

LUCAS

Center for Applied Software Research

# Activity Report

2000-2001



LUND INSTITUTE OF TECHNOLOGY  
Lund University

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# LUCAS 2000-2001

LUCAS - Center of Applied Software Research was established in late 1999 as a research center at Lund Institute of Technology, Lund University, Sweden. The center is aimed at gathering the competence on applied software research at Lund Institute of Technology into a network, which comprises about 35 researchers of which half are faculty members and half are Ph. D. students.

The research of LUCAS covers three thematic areas:

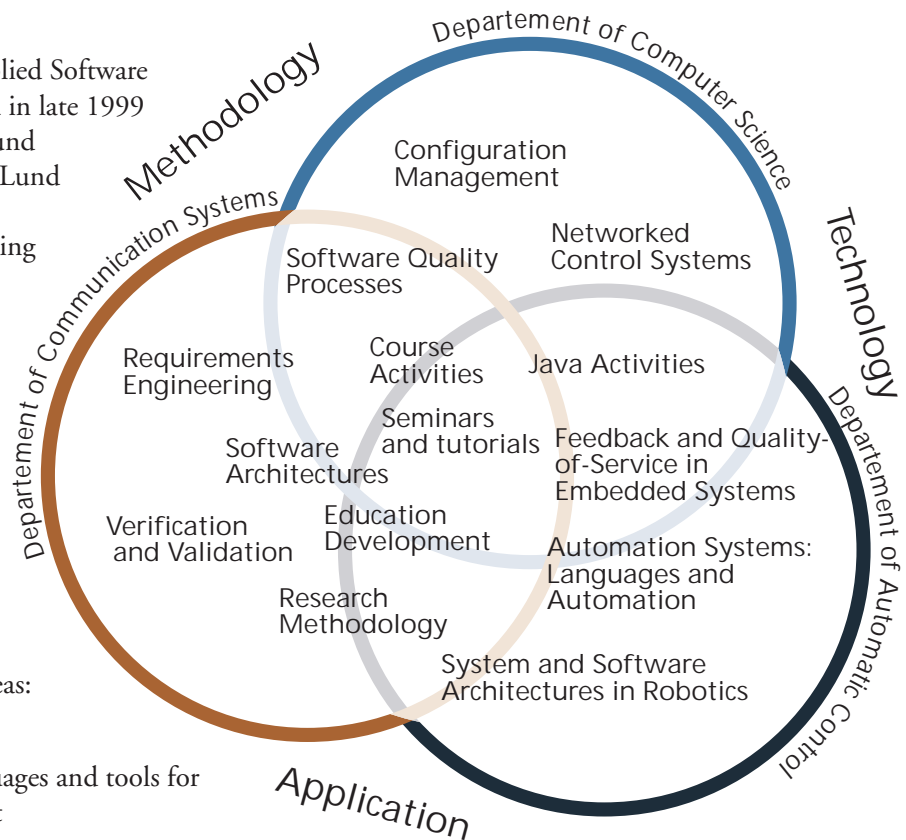
- Software Engineering Environments - languages and tools for software development
- Methods in Software Engineering - methods and processes for software development
- Real-Time System Software - software in systems with hard real-time requirements

Industry relevance is a key issue for the LUCAS research and much of the actual research is conducted in joint projects with Swedish industry. During 2001 LUCAS has increased the connections, and established a common interface to our industrial partners and members. A wide spectrum of involved groups offers a variety of application domains for software research and gives LUCAS unique possibilities to perform interdisciplinary software research. Examples of joint efforts are co-funding of Ph.D. students, industrial students, and using industrial projects as research objects.

During 2001, 9 new researchers (3 seniors, 6 Ph.D. students) have been recruited to LUCAS and LUCAS has thereby reached its planned size and enters the future well confident in its ability to serve its purposes:

- to stay on the competitive edge on applied software research
- to offer results to industry for future software development projects
- to provide education and training to fulfill industry needs

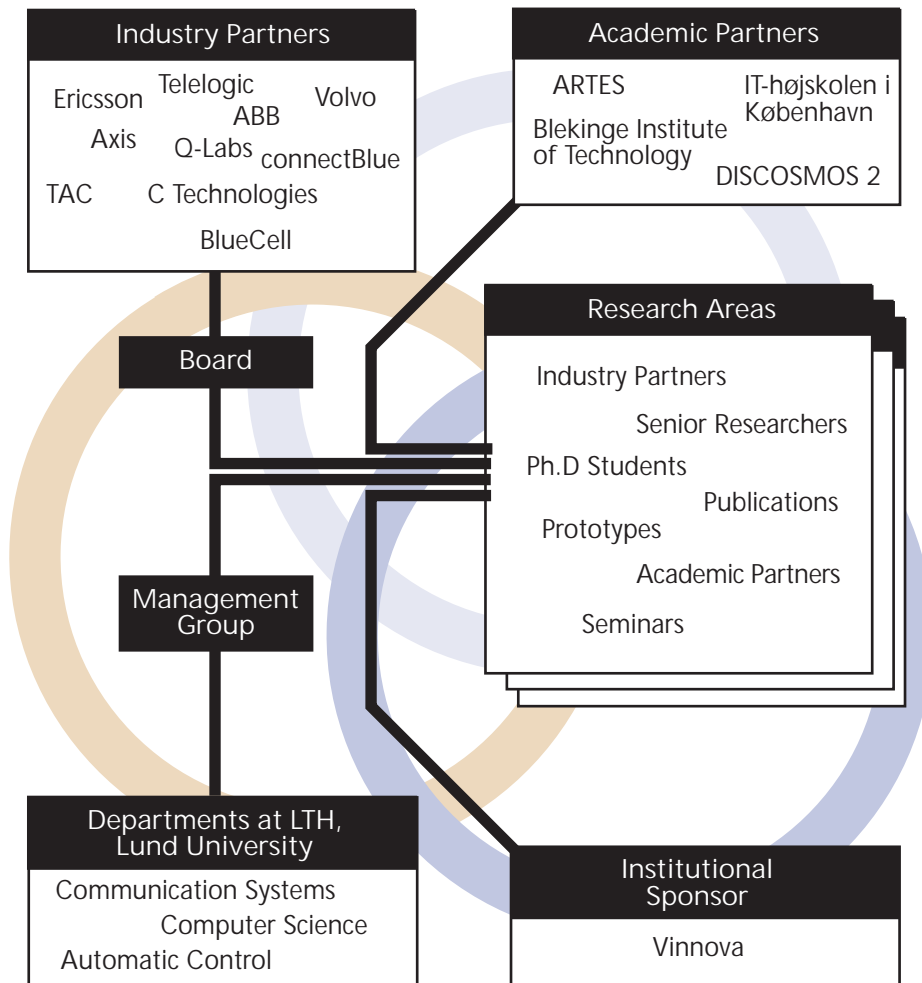
This report gives a brief picture of the structure, the economy and the major research areas of LUCAS year 2001. Please follow the research at [www.lucas.lth.se](http://www.lucas.lth.se).



