

# **Business Computing: the Second 50 Years**

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## **Conference Proceedings**

### **What have we learnt in 50 years?**

#### **Panel members**

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Keith Marlow Head of UKIE Engineering, Yahoo

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Roger Watson Head of Strategy and Planning, eBusiness, BT Ignite

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## Conference Sponsors' Panel: What Have We Learnt in 50 Years?

Chairman Chris Yapp (ICL Fellow, Lifelong Learning)

Members James Feeney (Adviser)  
Michael Gough (Chief Executive, National Computing Centre)  
Keith Marlow (Head of UKIE Engineering, Yahoo)  
Peter Morriss (Partner, KPMG)  
Roger Watson (Head of Strategy and Planning, eBusiness, BT Ignite).

Chris Yapp

I've asked the panellists to introduce themselves and then to open up with about five minutes each on their initial thoughts on the lessons that we have learnt over the fifty years.

James Feeney

My name is Jim Feeney. I started as a programmer with LEO some forty years ago and moved on to a company called Hoskyns, where I became Chief Executive, it's now part of Cap Gemini. For the last twenty years I have operated as an investor and part-time director in a variety of high-tech companies both here and in the United States.

I think lesson number one is that we've learned that we are not very good at programming. The dramatic decreases in cost of hardware and of communications bandwidth have not been mirrored in our ability to develop and build systems to time and budget. That's not for the want of effort and there have been a lot of false dawns and blind alleys that we've gone down. Modular programming, program generators, formal methods, logic programming, object oriented programming - but still we have difficulty in making reliable estimates, particularly on large scale projects. It's difficult because programming is still a design rather than a manufacturing process, but we must certainly try in the future to make greater use of software tools and package solutions. There is also hope now that the vast increases in hardware capability and the reduction in cost will enable us to move towards reliable reusable components, no longer being constrained by the need for efficiency on the hardware front.

I think the second thing that we've learned is inadvertent. One of the great blessings to the industry over the last fifty years was the Justice Department's consent decree with IBM. It did tie at least one of its hands behind its back. Had IBM been unconstrained we would have never had the minicomputer let alone the micro and then the PC. Microsoft has inadvertently or otherwise inherited that monopoly position from IBM with none of the constraints from the Justice Department. It's not just Microsoft, Oracle is in a very dominant position and there are companies like SAP as well. I think we do need a strong competition policy and that's not going to come from the United States, I think that Europe has a part to play in it.

Michael Gough

I have twenty years in the IT industry. I am Chief Executive of the National Computing Centre. I'm on the Board of Directors of the Association of Independent Research and Technology Organisations. I'm also a director of the DSDM consortium, one of the only organisations in the UK that is actively pursuing an interest in methodological development. Previously I was the technical director for Sema Group in the UK.

It's the National Computing Centre's thirty-fifth anniversary this year. Thirty five years ago there was a small number of dominant manufacturers, a lack of useful software and a skills shortage. One might say a similar situation to today. During that thirty-five year period we've moved through an era where we were focused on computing and computational solutions into data processing, into IT, then with the convergence of the telecom sector into what we now know as ICT, and next is supposed to be knowledge management. There are some common themes that arise from all of this. One of the underlying problems is information management. We seem to have been very good at accelerating the pace of information capture and dissemination but very poor at unravelling what it all really means.

Another theme is that we seem to learn best when we share our learning with each other. In the sixties, when NCC was formed, there was tremendous risk aversion in business management in the UK to the adoption of IT. And in recent circles that I've been mixing in within the CBI I still find the same kind of mood. Senior managers are not enthusiastic about e-business and e-commerce. That's a problem that we have to deal with.

At the end of the day success with projects relies on understanding how to apply technology and how to manage processes, and that's the world of methods. Although we've had various incarnations of methods over the years, structured design methods and SSADM and so on, it still is a major bugbear to me that we have very few design methods that allow us to create repeatable processes for systems development.

The final point I'd like to make is about change. Transition over the decades and over different computing platforms has created step changes in capability. We need to get better at managing the change that occurs in business as a consequence.

Keith Marlow

I'm head of UK engineering for Yahoo. Depending on whether you count the first computer program I sold as the beginning of my professional career, I've been involved in computers for about twenty years. I'm in charge of looking after the UK servers, making sure the site works and dealing with future developments.

