Queen's Award Presentation

C.A.R. Hoare

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My Lord, Ladies and Gentlemen

The Queen's Award for Technology is the highest recognition which this Country can offer to a team of scientists and engineers who by their brilliance of insight and invention and by their pertinacity in execution and implementation have achieved a major advance in the state of the art, and then applied it to the economic benefit of industry and thereby of Society.

So it is just and proper that you, as the representative of Her Majesty, should make your presentation of the symbol of the award to Bill Roscoe, the leader of the team responsible for the work. It is just and proper that you have in your presentation address emphasised the significance of their achievement and the outstanding qualities of the work of the immediate members of the team: Geoff Barrett and David Shepherd now working for Inmos, and Tony Cox and Michael Goldsmith now working with Formal Systems Limited at Oxford. It is they who have earned the congratulations and honour conferred upon them today.

But the Queen's award is presented not just to a single leader or just to the team which carried out the work: it is attributed to the entire Laboratory or Institution or company within which the project was accomplished. It is the Computing Laboratory and Inmos Ltd. which will enjoy the privilege in the next five years of proudly bearing and displaying the coveted insignia of the award.

And this too is only just and proper, because outstanding achievement in this technological age is hardly possible except within a community of scientists who provide the intellectual atmosphere and material support for the pursuit of excellence - its nurture and fostering until it flowers and yields its fruit. A prize in a Flower show does not honour just a single bloom, but also the work of the breeders of the plants, and the preparers of the soil and the sowers of the seed and growers of many other plants and shrubs and trees, whose quality closely matches that of the winner of the award; often the only reason why they remain in relative obscurity is one of policy or timing or chance. But the laws of chance are very fair; they dictate that most of the highest awards will be won by the companies and laboratories which are engaged in a large number of projects of award-winning quality. At any given time some of them are just the seeds of ideas; some are sturdy growths; some have reached their prime; and others have already yielded their fruits in full abundance, and been replaced or overtaken by yet further advances.

So in accepting the prize on behalf of the Computing Laboratory, I would like to record and give credit to the work and achievements of all its members, the teachers, the students, the research and the general support staff, without whom no such significant advances would be possible.

But most importantly I would like to give the due credit to our partners in this project, the Inmos Company, its founder Iann Barron and its chief architect David May. The foundation of the Company was based on a technological insight which I share that the future of computing lies in concurrency; that the new problems of controlling massively parallel computations can be met by basing the design and architecture of a range of computers upon a sound and elegant mathematical theory, embodied in a new and simple programming language. This theory has been explored not just by a safely graded series of experiments, but by staking the whole future of the Company on the resulting range of products. And the theory and language were not only the basis of the externally announced design; they were used extensively in the specification, structuring, design, simulation and implementation of all parts of the product. The floating point unit of the T800 was only just one of the parts of just one of the products: similar new insights were applied to an appropriate degree to all the other parts of all the other products in the range. We salute the courage and perseverance of Inmos, the whole Company and all who work for it, in pursuit of a technological ideal through the many vicissitudes of commercial life.

Now I would like to say some nice things about my colleagues in the Computing Laboratory, and in particular in the Programming Research Group. The Group was founded by Christopher Strachey in 1965, and we are celebrating this year, like the Queen's Award itself, our twenty fifth anniversary. On Christopher's tragic death, I had the privilege of appointment as his successor. On my arrival I found in his desk drawer a draft of a submission for his main research grant, and lit upon the following words:

"It has long been my personal view that the separation of practical and theoretical work is artificial and injurious. Much of the practical work done in computing, both in software and in hardware design, is unsound and clumsy because the people who do it have not any clear understanding of the fundamental design principles of their work. Most of the abstract mathematical and theoretical work is sterile because it has no point of contact with real computing. One of the central aims of the Programming Research Group as a teaching and research group has been to set up an atmosphere in which this separation cannot happen."