*Research at LUCAS*

## Organizational Structure of LUCAS

A typical LUCAS research project is built on a combination of senior researchers, Ph. D. students and one or more industry partner. The figure below illustrates the internal and external organization of LUCAS.



## The LUCAS Industry Members

LUCAS offers a wide range of opportunities for cooperation between industry and academia. A company can join as:

- Gold participant which involves funding to projects over different thematic areas and thereby getting full benefit of the LUCAS expertise.
- Silver participant which involves partial or full funding of a Ph. D. student, and thereby impact on the research topics of the research center.
- Bronze participant which gives the company access to seminars and tutorials on the latest topics in applied software research.

The following companies were LUCAS members during year 2001.

### Gold members

Sony Ericsson Mobile Communication , Lund



Ericsson Mobile Platforms, Lund



ABB Automation Technology Products, Malmö



### Silver members

Ericsson Microwave Systems, Mölndal



Q-Labs, Lund



Telelogic, Malmö



### Bronze members

IAR, Uppsala



BlueCell, Lund



TAC, Malmö



connectBlue, Malmö



ABB Robotics, Västerås



Axis, Lund



C Technologies, Lund



## Examples of Industry Benefits

### JAVA in Ericsson Mobile Phones

During the late ninetieths Ericsson integrated a Java Virtual Machine, developed by LUCAS, in a mobile phone. The experiences from the project were very useful when the company later on faced commercial Java technology suppliers. By sponsoring one researcher for one year the application development team got an opportunity to try out advanced Java technology at an early stage.

### Configuration Management

When Ericsson looked for a Configuration Management tool that could serve multiple projects over multiple sites, CM-researchers from Lund Institute of Technology (LTH) were involved. The researchers had an opportunity to study CM practices in a real world project and test ideas from the CM-prototype COOP/Orm, developed at LTH. The tool supports concurrent and distributed development, provides remote awareness through the tool and gives a strong support for merging of structured data. The cooperation gained both academia and industry. LUCAS gained practical experiences from COOP/Orm. Ericsson gained experiences that became useful when adjusting and configuring other CM-tools.

### LUCAS Architecture Academy

Software Architects from ABB, Ericsson, Telelogic and Q-Labs have, in collaboration with Ph.D. students within LUCAS, exchanged experiences, problems and architectural solutions. The sessions have formed a unique and qualified meeting-place, giving the participating companies valuable links to research in academia and the researches links to practical experiences.

### eXtreme Programming

During the last couple of years there has been a strong and increasing interest among the LUCAS industry partners for evaluating and introducing XP practices into their software development processes. LUCAS has been very active in this area, offering expertise, leading working groups, and giving seminars. Recently, a combined industry and graduate course has been given on XP coaching which attracted several participants from the LUCAS companies.

### Distributed Prioritizing with Focal Point

Focal Point develops a support tool for decision-making in product development. The company has in cooperation with Telelogic and LUCAS implemented new methods for visualization of the results from distributed prioritizing of requirements. Special color graphics illustrates satisfaction and disagreement among stakeholders participating in selection of functions for a software product, which gives a better basis for the selection of new features for the next generation of a product. The first version of the tool was released in December 2001.

### BlueCell and Java Virtual Machine in Mobile Units

The co-operation between BlueCell and LUCAS has brought about implementation and practical experiences of Java Virtual Machine (JVM) for mobile units. The purpose of the JVM was to let the a handheld computer discover wireless services and to dynamically upgrade applications and data. The practical consequences for BlueCell were early experiences of operating wireless systems for e. g. building automation. This, in turn, meant market advantages for BlueCell and its customers.

## People in LUCAS 2001

### Members of the Board

Jerker Wilander, chairman  
Sten Minör  
Göran Arinder  
Anders Ek  
Björn Wittenmark

### The Management Group

Boris Magnusson, Prof.  
Per Runeson, Dr.  
Karl Erik Årzén, Prof.

### Senior Researchers

Lars Bendix, Dr  
Görel Hedin, Dr.  
Roger Henriksson, Dr.  
Martin Höst, Dr.  
Even-André Karlsson, adj prof.  
Boris Magnusson, Prof.  
Klas Nilsson, Dr.  
Pierre Nugues, prof.  
Björn Regnell, Dr.  
Anders Robertsson, Dr.  
Per Runeson, Dr.  
Karl-Erik Årzén, Prof.  
Kasper Østerbye, Dr.