I've got four points. The first is, I remember from an early age that there was this vision of a paperless office, that paper would vanish. That hasn't happened, we are knee-deep in the stuff and it gets worse and worse with every passing year. We are still bound to a lot of paper-based procedures. We still have to move paper from department to department, put things in the post etc. Is there an alternative available out there? I don't know.

The second is information overload. We seem to be very good at generating e-mails, spamming people, sending information left, right and centre, but the mechanism of indexing this information and keeping track of it lags behind. Even the best search engine on the Internet is a minimum of three months behind what is actually out there.

The third is technical project management. In Yahoo we don't actually employ a very hard line technical style of management, we recognise that it's a creative process. Other companies are developing new technologies, so if you have a hard specification of what you are planning to implement over the next year, guess what? At the end of the year what's available for you to implement has changed. Very difficult problem.

And the fourth one is education. When I was doing my A-level in computer science I was taught about tape drives. I've yet to see one in my professional career. Now, several problems there. Teachers base their teaching on their past experience. But the sheer pace of change that we've got in technology quickly makes that irrelevant. As a result everyone going into a new employment has to be trained by the particular company to get up to a reasonable level of proficiency in the technologies that are there. Then of course they are on the treadmill and training has to keep on going. So that's my four points.

Peter Morriss

I'm from KPMG where I head the information risk management global team. I qualified as a Scottish chartered accountant in the City and I entered my computing career in about 1967. I've just finished forty years in my professional life, so it encompasses accounting and computing.

I've got four, not so much lessons we've learned, but areas of interest, because I think learning is very much a continuing process. My first one is whether we've paid enough attention, and still pay enough attention, to the human element in the business computing process. Right across the board, from the user requirements to design and implementation. The integration of the people element of that whole process is the one difficulty that repeats whatever the new wave of technology happens to be.

The second is the importance of project management. Businessmen are looking, quite rightly, for a payback. They are looking for benefits realisation (the methods we seem to have developed to measure benefit realisation are probably more imaginative than the benefits!). But the timeframe over which the benefits of very large complex investments can be realised seems to be becoming increasingly compressed, which threatens the whole of our business of using computing for commercial reasons.

The next area is all about security and control. The problem we've had for many years over security and control in computer systems is that it's something we try and put over the top after we've developed the system. If security isn't part of our original architecture it will never succeed and will be much more of a cost than a benefit. So from the audit perspective, and the management perspective, we need to take an integrated or holistic view of that element of our system design.

And the last one, which affects all those involved in e-commerce in any shape or form, is how we work together to achieve what I like to call a community of trust. Without a community of trust, which can be established and in some way monitored to the satisfaction of those who wish to use it, we are going to continue to have a hold-back on the rate of business progress using e-commerce.

Roger Watson

I'm from BT, a representative of the telecommunications industry. I'm head of strategy and planning for our e-business activities. If man is to be known from his works you'll know me from the 1471 call return service and the 1571 call minder service, and I hope there are many satisfied users of those services here today.

It is, of course, a lot more than fifty years ago that my corporate ancestor, the Engineer in Chief of the Post Office, gave his measured view that the Americans may have need of the telephone, but we do not: we have plenty of messenger boys! As it happens we are fifty years on from a milestone in the telecommunications industry as well as in the computing industry. The Telephone Act of 1951 gave the telephone its first ever, if you can believe this, recognition in UK law, as something in its own right. It was previously treated as an extension of the telegraph. It was also in that year that the first answering machine was unleashed on a grateful UK public. So this does seem an appropriate time to be thinking about what we've learnt in telecommunications as well as computing.

So what have we learnt? Well, I think culturally one of the most significant things is, if you'll pardon the sloganeering, that it really is good to talk. Over the last ten years the price of a call has roughly halved in real terms, and we've seen the number of calls made more than double commensurately. The point here is that we always used to think that we British would never spend all day on the phone like the Americans, basically because we weren't friendly enough. But now we know that given the chance we are actually quite a sociable nation. We've seen this with mobile phones as well, make them affordable and suddenly everyone's on the phone all day.

