in empirical studies or data collection.
- A comprehensive repository of all studies on a particular family of defect reduction technologies, i.e.,

reading techniques for improved software inspections. CeBASE collaborators can access materials and data for reuse in their own work.

- Results of expert workshops that were held to discuss important software engineering phenomena across organizations and industries, such as defect reduction, COTS-based software development, and Agile methodologies.
- A repository of lessons learned on COTS-based system development, accessible via keyword search or a prototype visualization interface.

All of the above features are interactive, and users of the website are encouraged to submit their own experiences and data as well as review what is already offered.

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Software Experience Center

The goal of the Software Experience Center (SEC) Consortium, a joint project between FC-UM and Fraunhofer IESE, is to improve member companies' software competencies and development practices. To achieve this goal, member companies share past and ongoing experiences in software process improvement and particular development technologies. The Fraunhofer organizations contribute their expertise to help analyze, package, and disseminate the lessons to be learned from these experiences.

The Fraunhofer organizations provide a number of services to member companies: Twice-yearly workshops present a forum for the discussion of software development experience. The Fraunhofer organizations produce a series of experience reports addressing specific technologies of interest to the Consortium that are gathered and stored in the Fraunhofer-operated SEC Experience Base for use and feedback by all members. The Fraunhofer organizations have developed an extensive network of software experts, both within the organizations and externally, that can be made available to SEC member companies.

The Consortium is currently composed of five international corporations with significant investments in software development: ABB, Boeing, DaimlerChrysler, Motorola, and Nokia. The latest Consortium workshop was held in April 2003, at Motorola's offices in Chicago, Illinois, and sessions ranged from in-depth working groups to presentations of experience reports. Session topics selected by the member companies included Agile Software Development, Dissemination of Research Results, CMMI, and Software Architecture.

In order to increase knowledge and experience sharing, the consortium has used the eWorkshop developed by FC-UM. The eWorkshop allows SEC members to come together and discuss important issues electronically without leaving the office. External experts are invited to the eWorkshop in order to provide a broader base for discussion. In addition to this dynamic exchange of knowledge and experience, the participants receive an analysis of the discussion in real-time and a more extensive analysis shortly after the eWorkshop concludes.

Contact

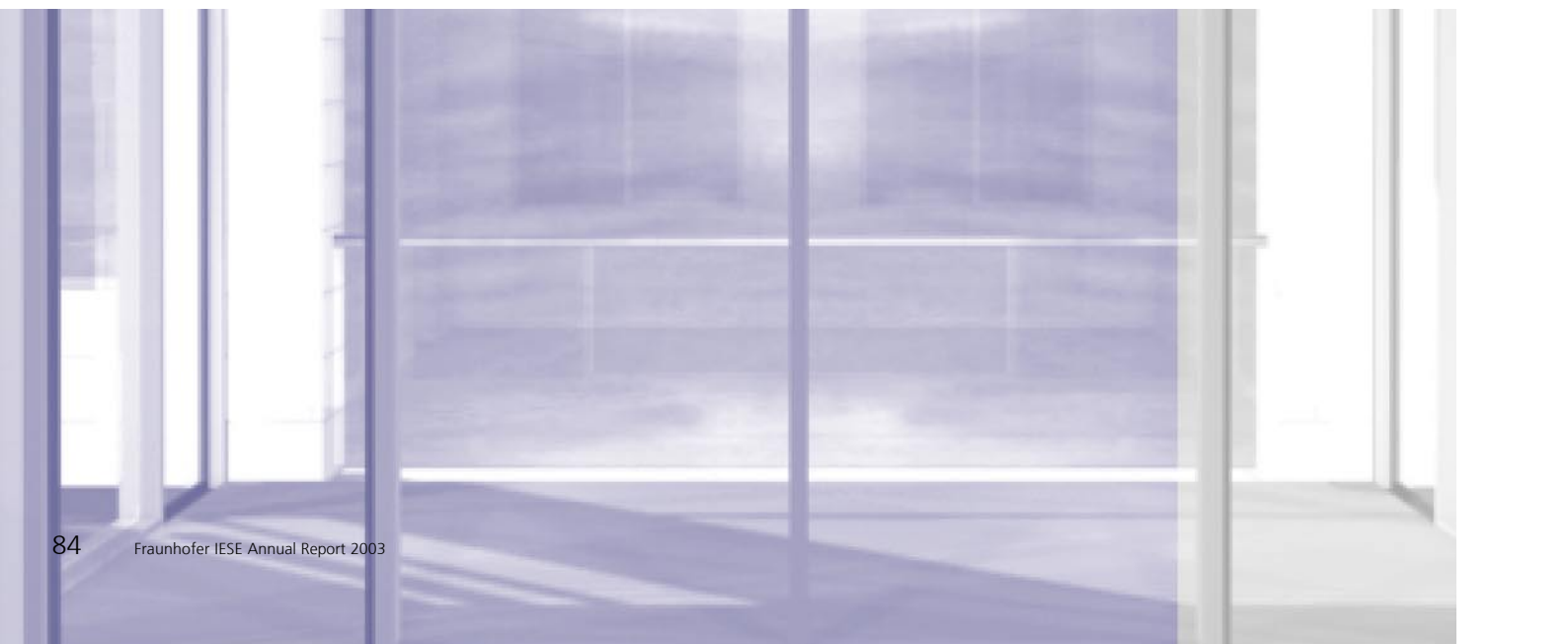
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Software Industry Consortia