### Ph.D. Students

Carina Andersson, Ph.D. Stud.  
Christian Andersson, Ph.D. Stud./adj  
Ulf Asklund, Ph.D. Stud.  
Tomas Berling, Ph.D. Stud./ind.  
Anton Cervin, Ph.D. Stud.,  
Johan Eker  
Torbjörn Ekman, Ph.D. Stud.  
Magnus Gäfvert, Ph.D. Stud.  
Mathias Haage, Ph.D. Stud./adj  
Dan Henriksson, Ph.D. Stud.,  
Anders Ive, Ph.D. Stud.,  
Enrico Johansson, Ph.D. Stud./ind  
Lena Karlsson, Ph.D. Stud.,  
Daniel Karlström, Ph.D. Stud.  
Bo Lincoln, Ph.D. Stud.,  
Johan Natt och Dag, Ph.D. Stud.  
Josef Nedstam, Ph.D. Stud.  
Anders Nilsson, Ph.D. Stud.  
Magnus C. Ohlsson, Dr 2001  
Thomas Olsson, Ph.D. Stud.  
Håkan Pettersson, Ph.D. Stud.  
Sven G. Robertz, Ph.D. Stud.  
Thomas Thelin, Ph.D. Stud.

### Technical Staff and Administration

Anders Blomdell, tekn  
Jonas Wisbrant, project secretary

### Company

Sony Ericsson Mobile Communications AB  
ABB Automation Technology Products AB,  
Telelogic AB  
Lund Institute of Technology

### Funders

Vinnova, LTH  
Vinnova, LTH  
Vinnova, LTH, EU, SSF,...

Vinnova, LTH  
Vinnova, LTH  
Vinnova, LTH  
Vinnova, LTH, ESERNET  
Vinnova, Q-labs  
Vinnova, LTH  
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Vinnova, LTH  
Vinnova, LTH, EU, SSF, ...  
IT-høyskolen, Köpenhamn

Vinnova, LTH  
Vinnova, LTH  
Vinnova, LTH  
Ericsson Microwave Systems  
SSF, LTH

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Vinnova, LTH  
Ericsson Mobile Plattformen  
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SSF, LTH  
Vinnova, LTH

Vinnova, SSF, LTH  
Vinnova

# Research

## Networked Control Systems

Networked control systems where sensors, actuators, and controllers are distributed as nodes in a distributed system are becoming increasingly common in several industry branches, e.g., the automotive industry. Within LUCAS we are studying the real-time system software implications of this type of systems. Of particular interest are wireless ad-hoc networks, e.g. Bluetooth.

The project studies how wireless networks can be used for implementing feedback control systems and how the control system requirements influence the data and communication layers of Bluetooth. Issues of interest are whether the current Bluetooth protocol is suitable for real-time control data, and what modifications are necessary. On the system architecture level we study how the new possibilities that wireless communication presents influence the overall control system and software architecture. On the programming level we study the necessary programming tool support needed for distributed wireless control systems and how Java technology and its support for highly flexible solutions, in particular updating code can be utilized here. This activity has partial funding from the VINNOVA/Netgroup Program.

### Staff

Anton Cervin, Johan Eker, Magnus Gäfvert, Dr. Roger Henriksson, Anders Ive, Bo Lincon, Prof. Boris Magnusson, Anders Nilsson, Prof. Karl-Erik Årzén

### Publications

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## Automation Systems: Languages and Automation

In this project we are investigating domain-specific languages, in particular for industrial automation where the IEC 61131-3 is one example of the type of languages that are commonly used. In addition to the languages themselves we are also studying programming environments and run-time systems for these languages. A special focus is the use of modern object-oriented concepts and techniques.

One part of this project is performed in collaboration with ABB Automation Technology Products. Here we study object-oriented extensions to SFC (Sequential Function Charts), a state-oriented language within IEC 61131-3, and how the graphical notation of SFC can be integrated with ordinary text-based Java code. A basis for this work are the AppLab and JastAdd environments developed at Computer Science which use object-oriented compiler technology. In particular, we have developed the techniques of reference attributed grammars and aspect-oriented grammars which are especially suited for modular implementation of object-oriented and state-based languages. In related work at Automatic Control, Java-based implementations of Grafchart, a Petri-net based extension to Grafcet/SFC are under development. A graphical editor written in Java/Swing and using the JGo class package is used as the basis for the development. The Grafchart programs can either be interpreted in the host machine or code can be generated for execution in some target.

Another activity in this project concerns the development tools that allows co-simulation of real-time kernels and communication networks with control applications. The aim is to evaluate how the temporal non-determinism caused by preemption, blocking, and communication delays influence the control performance. A Matlab/Simulink based version of the simulator called TrueTime is under development

During 2001 LUCAS has given a combined Ph.D.-level graduate course and industrial seminar series on "Programming Languages for Automation".

### Staff

Anton Cervin, Johan Eker, Torbjörn Ekman, Dr. Görel Hedin, Dan Henriksson, Prof. Boris Magnusson, Dr. Klas Nilsson, Prof. Karl-Erik Årzén

### Partners

ABB Automation Technology Products, ABB Robotics, TAC

### Publications

Henriksson, D., Cervin, A., Årzén, K.-E., "TrueTime – Simulation of Control Loops Under Shared Computer Resources", Submitted to IFAC World Congress 2002.

Årzén, K.-E., Olsson, R. and Åkesson, J., "Grafchart for Procedural Operator Support Tasks", IFAC World Congress 2002.

