THE NUFFIELD FOUNDATION

Undergraduate Research Bursaries Final Report

The purpose of the bursaries is to give experience of research to undergraduates with research potential and to encourage them to consider a career in scientific research. At the end of the bursary the supervisor and student should complete this brief report for the Nuffield Foundation. Bursars may wish to prepare a more detailed report for themselves and their supervisors but these do not need to be sent in. Sections of the report may be used on the web site or in publications to promote the scheme, therefore photographs of the bursar working on the project or to illustrate the subject area would be very welcome.

Please return this form and the Institution's financial statement by 1 November to: Joanne Campbell (URB), The Nuffield Foundation, 28 Bedford Square, London WC1B 3JS
We regret we are unable to accept fax or e-mail versions.

1	Name:	Dr Gerald Luettgen	Year of Bursary:	2004
	Department:	Computer Science	Grant Ref:	**URB/01528/G**
	Institution:	University of York		
	Student Name:	David White		
	Student Dept & Instn (if different from above):			
	Project:	Integrating databases into the synchronous paradigm for reactive-systems programming		
2	A summary paragraph describing the project and its outcomes, written in language easily understood by the lay reader (not more than 150 words).			
	A current limitation in embedded/reactive systems design is the lack of database support integrated into design tools. This project has researched and developed mechanisms for accessing the relational database mySQL within the synchronous language Esterel, which underlies the popular Esterel Studio tool. The focus was on providing an as general as possible Applications Programmer Interface (API) for database use inside Esterel. Due to the variety of ways for passing back results from the database to the Esterel program, two APIs were defined to take account of different situations. Both APIs were tested in a case study modelling a warehouse storage system, in which a database is employed to retrieve information about customer orders and item locations. A robot uses this information to automatically pick a customer's order from the items in the warehouse. The system was implemented in the Lego Mindstorms Robotics kit and programmed in Esterel.			
3	Supervisor's account of the work done during the bursary and a brief assessment of its outcomes.			
	David White has approached the project in a very professional manner and has closely stuck to the project plan set out in the proposal. He first assessed the technical difficulty of extending the Lustre language of the SCADE design tool, as originally planned, and compared it to the one regarding the Esterel language and the Esterel Studio tool. The finding has been that Esterel is quite extensible, while Lustre is not, and has led him to focus on Esterel rather than Lustre/SCADE. David has then investigated several ways for defining Applications Programmer Interfaces (APIs) for using databases inside Esterel, each of which provides functions such as submitting database queries and processing query results. The conduct of the case study has turned out to be more challenging than expected. One difficulty has been to achieve a reliable communication between PCs and Lego Mindstorms RCX bricks. This has required David to develop a communications protocol for reliable communication, which is layered on top of the rather unreliable public domain protocol for the task. In addition, developing the warehouse robot, requiring very precisely controllable movements, has taken significant effort. While David has mastered the challenges, the technical report promised in the project proposal could only be drafted in time of the end of the project and will be published later this year. I am fully satisfied with the good quality research results produced by David, which are the more remarkable given the project's tight time scale and technical difficulties with some of the public domain software employed. David has clearly demonstrated the feasibility and utility of integrating language constructs for accessing databases, as well as for processing query results, within synchronous languages for embedded/reactive systems design. Equally important, both of the developed APIs are written in a way that they can be reused in future research projects related to embedded systems programming, and may also play a role in teaching.			
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4	Student's comments on the bursary experience, including what has been learnt, influence on future career, interest in scientific research or PhD training. Other comments on the experience, the scheme and careers in science are also welcome.

I greatly enjoyed my research over the summer; this was because of the interesting subject I was able to pursue and also having the freedom to approach it in a way that suited me. I appreciated being able to concentrate on only one problem for a time, in contrast to the projects within my degree course where time spent on project project has to be balanced with modules. I learnt a great deal from the bursary experience, expanding my knowledge of Computer Science both in the mainstream fields (Linux, databases, C programming and communications protocols) and the specialist field of synchronous reactive systems programming (Esterel). The knowledge I have gained in Linux , C programming and general communication protocols will be useful for my 4th year. This is especially true for my 4th year project which requires me to implement a solution to the parallel reinforcement learning problem. Below is a list of the main skills I felt I gained from the bursary experience.

Skills Learnt:

Improved knowledge of Linux by building software such as MySQL, using cross compilers to build BrickOS and device drivers for enabling the Lego Mindstorms infrared download tower to perform communication between the PC and Lego RCX.

Esterel programming language and the C interface it automatically generates.

MySQL C API.

SQL / MySQL Administration.

Perl, by building the C wrapping code around an Esterel reactive kernel.

Communication between RCXs and PC using LNPD and BrickOS .

Influence on my future career:

Thanks to my brief taste of research provided by the bursary, I am seriously considering doing a PhD after my undergraduate degree. So far I have not had a chance to find out what Computer Science in industry is like and therefore I am still undecided about my long-term career. However, I greatly enjoy university life and the opportunities it provides, so in the short-term I will probably stay in academic research after my graduation.

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5	A list of publications and presentations planned or produced, intellectual property arising and the use of the results in proposals to other funding bodies or for collaborations. The Foundation would also be pleased to know of any broader dissemination of the bursary and its outcomes.
	On the basis of his research conducted with support of the Undergraduate Research Bursary, David White has been invited to attend and to give a demonstration at the annual international workshop on Synchronous Languages, Synchron'04, which will be held at Schloss Dagstuhl in Germany in November/December 2004. A technical report describing the results of David's research is currently being finalised and will be published by the Department of Computer Science at the University of York shortly. In case of a positive reaction of the scientific community at Synchron'04 to David's research, the mentioned technical report will found the basis for a paper submission to the international workshop on Synchronous Languages, Applications and Programming, SLAP'05, which is co-located with the renowned ETAPS conferences and will take place at Edinburgh in April 2005.
6	A comment on the value of the bursary to the supervisor and research group (including future directions or continuation by a PhD student, post-doc or others).
	The bursary has been very valuable to the supervisor and his research team in embedded/reactive systems design and validation. On the one hand, it has provided many insights into current commercial design tools and their flexibility for extension and customisation, in particular regarding the access of databases within synchronous languages. On the other hand, it has produced quite complex artefacts that can assist in the teaching of the subject matter of embedded/reactive systems design. While this project has been, to the best of my knowledge, the first one to explore database access within sycnhronous languages, its impact on future research is difficult to judge at present. Much will depend on the reception of the project's results at the Synchron'04 workshop in late November/early December, where also representatives of commercial design tool developers will be present. The project may well be continued as part of a future PhD project which will look into the semantical rather than the practical issues of integrating databases into synchronous languages. The project's results and the produced artefacts will partly be reused in an upcoming forth-year student project, which will investigate issues of communication between several Lego Mindstorms RCXs.
	Student Signature: …… **Date**: …….. **Supervisor Signature**: …… **Date**: ……..
7	Financial Details Grant Awarded: £1450 This report should be accompanied by a financial statement from the Institution, which relates actual expenditure to the grant awarded. At the end of the grant, any outstanding balance of more than £50 should be returned to the Foundation.

Financial statement attached	YES/NO	YES	Grant Balance Amount £0 returned	YES/NO	NO