The Maryland Software Industry Consortium (SwIC) Project, in conjunction with the Maryland Department of Business and Economic Development, provides a software engineering resource to help Maryland organizations advance the practices of system and software engineering and improve the quality of their software related products and services. SwIC integrates research and experience into practical improvement, creates opportunities to develop and disseminate improvement practices, enhances the competitiveness of member companies (especially small to mid-size companies), accelerates new software technology adaptation, leverages member company experience, promotes inter-corporate cooperation of member organizations, and provides training and education.

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FC-UM in Figures



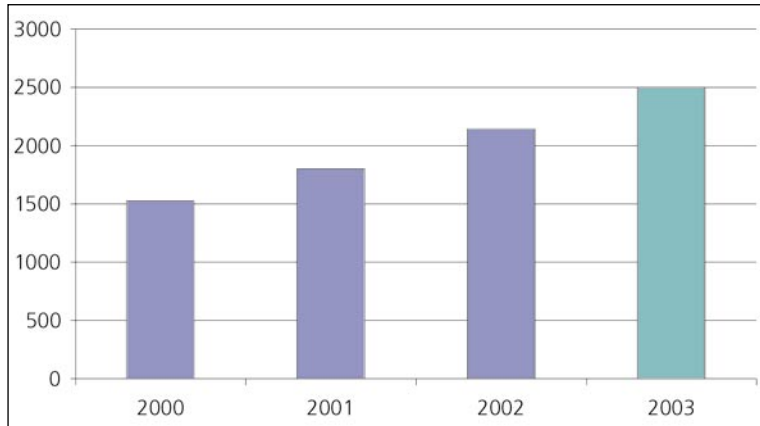
FC-UM in Figures

The Center is on track to earn a small profit in 2003 based on revenue growth of 17% from the previous year. Third-party revenue accounts for 75% of the total revenue.