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Cervin, A., "Towards the Integration of Control and Real-Time Scheduling Design", Lic Tech thesis ISRN LUTFD2 / TFRT—3226—SE, Department of Automatic Control, Lund Institute of Technology, Lund, Sweden, 2000

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## Feedback and Quality-of-Service in Embedded Systems

Using control-based approaches for modeling, analysis, and design of embedded computer and communications systems is currently receiving increased attention from the real-time systems community, as a promising foundation for controlling the uncertainty in large and complex real-time systems. Areas of growing interest include feedback architectures for adaptive real-time computing, theory for performance guarantees under uncertainty, integrated resource scheduling and feedback control, control-theoretical models of dynamic real-time systems, application of control theory for controlling timing behavior, and optimal, robust, or adaptive feedback control in real-time systems.

The use of control has the potential to increase flexibility, while preserving dependability and efficiency. For example, control techniques can be used to compensate for shortcomings and imperfections in the implementation platforms. Control approaches to resource allocation are especially interesting for distributed control systems. For example, a feedback scheduler can distribute the computing and communications resources in such a way that the global control performance, or Quality-of-Control (QoC, closely related to QoS), is maximized. QoC/QoS is also an alternative approach to increase dependability, e.g., through dynamic reconfiguration of resources in critical situations or for graceful degradation.

The work in this project is performed in cooperation with the SSF/ARTES project "Integrated Control and Scheduling". It is also the topic of the separate SSF proposal FLEXCON.

### Staff

Anton Cervin, Johan Eker, Dan Henriksson, Prof. Karl-Erik Årzen

### Partners

ABB Automation Technology Products, Teleca

### Publications

Cervin, A., Eker, J., Bernhardsson, B. and Årzen, K.-E. "Feedback-Feedforward Scheduling of Control Tasks", Real-Time Systems Journal, Accepted for publication in forthcoming special issue of control-theoretical approaches in real-time computing, 2001.

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## System and Software Architectures in Robotics

Domain specific architectures provide enhanced support for specific application areas, compared to software architectures in general as in the previous item. The LUCAS partners have been active for several years within control system architectures for industrial robots. This is related to the "Languages and Automation" item since robots are used as components in factory automation systems, but the focus here is on the programming and control issues for the robot as such.

Robots differ from other types of automation in due to flexibility, user programming (geometries, object manipulation), system programming (optimized real-time motion control), etc., motivating a domain-specific approach. On the other hand, it is of course important to support integration of robots with their surrounding systems, which is an ongoing topic within LUCAS. This is related to the work on domain specific languages and our approach to real-time Java.

In this perspective, the robotics laboratory, located at The Department of Automatic Control, serves as a common demonstrator platform for several of the LUCAS projects. The lab has three industrial robots provided by ABB Robotics. Two of these are reconfigured for experiments in both control and programming, whereas the third robot includes the complete ABB software that has been extended for external sensor based control and are located at ABB in Västerås.

### Staff

Anders Blomdell, Mathias Haage, Dr. Klas Nilsson, Dr. Anders Robertsson,

### Partners

ABB Robotics

### Publications

Bengtsson, J., Ahlstrand, A., Nilsson, K., Robertsson, A., Olsson, M., Heyden, A., and Johansson, J., "A robot playing scrabble using visual feedback", In 6th Int. IFAC Symposium on Robot Control (SYROCO 2000), Vienna, Austria, September 2000.

Johansson, R., Robertsson, A., Nilsson, K. and Verhaegen, M., "State-space system identification of robot manipulator dynamics", Mechatronics, 10, pp. 403 418, 2000.

Robertsson, A., Valera, A., Nilsson, K., and Johansson, R., "On-line reconfiguration of real-time robot motion and force control", In 6th Int. IFAC Symposium on Robot Control (SYROCO 2000), Vienna, Austria, September 2000.

## Configuration Management

Configuration management (CM) has become a very active area over the last few years. CM systems has come in focus both because its importance for repeatability in the CMM model, because it is practically needed in development, particularly in a distributed setting, and because of its impact and relation to process considerations.

The research in LUCAS is aimed at several of these aspects. One activity is the development of fine-grained, structure-based CM models and prototype tools to support them. The goal here is to better support users of CM tools in particular in distributed settings through e.g., support for collaborative awareness, concurrent development, and merging. In addition to basic research and development, we have an active dialogue with industry through numerous seminars, working groups, and interviews.

The recent interest in XP and other lightweight processes has also put new demands on the CM capabilities that we are looking into. Currently we are also transferring some of this material into an undergraduate course. The project has academic cooperation with Alborg University and University of Aarhus and frequent contacts with other researchers in the field through our involvement in the SCM conference. Here we have also frequent interaction with the designers behind the leading commercial products. In Sweden we have interacted with several companies on these issues, KCS, Ericsson Mobile, Sigma Systems, and many more through VI and the SPIN-Syd network.

### Staff

Ulf Asklund, Dr. Lars Bendix, Prof. Boris Magnusson,

### Partners

Sigma Systems, SPIN-Syd, Sony Ericsson Mobile Communication and Ericsson Microwave Systems

### Publications

Ask Lund, U. and Bendix, L., "Configuration Management for Open Source Software", In Proceedings of 1st Workshop on Open Source Software Engineering. Toronto, Ontario, Canada, May 13, 2001.

Ask Lund, U. and Magnusson, B., "Support for Consistent Merge", In Proceedings of SCM-10, 10th International Workshop on Software Configuration Management: New Practices, New Challenges and New Boundaries and van der Hoek (Ed.), Toronto, Ontario, Canada, May 12-14, 2001.