Talking of friendly, forty-two years ago, in 1959, the Post Master General presented his so-called Friendly Telephone Policy. Subscribers were henceforth to be known as customers and operators were, for the first time, to be allowed to bid their customers Good Morning. Previously they'd only been able to communicate using crypto-instructions such as Number Please. And this was the start of one of the things we've learnt, which is at least the ideal of customer service. This did prove to be a bit of a false dawn and things slipped back to the point where you could wait eighteen months for a new phone line here, in the City of London. Going to show, I think, that not all new learning is handed down between the generations. But I think it is fair to say now that the customer is king, at least so long as he is prepared to give his commands to a computerised courtier.

We have seen technology replacing people in our industry, particularly over the last twenty years, and in BT to the extent that half the number of people now run a business twice the size compared to ten years ago. What we have learnt, and this applies, I think, across a lot of industry, is that this has not had the expected effects on our leisure time. It was expected that technology replacing the mundane things that people do would save one hundred per

cent of people fifty per cent of their time. It's actually saved fifty per cent of people one hundred per cent of their time. We now increasingly have the divide between the time-rich and cash-poor on the one hand and the time-poor and cash-rich on the other, which is not at all the effect that we were expecting.

Of course, replacing technology with people has enabled us to do things we otherwise simply wouldn't have been able to. My great-grandfather's telephone number was 2. Now, that same telephone number is \*\*\*\*490262. To switch today's volumes of calls manually would require the entire population to act as operators. We have learnt that technology can bring us enormous potential to do things we never thought we could do - or even wanted to do. What perhaps we haven't learnt is that the impact of technology is not foreseeable. I suspect that while the Internet will bring opportunities for huge cost savings, most of those savings in a competitive economy will flow through to consumers, and businesses will have to find whole new ways of generating value. As Gary Hamel has said, too many businesses for too long have made customer ignorance a profit centre. We can now see a future where there is no such thing as a weak customer, or an ignorant customer. We, the industry, need to look beyond processor speed and bandwidth, to ask ourselves how we can improve the human lot itself. Picasso famously said computers are useless, they can only give you answers. I am certainly looking forward to debating with you today what some of the questions might be.

Chris Yapp

Let me add one point to that list of lessons: the role of standardisation in our industry. In order to be able to move on, standardisation is very important, both in terms of de facto and de jure standards. Standardisation bodies have big problems in getting their de jure standards processes to work at the pace at which the industry works, but market-based, de facto standards encourage the tendency to monopoly, whether they come from IBM, Microsoft, Oracle, or any of the others.

Let me now throw the floor open to you, for your questions.

Frank Land (London School of Economics, and also LEO Foundation and LEO Society)

I am wondering to what extent we have the capability of learning? We keep seeing the same mistakes being repeated, and incidents of computer failures are still at the same sort of level as they were years ago. Why don't we learn from these earlier mistakes?

James Feeney

I think we are overly ambitious in many cases. Because something can be built we think it ought to be built. Many major projects have suffered from that. My former boss John Hoskyns, before he went into politics, said return on capital was the wrong measure, you should measure the IT industry by return on IQ, and you'd find that it was very poor. Our industry did bring in a vast number of very talented people and competitive pressure caused many, many, companies to overreach themselves. If you weren't going to promise it, the

competitor down the road would. And there's a question of educating users, as well as programmers and project teams and suppliers.

Chris Yapp

I think there is a more general pattern at work here. Any given cohort learns a way to do things and then the next cohort reacts against that, which you might regard as a deliberate unlearning, and then the next one again goes back to, and builds on, the previous generation but one's. But as to whether we can learn, well, by the normally accepted measures, like wealth or productivity, I guess the data shows that we do. Because gradually, over time, we seem to get better, at least at the output level.

I'd add that back in 1985 I became project manager of the National Unemployment Benefit System, and because of the perennial skill shortages I hadn't time to be trained in being a project manager. I delivered that project, 912 mini-computers, 12,000 terminals and 200 man years of software, in two years, on time and below budget. And then, having done it, was allowed to go on a project management course. What was interesting was that none of what I was taught on that course was relevant to actually delivering the project. None of the human factors elements that I'd found relevant to being a project manager were taught in project management courses.

Patricia Drakes

I am Chair of the advisory board of the Internet Society and a Past Master of the Worshipful Company of Information Technologists, but more importantly have been in IT for thirty-five years: as a user, as a software entrepreneur, but I've never written a line of code. So perhaps I could add to the lessons learned from my experience. I've picked up two. The first is removing the cloak of mystery, as to what the technology does and what business needs to do with it. The second lesson is the need really to understand what business needs from its people, from its suppliers, from its users and from its market.