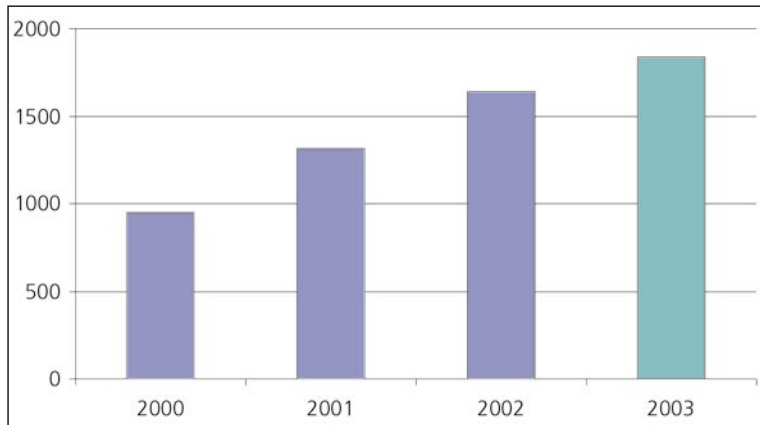


People

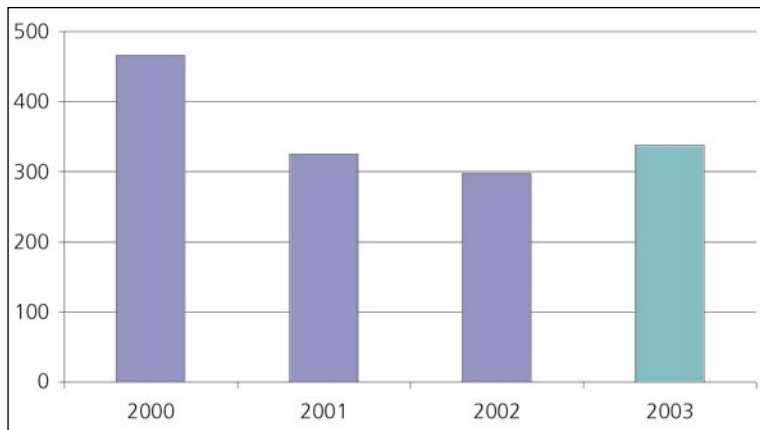
Staff size has been stable this year with plans for limited hiring towards the end of 2003.



Total revenue (in T US dollars).



Third party revenue (in T US dollars).



Retained earnings (in T US dollars).



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Fraunhofer VIESE Locations

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How to reach us:

By car
 Arriving on highway A6 from either the west (Saarbrücken) or the east (Mannheim), take the exit *Kaiserslautern-West* and follow the signs that read *Lauterecken*. About 500 m after exiting the highway, make a left towards *Siegelbach*. Follow the road leading through a forest. Right after entering *Siegelbach*, turn right at the first junction into the street *Sauerwiesen*. After about 100 m you find IESE on your right-hand side.

By train
 After arriving at the Kaiserslautern railway station, take either a taxi (ca. 8 km) or the bus (line RSW 6510, departs from bus stop AV2 at the railway station, destination: Siegelbach) to Siegelbach. Get off at the bus stop *Siegelbach Sand*, which is about 100 m from the Institute.

By airplane
 After arriving at Frankfurt/Main airport, take either the train (about 2 hours) or rent a car (about 1.5 hours).

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How to reach us:

By car
 Arriving on highway A6 from either the west (Saarbrücken) or the east (Mannheim), take the exit *Kaiserslautern-Ost* and follow the signs that read *Kaiserslautern Stadtmitte*. About 500 m after exiting the highway and crossing under the highway, turn left into PRE-Park and follow the road for about 300 m. At the junction of the main road turning to the left, continue straight. After about 50 m, you find the contact office on your left-hand side.

By train
 After arriving at the Kaiserslautern railway station, take the bus (# 2, 5, or 7) to *Schillerplatz* stop. Change into bus # 4. Get off at the *PRE-Park* stop.
 Attention: Not every bus stops at PRE-Park!

Contact Office at the University of Kaiserslautern

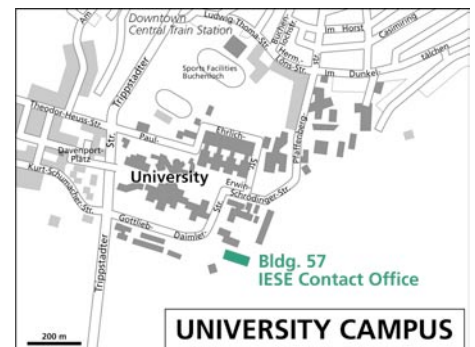
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How to reach us:

By car
 Arriving on highway A6 from the west (Saarbrücken), take the exit *Kaiserslautern-West* and follow the signs to Pirmasens on B270. After approx. 1 km (1/2 mile) turn right onto *Pariser Straße*, following the signs *Universität* and *Stadtmitte*. After approx. 1.5 km (1 mile), you will see a white sign *Universität* on your right. Do not take this turn, but rather continue for another 50 m. Then turn right at the traffic light and follow the sign to *Universität*. The Contact Office is located in Building 57 on the fifth floor.