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## Requirements Engineering

Requirements engineering (RE) is the starting point for development of software products. In particular, market-driven software development manages various types of requirements from different sources continuously. This project concerns decision support for the RE process, in particular elicitation and prioritization of requirements.

Long-term cooperation with companies have identified a set of research issues:

- Methods for understanding and planning of the RE activities, based on building and running simulation models.
- Techniques for semi-automatic identification of duplicates and other dependencies, in a requirements database. The identification is based on techniques for natural language processing.

Further, a broader survey of current practice within RE is under planning. The project has academic contacts with högskolan i Skövde and Department of Linguistics at Lund University, Industrial contacts include Telelogic, C-Technologies and ABB.

#### Staff

Dr. Björn Regnell, Lena Karlsson, Johan Natt och Dag, Josef Nedstam

#### Partners

Högskolan i Skövde, Department of Linguistics at Lund University, Telelogic, C-Technologies, ABB.

#### Publications

Höst, M., Regnell, B., Natt och Dag, J., Nedstam, J. and Nyberg, C., "Exploring Bottlenecks in Market-Driven Requirements Management Processes with Discrete Event Simulation", Software Process Simulation Modeling Workshop (ProSim 2000), London, UK, July 12 - 14, 2000.

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## Verification and Validation

Verification and validation (V&V) of software systems take a substantial share of project efforts. Shares up to 50% of the total project budget are often reported. Further, for certain application domains, particularly for embedded systems, the software quality may be crucial. Hence, the efficiency and effectiveness of the V&V process is important. This project aims at understanding the current practice and improving the verification and validation processes. Surveys have previously been conducted at ABB and Ericsson Microwave to benchmark the current practice, and find areas for improvement and research. Another survey is currently conducted with SPIN-syd companies. These surveys have ended up in the following research issues:

- Inspection techniques are investigated in empirical studies, both with respect to effectiveness and efficiency of reading methods used in the inspection, and prediction models for estimation of remaining defects after an inspection.
- Test selection techniques for system test are developed and evaluated for characteristics of software systems.

- Methods for understanding and planning of V&V activities, based on building and running simulation models.
- Improved information management in, for example, requirements and test documents. Issues investigated are which information is present in both sources, when the information is derived, and how this can be improved.

The project is performed in cooperation with ABB, Ericsson Microwave Systems, and SPIN-syd.

#### Staff

Tomas Berling, Dr. Per Runeson, Thomas Olsson, Thomas Thelin, Håkan Pettersson, Carina Andersson

#### Partners

ABB, Ericsson Microwave Systems, SPIN-syd

#### Publications

Berling, T. and Runeson, P., "Evaluation of a Perspective Based Review Method Performed in an Industrial Setting", Proceedings 5th International Conference on Empirical Assessment & Evaluation in Software Engineering, (EASE) Keele University, Staffordshire, UK, 2001.

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Wesslén, A., Runeson, P. and Regnell, B., "Analyzing the Sensitivity to Usage Profile Changes in test Planning", Proceedings 11th International Symposium on Software Reliability Engineering (ISSRE00), pp 317-326, 2000.

Wohlin, Claes, Höst, M., Ohlsson, M. C., "Understanding the Sources of Software Defects: A Filtering Approach", In proceedings of 8th International Workshop on Program Comprehension, pp. 9-17, Limerick, Ireland, 10-11 June 2000.

## Software Quality Processes

Software processes are means for giving support to the development of software systems. This project is concerned with software processes and their improvement, company-wide large processes as well as lightweight processes for smaller projects. Furthermore, processes in different cultural contexts are investigated. The following tasks are performed within LUCAS:

- Understanding which roles processes have and are expected to have in software development projects.
- Methods for evaluation of processes and their flexibility to changing circumstances in the project and its environment.
- One specific research issue is lightweight processes, such as eXtreme Programming (XP). This activity takes its form as presentations at companies, seminars at industry conferences, active working groups with industry, and pilot industry projects.
- A current activity is a graduate course focused on XP-coaching open also for industry participants. This course has attracted a number of people from industry making it into a meeting place for academics and practitioners with an interest in lightweight processes.



- Finally, investigations are performed of the process that is used for developing a series of products based on the same software platform. This is highly related to Software Architecture issues, see below.

Groups at Ericsson Microwave Systems, Sony Ericsson Mobile Communications, Ericsson Mobile Platforms and SPIN-syd companies are involved in the studies.

#### Staff

Dr. Martin Höst, Dr. Görel Hedin, Daniel Karlström, Lena Karlsson, Prof. Boris Magnusson, Josef Nedstam

#### Partners

Ericsson Microwave Systems, Sony Ericsson Mobile Communications, Ericsson Mobile Platforms, SPIN-syd companies

#### Publications

Andersson, C., Karlsson, L., Nedstam, J., Höst, M., Nilsson, B. I., "Understanding Software Processes through System Dynamics Simulation: A Case Study", proceedings of Swedish (National) Conference on Software Engineering Research and Practice (SERP01), Ronneby, Sweden, 2001.

Nedstam, J., Höst, M., Regnell, B., Nilsson, J., "A Case Study on Scenario-Based Flexibility Assessment for Risk Reduction", In proceedings of PROFES'2001: International Conference on Product Focused Software Process Improvement, pp. 42-56, Kaiserslautern, Germany, 10-13 September, 2001.

Ohlsson, M. C., "Controlling Fault-Prone Components for Software Evaluation", Ph.D. Thesis ISRN LUTEDX/TETS-1051-SE+218P.