Roger Watson

I think that's a very important point, and we far too often see technology chasing a market. At the same time, if you think of the really innovative business models in the ICT environment over the last five years or so, I would suggest they were created by Amazon, E-Bay and Yahoo. We can all see today that their innovations meet a very powerful need and have therefore created their own market, which fifteen years ago none of us would have thought of. They are therefore perhaps examples of technology not chasing a market but creating a market.

Michael Gough

On innovation, I was a juror at the recent BAFT awards and it emerged that thirty per cent of games software is written by Britons, and the sheer range and diversity of talent now getting involved in everything from music to publishing, film post-production, animation, the lot, make London one of the global centres of the creative industries. If

we ducked the opportunity to exploit and make these technologies come alive, we would be doing ourselves and our industry a massive disservice.

Edward Wolton (mi2g)

It's very refreshing to have a panel with such a wide range of experiences and from so many different roles. I'd like to ask a very simple question. In the past the large software houses have developed software in-house with budgets, with resources, enclosed in a bricks and mortar environment. However Linux is developed by individuals and groups of people worldwide with no set agenda other than the improvement of the software and for very little commercial or financial gain. How do the panel view the development of software over the next fifty years, where the past model cannot be taken for the today model?

Michael Gough

I went to Brussels recently to talk with the European Commission about stimulating the uptake of Open Source. For those of you who are not aware, there are currently 186,000 developers subscribing to a website where they freely exchange updates to a codebase. In Brussels I attended a meeting with the secretariat of one of the investment programmes, involving representatives from more or less every Open Source distributor and also a number of very influential developers. The thing that struck me about this meeting was that they were primarily interested in just one thing, the overturning of the proprietary software licensing model. So my observation was there is actually a disconnect between the user community and the development community on a very big scale. There are NCC members today who are installing Open Source based office application suites and saving large sums of money, but they are having to do it with very limited help from organisations other than my own. What we require is a creativity model that really brings those 186,000 people who are developing software into the frame of building useful applications.

Keith Marlow

Yahoo are very heavy users of Open Source. Everything you see on Yahoo is running on an Open Source operating system. Open Source to me is very useful when you want to solve a problem by going into the source, if you have the skills set, and tweaking it. But Open Source needs to address the area of support for users of the software. There's moves afoot to put training in place etc, but a lot more work needs to be done there to encourage people into using the software.

Derek Grover (BCS)

It seems to me that we talk about information as a generalised end product, whereas I see information in different sorts of categories. There's the entertainment category – televisual, music, games - where it's a consumer product. There's another category in business control, and another in resource management. Perhaps one of the more important categories is that set of numbers on computers which defines our wealth (it does worry me that all my wealth is simply a number now on a computer). And the

worst category, perhaps, is the emails and so on which are gluing up the system. All these seem to be categories with different degrees of importance. Does the panel consider there are other categories we should think about, and is there any sort of discipline which should apply in giving priorities to them?

Peter Morriss

I go to the data first, because I think that is the precursor for the information that you mention. In business computing, where my clients are, the people that I find at the front end of thinking, who have flexibility, fleetness of foot, the ability to change things around very large companies, they've stepped back, in a way, to start to define a data model independent of applications. I find that a very fascinating trend, because we've all got locked in to data modelled within applications over the last few years. One of the challenges for us, and it comes back to standardisation, is how we can achieve data independence from applications. That will actually change the marketplace quite significantly for bringing in new applications and new uses of technology.

James Feeney

I think we could separate out data which has procedural significance and data which has financial significance and treat them in special ways. Data for process management, be it in a manufacturing process, or even in an administrative context, is a finite thing. It can be defined and it can be managed. Similarly with data defining financial transactions, and that used in what we all know and love as our report and accounts and so on. But we are halfway down a slippery slope on other forms of information management. If I don't sit at my desk for a day I will receive probably a hundred emails. The likelihood is that I will file the ones with attachments, I will not read the ones that I don't recognise and I will focus on the ones that come from outside the company. So I'm tacitly applying an information management strategy just to deal with that which is being thrust at me through email. Gone are the days where one had the luxury of sitting there and actually thinking, when one is bombarded with that volume of information. So I think we are halfway down the slippery slope and it's getting worse.