Christopher Strachey and his colleague Joe Stoy had succeeded admirably in achieving this goal; and I immediately adopted it as my own. It has inspired me throughout the remarkable and rapid growth of Strachey's subject at Oxford, and I hope I have passed on that inspiration to all my colleagues recruited since. The attempt to balance practice with theory may give the impression that our Laboratory is more theoretical than most. It is certainly true that all our lecturers and researchers are motivated by the belief that our subject of Computing is a proper Engineering science. Like all such branches of Science, it thrives on the fruitful interaction between mathematical theory and the engineering of useful applications. The goal of research in theory is to reduce and master complexity by classification, abstraction and formalisation; and the goal of research in practice is to increase the effectiveness, efficiency and reliability of products by organisation, invention and judgment based on experience. Advances in technology, as well as the needs of application, are a constant stimulus to the development of new theory; and the theory in turn provides the basic understanding, conceptual framework and common terminology needed by engineers for discussion of ideas and communication of decisions among specialists. Even more, the theory is needed for education and training of the professional of the future, as well as for derivation of mathematical equations and formulae to guide and validate all stages of professional practice.

Theoretical research is best conducted individually by long periods of thought in the privacy of our own studies. But there must be frequent and seemingly random discussion with sympathetic specialists in other related branches of theory. I believe that our Laboratory is characterised by the number of interlinked and informal discussion groupings, providing valuable support and assistance and confidence to each of its members. We enjoy within the group a remarkable homogeneity of goals and methods, and a remarkable complementarity of skills and experience.

But equally important are strong links and frequent interactions with specialists in unrelated or even rival theories; and more important still are strong links with yet wider classes of engineer and practitioner, - the users of computers, who are the people who might be able to benefit by putting selected combinations of our theories into practice.

And it is in this that the Computing Laboratory at Oxford is truly remarkable. As a Computing Science Department, in spite of a rate of growth that has been meteoric by Oxford standards, we are still relatively small in comparison with other leading Universities throughout the world. In the last ten years this small Group has set up three new degree courses at the University of Oxford, an institution in which in the old days the expected period for thinking about even a single new degree could be half a century or more. At the same time our research has won the highest national and international acclaim.

This is because both our teaching and our research have been inspired and enhanced by the intensity of collaboration with outside industry; with researchers in other leading laboratories in Europe; and with other departments of this same University, whose research depends on advanced computer application.

In addition to our normal pure research funded by SERC, the Group is contracted to engage in some twenty collaborative projects. Our first and most significant collaboration has been running for over ten years, funded by IBM (UK) Limited. The results of this research, like that which has won the award, have also been installed in industrial practice; and according to the latest reports, the Company is beginning to reap the rewards of their foresight and courage in the form of measurable reductions in production cost and measurable improvements in product quality of one of their most successful software products.

More recently started collaborations include four other projects directly funded by outside industry in Britain and the US. Another four collaborative projects are funded from national sources (jointly by SERC and DTI) and no less than eight projects are funded by the European Commission (Esprit II), five of them under the umbrella of basic research actions. These projects alone bring us into regular scientific exchange with some 45 separate university groups (including some duplicates) and 25 separate industrial groups throughout Britain and Europe. This is a record which would be enviable in a department twice our size; and with only a half of our responsibilities for course development.

This leads to the main point which I want to make in this speech of acceptance and thanks. Our collaboration with Inmos is only one of many similar projects. It is the same scientific and social goals that are pursued in each of our twenty collaborations and by each of our seventy partners. It is the same integrity and objectivity in adherence to valid scientific principles; and the same perseverance and concentration of intellectual endeavours on their successful application. In all these aspects our other projects aim at the same standards as the project which has won the award; and come very close to achieving them.

And so it is with great pride and some trepidation that on behalf of my many colleagues in the Computing Laboratory I accept this Her Majesty's gracious award for technology. My pride is in the achievements of all; my trepidation is also shared by all because we know how much there still remains to achieve. We are inspired and encouraged by the Award, and we are determined that by our future efforts we will continue to be worthy of it.

To pride and trepidation we add one more powerful emotion - gratitude - to the Queen and the Prime Minister and their advisors for their recognition of our work. And to you, Sir Ashley, we will be doubly grateful if you would convey our humble respects and appreciation to her Majesty.