Bratthall, L., Johansson, E. and Regnell, B., "Is a Design Rationale Vital when Predicting Change Impact? - A Controlled Experiment on Software Architecture Evolution", PROFES'2000: International Conference on Product Focused Software Process Improvement, Oulu, Finland, 20-22 June, 2000.

Höst, M. and Johansson, C., "Evaluation of Code Review Methods through Interviews and Experimentation", Journal of Systems and Software, Vol 52, No. 2-3, pp. 113-120, 2000. Paper selected for journal publication from EASE 1999.

Höst, M., Berling, T., "An Interview Based Evaluation of a Process Change Proposal", In proceedings of EuroSPI'2000 (European Software Process Improvement), Copenhagen, Denmark, 7-9 November, pp. 3-38 - 3-47, 2000.

Regnell, B., Runeson, P. and Wohlin, C., "Towards Integration of Use Case Modeling and Usage-Based Testing", Journal of Systems and Software, Vol. 50, No. 2, pp. 117-130, 2000.

Runeson, P., Borgquist, N. and Landin, M., "An Evaluation of Functional Size Methods and a Bespoke Estimation Method for Real-Time Systems, Proceedings", International Conference on Product Focused Software Process Improvement (PROFES00), Oulu, Finland, pp. 339-352, 2000.

Wesslén A., "A Replicated Empirical Study of the Impact of the Methods in the PSP on Individual Engineers", Empirical Software Engineering: An International Journal, Vol. 5, No. 2, pp. 93-123, 2000.

Wohlin, C., Höst, M. and Regnell, B., "Organizational Learning from Software Project Success", Keynote at the 11th European Software Control and Metrics conference in proceedings pp. 3-11, Munich, Germany, April, 2000.

Wohlin, C., Von Mayrhauser, A., Höst, M., Regnell, B., "Subjective Evaluation as a Tool for Learning from Software Project Success", Information and Software Technology, Vol. 42, No. 14, pp. 983-992, 2000. Paper selected for journal publication from ESCOM 2000.

Von Mayrhauser, A., Ohlsson, M. C. and Wohlin, C., "Deriving Fault Architectures from Defect History", Journal of Software Maintenance.

Von Mayrhauser, A., Wohlin, C. and Ohlsson, M. C., "Assessing and Understanding Efficiency and Success of Software Production", Journal of Empirical Software Engineering Vol. 5, No. 2, pp. 125-154, 2000.



## Software Architectures

The architecture of a software system interacts with many factors. Examples include project organization, tools, development methodology, and historical background. The efforts within LUCAS aim at taking a holistic viewpoint and balancing these different aspects.

Part of the work is based on benchmarking between companies. Thereby the researchers explore and evaluate different approaches to solve upcoming problems with respect to the software architecture. The practitioners involved in the work learn from each other and may based on this gained knowledge improve their way of working in industry. ABB, Ericsson Mobile Platforms, Telelogic and Q-Labs are involved in the work.

The project is managed by the adjunct professor from Q-Labs who is involved in LUCAS. Within the actively ongoing so called LUCAS Architecture Academy, LAA, representatives from the involved companies exchange experiences, problems, and architectural solutions. The sessions have formed a unique meeting-place for the involved companies, with connections to research in academia.

### Staff

Enrico Johansson, Dr. Martin Höst, Prof. Even-André Karlsson

### Partners

ABB Automation Technology Products, Ericsson Mobile Platforms, Telelogic, Q-Labs

### Publications

Johansson, E., Wesslén, A., Bratthall, L., Höst, M., "The Importance of Quality Requirements in Software Platform Development - A Survey", In proceedings of Thirty-Fourth Hawaii International Conference on System Sciences (HICSS-34), Software Architecture Minitrack, Maui, Hawaii, 3-6 January, 2001.

Bratthall, L. and Wohlin, C., "Understanding some Software Quality Aspects from Architecture and Design Models", 8th International Workshop on Program Comprehension, Limerick, Ireland, 10-11 June, 2000.

Blomdell, A., "Eager evaluation considered harmful", Technical Report ISRN LUTFD2 / TFRT—7590—SE, Department of Automatic Control, Lund Institute of Technology, Lund, Sweden, March 2000.

## Java Activities

An overall strategy to enable use of modern object-oriented implementation methods for real-time embedded systems is a goal in several of the activities. These activities include implementation techniques for small targets as well as tools and methods for analysis and design of such systems and, of course, experiments on actual hardware.

The LUCAS approach to real-time Java differs from other proposals such as RTJ ([www.rtfj.org](http://www.rtfj.org)) in that we maintain a uniform object model and programming API even for small embedded systems, which is very crucial for the so called **vertical integration** in automation systems.

Encouraged by successful experiments during 2001, we are eager to continue the efforts in close collaboration with our industrial partners. The first product using our techniques is expected during 2002.

#### Staff

Dr. Görel Hedin, Anders Nilsson, Torbjörn Ekman, Prof. Boris Magnusson, Dr. Klas Nilsson, Anders Ive, Andes Blomdell

#### Partners

Ericsson Mobile Communication, BlueCell, ABB Automation Technology Products

#### Publications

Hedin, G. and Knudsen, J. L., "On the Role of Language Constructs for Framework Design", ACM Computing Surveys, Symposium on Object-Oriented Application Frameworks.

Nilsson, A. and Ekman, T., "Deterministic Java in Tiny Embedded Systems", In Proceedings of ISORC 2001, 4th IEEE Symposium on Object-Oriented Real-Time Distributed Computing.

Cornils, A. and Hedin, G., "Statically Checked Documentation with Design Patterns", In proceedings of TOOLS Europe 2000, the 33rd International Conference on Technology of Object-Oriented Languages.