Keith Marlow

At Yahoo there was a time, not long ago, when we were adding 500 gigabits of storage a week to cope with all the email. Of course it's an accumulative effect. You receive an email, you send it on to your friend, you add an attachment, he then sends it on, etc. So you've got this mass duplication of information and the big problem of separating what is information from what is junk. It's almost a data smog.

Charles Hughes (Emanagement and the BCS and WCIT)

More or less all of the discussion so far has been introverted, looking at the technology and the management problems in the industry. We are now fifty years old, as an industry and a profession, and what I'd like to do is just stand back for a moment and look at the industry in the context of the broader economy. Frankly the perception of most people is that we are pretty poor. We are seen as techies, we churn out huge amounts of jargon.

The number of women in IT was growing for a number of years, at one point one or point two per cent per annum, reached a magnificent number of something approaching twenty odd per cent - and has been declining for the past five years. We have a very distinct us and them view, or if we don't then from outside we are certainly seen as them. And we sort of wallow in this delight, being seen to be separate and different.

Our projects go wrong. We often claim that that's not our fault, which, in truth, it sometimes isn't. But nevertheless the perception externally is that we do mess it up more than we get it right and we've been doing this now consistently for fifty years. If we look at the external view as to whether there is a coherent industry position, there isn't. There is a lack of co-ordination and most people, including the government, complain that the industry has got no leadership. There was a report published a fortnight ago looking at the IT industry and its attitude to corporate social responsibility. With a few notable exceptions like, for example, the Worshipful Company, maybe Microsoft, BT, one or two others, it found that the IT industry is desperately poor in accepting any corporate social responsibilities, largely through ignorance rather than positive negative decision. A respected colleague of mine described our industry as immature and absolutely the worst that he could think of looking across many industries and professions. Ought we to be in that state after fifty years?

James Feeney

I don't accept that we are! Far too many points to address them all, but I can remember, when I started work, the vast armies of clerks. You remember perhaps the scene from the Citizen Kane film, that vast office and rows of girls on their calculating machines. We've eliminated an awful lot of drudgery from the workplace, as well as the fact that a large part of modern life would not be possible without computers.

Peter Morriss

Fifty years, for an industry, is actually not a very long time. In computer speak it looks like forever, but in historical perspective it isn't. So there is obviously a learning curve to go up. If you want a profession that's existed a lot longer and managed to keep its mystique try the medical profession. The names of the most simple medical procedures defeat me totally and my doctor friends make sure it stays that way.

Chris Yapp

On your broader viewpoint, I think our success in this respect might be measured by identifying ways in which we can really make a difference, for example by bringing communities, nations, continents together other than in times of war. There is a glimmer of hope that makes this more than pie in the sky in distributed computing. Then there is the unravelling of the genome. Maybe our aim should be to feel we are really making a difference to the bottom ten per cent of the world's or even our nation's population, rather than, as has tended to be the case, increasing the wealth of the top twenty five per cent. We are still some way off that yet.

Paul Dixon

I am ex-LEO, about forty four years ago. This morning it was said that we have improved the speed of computers twenty million times in fifty years and productivity by seventeen per cent rising to thirty per cent per annum. During the same period of fifty years, could the panel tell me what improvements there have been in the training, selection and appointment of managing directors and senior management?

James Feeney

I think the problem is we are using computers to do it!

Chris Yapp

I think we've got a seventeen per cent turn over in chief executives in the industry at the moment!

Michael Gough

In a recent NCC survey we discovered that only about seventeen per cent of the respondents, and there were 1500 respondents, told us there was an IT director on the board of their company. What that tells you is that IT is still not a major issue for most UK companies. That is a problem which organisations like the CBI, the IOD, the NCC, anyone who is involved with business and IT, need to grapple with.

Keith Marlow

I know engineers are traditionally seen as the people that you put downstairs in the dark and go down to when something is broken. Luckily Yahoo is more mature and actually brings them up into the main business and gets them involved in the day-to-day processes. But I think there's a fundamental problem in that the profession of being an engineer is not promoted into the education world.