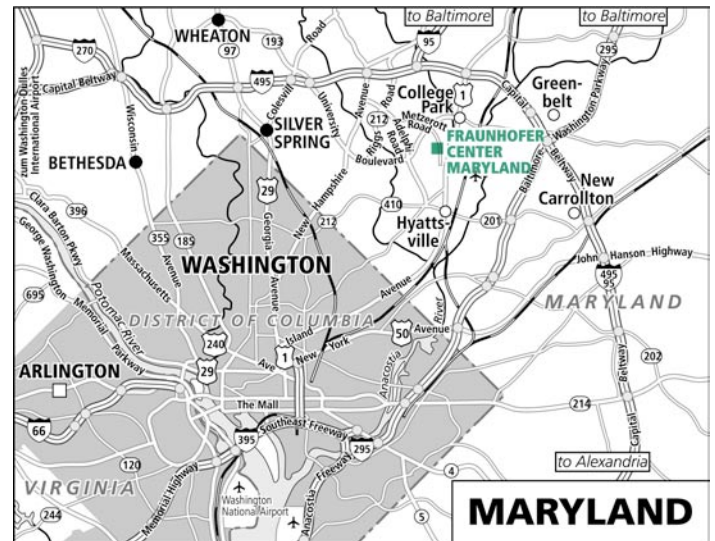
Arriving on highway A6 from the east (Mannheim), take the exit *Kaiserslautern-Ost* and follow the signs to *Stadtmitte* on *Mainzer Straße*. Then follow the signs *Universität*. The Contact Office is located in Building 57 on the fifth floor.

By train
 After arriving at the Kaiserslautern railway station, take either a taxi or bus # 5, destination *Uni-Wohngebiet*. Get off at the *Uni-Ost* stop. After walking approx. 300 m in the opposite direction, you will see signs to Bldg. 57. The Contact Office is located on the fifth floor.



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How to reach us:

By car

Directions from Points North:
 Follow I-95 South to the point where it merges with I-495. Follow the signs for Exit No. 27- Richmond (I-95/495 South). Then follow the Exit 27 signs staying to the left so you can take the special Rt.1/College Park exit lane. This will briefly put you back on I-95. Stay to the right and take Exit No. 25 onto Route 1 South (towards College Park).

For directions from this point on, see "Further directions" on this page!

Directions from Points South:

Follow I-95 North to the point where it merges with I-495. Follow the signs for Baltimore (I-95/495 North). Take Exit No 25 onto Route 1 South (towards College Park).

For directions from this point on, see "Further directions" on this page!

By train (15 minute walk)

Exit College Park Metro station by turning right after you exit the turnstile and going through a tunnel to Calvert Rd. Take Calvert Rd. for 4-5 blocks to Rt. 1. (Calvert ends there). Cross Rt. 1 and go right a block to Hartwick Rd. Turn right (there's a Kinko's Copy sign on the corner). Our building (4321) is on the left.

By plane

B.W.I. airport (about 45 minutes by car):
 Exit the airport on I-195 (main road out of airport). After a few miles, take I-95 South towards Washington.

From this point, follow directions from Points North.

National Airport (about 90 minutes by car; also a stop on the Yellow Metro line):

Exit the airport towards I-395 North towards Washington, D.C. Continue on I-395 North to New York Avenue. Turn right onto New York Avenue (US Rt. 50 East) to MD Rt. 295/Baltimore-Washington Parkway for approximately six miles. Stay on BWI Parkway to the exit for Maryland Rt. 193. This is Greenbelt Road/Rt. 193. Take Rt. 193 East to Rt. 1 South.

For directions from this point on, see "Further directions" below!

Further directions:

Stay on Rt.1 South, going past the University of Maryland. After passing the University, you will encounter 2 stop lights – the 2nd one being Knox Rd. Take the next right after Knox onto Hartwick Rd (there's a Kinko's Copy sign on the corner). Our building (4321) is on the left – turn left past the building into the parking lot and park anywhere.

We're on the 5th floor – directly opposite the elevator.



Map of Kaiserslautern

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