Cornils, A. and Hedin, G., "Tool Support for Design Patterns based on Reference Attributed Grammars", In proceedings of WAGA'00, Workshop on Attribute Grammars and Applications.

Persson, P., "Predicting Time and Memory Demands of Object-Oriented Programs", Licentiate Thesis, Lund Institute of Technology, Lund University, Lund, Sweden, 2000. ISSN 1404-1219, Dissertation 12, 2000.

Persson, P., Hedin, G., "An Interactive Environment for Real-Time Software Development ", In Proceedings of the 33rd International Conference on Technology of Object-Oriented Languages and Systems TOOLS Europe 2000), Mont St. Michel, France, June 2000.

## Course Activities

During 2000-2001 four combined industrial seminar series and graduate level courses have been given as a means to stimulate the exchange between industry and academia:

- ABB Automation Products have initiated the course **Programming Language for Automation**
- ConnectBlue and LUCAS have jointly given the course **Bluetooth in Industry**.
- The **LUCAS Software Architecture Academy** has been initiated in collaboration with Q-Labs. The Architecture Academy aims at providing education to the software architects among LUCAS gold and silver members as well as feedback and industrial contacts for the researchers and the graduate students.
- The course on **XP-coaching** has attracted several participants from the LUCAS companies.

Some of the courses are further developed and will be given again and, parts will be integrated to undergraduate education.

#### Staff

Dr. Görel Hedin, Prof. Even-André Karlsson, Prof. Karl-Erik Årzén

#### Partners

ABB Automation Technology Products, connectBlue, C Tehnologies, Ericsson, Q-Labs, TAC

## Undergraduate Education Development

Most of the members of LUCAS are also active in the undergraduate education. The competences of LUCAS researchers are here used to develop and give advance courses. Courses in the area of real time programming, real time systems, advanced software engineering and programming languages are typical among these. During year 2001 a number of new courses were developed by LUCAS staff:

- Compiler Construction
- Computer Graphics
- Configuration Management
- Game Engine Technology
- Language Processing and Computational Linguistics
- Programming in Teams
- Requirements Engineering
- Verification and Validation
- Software Quality
- Software Engineering Process

### Staff

Ulf Asklund, Dr. Lars Bendix, Dr. Görel Hedin, Dr. Martin Höst, Prof. Boris Magnusson, Dr. Björn Regnell, Dr. Per Runeson

### Publications

Höst, M., "Introducing Empirical Software Engineering Methods in Education", Proceedings of Conference on Software Engineering Education and training (CSEE&T), Feb. 25-27, Covington, Northern Kentucky, USA, 2002.

Runeson, P., "Experience from Teaching PSP for Freshmen", Conference on Software Engineering Education & Training, Charlotte, NC, USA, 2001.

Runeson, P., "A New Software Engineering Program - Structure and Initial Experiences", Proceedings of the 13th Conference on Software Engineering Education & Training, pp. 223-232, Austin, Texas, USA, March, 2000.

Runeson, P. (redaktör), "Industriell programvaruteknik, - Forskningsresultat i kortform", NUTEK Förlag 2000. ISBN B-91-7318-3350. (in Swedish)

## Research Methodology

The research within LUCAS is conducted with the aim to develop engineering solutions to industry relevant problems. Controlled experiments are conducted to evaluate methods in-the-small. Surveys are launched to get a broad overview of current practice in software engineering. Pilot systems are built to evaluate technologies and research solutions. Case studies are conducted to evaluate how the research results apply to industrial use.

LUCAS researchers also develop the research methodology forwards. The first book on experimentation specifically in software engineering was published by members of LUCAS in the year 2000. Inclusion of quantitative research methodology into the rather technical research field is underway.

### Staff

Dr. Per Runeson, Thomas Olsson, Dr. Martin Höst, Dr. Björn Regnell

### Publications

Olsson, T., Runeson, P. "V-GQM: A Feed-back Approach to Validation of a GQM Study", International Software Metrics Symposium, April 2001.

Runeson, P., Ohlsson, M. C., Wohlin, C., "A Classification Scheme for studies on Fault-Prone Components", In Proceedings of International Conference on Product Focused Software Process Improvement (PROFES01), Kaiserslautern, Germany, pp. 341-355, 2001.

Höst, M., Regnell, B. and Wohlin, C., "Using Students as Subjects - A Comparative Study of Students and Professionals in Lead-Time Impact Assessment", Empirical Software Engineering, Vol. 5, Issue 3, pp. 201-214, 2000.

Wohlin, C., Runeson, P., Höst, M., Ohlsson, B., Regnell, B., Wesslén, "Experimentation in Software Engineering - An Introduction", Kluwer academic publisher, 2000.

## Seminars and Tutorials

In order to share the results of LUCAS research, and to continue a dialog with other companies, academic partners and organizations, seminars and tutorials related to the center are provided. The seminars normally take 60-90 minutes and the tutorials normally take half a day to one day. During 2000-2001 about 40 external seminars or tutorials were given.

Example of seminar titles:

- A Market-driven Requirements Engineering Process - Results from an Industrial Process Improvement Programme
- An Overview of Inspections and Reviews
- Estimation of Fault Content after Inspections
- Integrated Control and Scheduling
- Systematic Software Testing
- The Relationship between Requirements and Testing
- Evaluation of Software Process Change Proposals

- XP - eXtreme Programming
- Design Patterns and Frameworks
- Language Support for Application Framework Design
- Interactive Language Development for Embedded Systems
- Java and Real-time Systems
- Distributed Development and Configuration Management
- Using Automatic Memory Management in Hard Real-Time Systems
- Hardware/Software Co-design
- Constraint Programming- A New Programming Paradigm

Examples of tutorials:

- Empirical Evaluation of Software Technology
- Requirements Engineering Essentials
- Real-Time Control Systems
- Software Processes and Software Process Improvement
- An Introduction to Automatic Memory Management Techniques

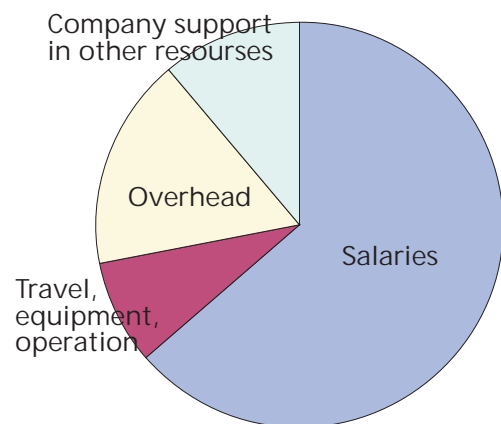
#### Publications from LUCAS 2000-2001

Dr. Thesis	1
Lic. Thesis	7
Books	3
Journal papers	22
Conference papers	56
Technical reports	7

# The Economy & Funding of LUCAS 2000-2001

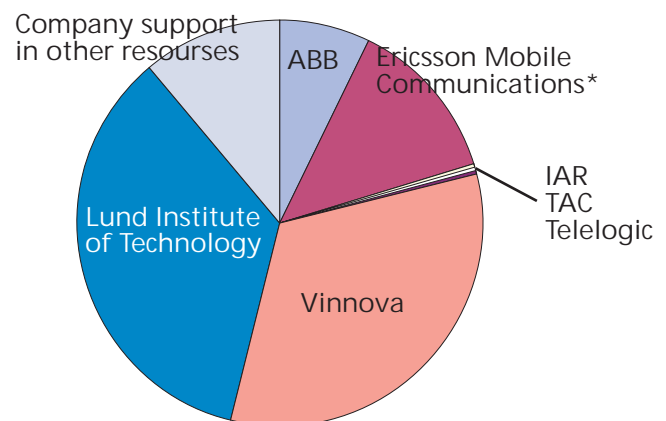
## Costs (kkkr)

Salaries	14 483
Travel,equipment, operation	1 908
Overhead	3 870
Company support in other resources	2 598
Total	22 858



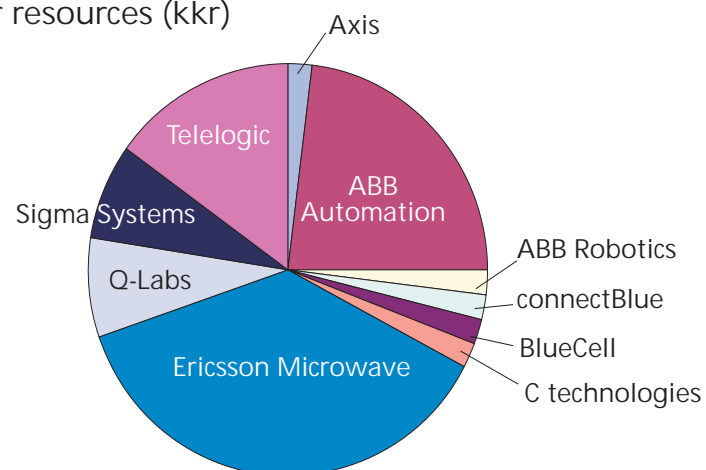
## Financing (kkkr)

ABB Automation	1 650
Ericsson Mobile Communication, Lund*	3 000
IAR	50
TAC	50
Telelogic	50
Vinnova	7 500
Lund Institute of Technology	7 960
Company support in other resources	2 598
Total	22 858



## Company support in other resources (kkkr)

Axis	50
ABB Automation	600
ABB Robotics	50
connectBlue	50
C Technologies	50
BlueCell	50
Ericsson Microwave	960
Q-Labs	200
Sigma Systems	200
Telelogic	388
Total	2598



Related funding of research at the departments of Automatic Control, Computer Science and Telecommunications, year 2000-2001 (kkkr).

Vinnova/Promodis:	2 952
SSF/Artes	960

\* Split into Sony Ericsson Mobile Communication and Ericsson Mobile Platforms from October 2001





## Addresses

**Internet:** [www.lucas.lth.se](http://www.lucas.lth.se)

**Phone:** +46 46 222 00 00 (vx)

**E-mail:** [lucas-info@cs.lth.se](mailto:lucas-info@cs.lth.se)

**Fax:** +46 46 13 10 21

**Mailingaddress:** LUCAS Lund University, P.O.Box 118, SE-221 00, Lund Sweden

**Visit:** Lund Institute of Technology, E-huset (The E-house), Ole Römers väg 3, Lund

## Contacts @ LUCAS

### **Professor Boris Magnusson**

Department of Computer Science

Phone +46 46 222 80 44

E-mail: [boris.magnusson@cs.lth.se](mailto:boris.magnusson@cs.lth.se)

### **Professor Karl-Erik Årzén**

Department of Automatic Control

Phone: +46 46 222 87 82

E-mail: [karl-erik.arzen@control.lth.se](mailto:karl-erik.arzen@control.lth.se)

### **Associate Professor Per Runeson**

Department of Communication Systems

Phone: +46 46 222 93 25

E-mail: [per.runeson@telecom.lth.se](mailto:per.runeson@telecom.lth.se)

### **Project Secretary Jonas Wisbrant**

LUCAS

Phone: +46 46 222 34 83

E-mail: [jonas.wisbrant@cs.lth.se](mailto:jonas.wisbrant@cs.lth.se)



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Lund University