Rudi Bric (Hermes Softlab, Slovenia)

There was business computing also in communist countries. In 1990 I started a company in Slovenia with four people and one PC. Today we have 600 professionals, which makes us the biggest independent software house in Eastern and Central Europe. You talk about India and China and distant countries, but in this lost continent, less than two hours away, you have three hundred million people. Of those three hundred very many are young and brilliantly educated and they don't have enough work. And there is proof in practice that they can build big, quality systems, which, of course, are always resold by Western big corporations.

My question for the panel is about the decision of the majority of the big governments of Europe to allow taxes on air. I am talking about the 3G licenses. How does this go with their rhetoric on the important role of the information society being on the political agenda of the European Union?

Roger Watson

I agree that this was effectively an enormous tax on the telecoms industry and therefore, inevitably, on the consumer.

James Feeney

I think it was an appalling mistake.

Chris Yapp

Does anybody think it wasn't? No. We don't understand it either. But Chancellors are greedy people, by their nature.

Philip Virgo (EURIM)

We are getting intellectual property rights wrong. We've got software patents where it's the idea that's rewarded regardless of whether anybody makes it work. We've got copyright, where it's the code that's rewarded, regardless of whether it works. But one of the lessons over the years is that the real IPR lies in debugging. Can we reconcile Open Source software, and a world where the value lies in debugging software so it works, in training, support, things that make it useable by human beings, with the World Trade Organisation software patents and the Millennium Copyright Act?

Peter Morriss

I think there's an essential conflict which has got to be worked out, between the Open Source type of arrangement and the understandable desire of people to realise the economic benefit of the investment they've put into a product. There is a real issue here and investment on a huge commercial scale. A hundred and eighty-six thousand sounds like a lot of people. That economic situation is the seat of your problem.

Roger Watson

We work with many of the world's biggest and best software companies, because we host, distribute, support, install, their software with our customers, and you might think that their software would arrive fully formed into our labs. Absolutely the reverse is the case. We spend weeks and months debugging their software. And it is impossible always to recover the value of that work. Maybe the software companies have tended to find that the customers will put up with a level of dysfunctionality, and we have come at it with a different approach. But one way or another we don't always find that customers are willing to pay more for the work that we've done, giving them a better software product at the end of it.

Michael Gough

One of the models of Open Source that I've seen used effectively is where there is a version of a piece of software available for free use with all the source included, but if you want to get right to the cutting edge and get the latest development then you have to pay a small charge. And if you want to take that software and tune it to your own particular needs, or take it off in a direction that it hasn't gone before, then you have to talk to the developers and establish what they will charge.

James Feeney

I think the viability of Open Source, notwithstanding the legal issues, revolves around what type of service you can build on it and offer to the customer. That means that the intellectual property value arises, not only from the implementation of the working system, but also in its content.

Ralph Land (Russo-British Chamber of Commerce and LEO Foundation)

We are celebrating fifty years of the computer industry. We ask what we've learned, and anybody listening would go away thoroughly depressed. We've learned that we may not be able to learn, that we can't project manage, that there are more failures than successes. Are there really more failures than successes? The fact is that what we learn from these fifty years is that this industry can change society, can have huge achievements. What one would have believed impossible a few years ago is now possible and likely. We should be addressing what we have learned about what we can do better, and indeed what we can do.

Michael Gough

I endorse that. It wouldn't have sat well to have patted ourselves on the back, but I think the achievements of the industry are enormous.

Keith Marlow

Engineers are highly orientated towards problem solving, problem design, and are never satisfied with the outcomes of what they achieve. So it could be that we are just by nature self-critical.

David Hoyle (ex-LEO from 1957)

I think it was in the middle 1950s that Cobol was first produced and I see, looking at adverts from time to time, that Cobol programmers are still in demand. What does this tell us about the improvement in software methodology?

Chris Yapp

It doesn't tell you anything about software methodology, it just tells you we haven't thrown very much out. One of the reasons the Y2K problem came sneaking up on

people was that in the sixties people were buying systems on the basis that they were going to be thrown away in five, six, seven years time. Nobody envisaged that those programs would still be running thirty, forty years later. Fortunately there are better languages than Cobol around today.

Ferenc Olti

I work for a bank in Hungary. Is there any progress in respect of ethical standards for the IT profession? For example we do not seem to get any better at our obligation to document software properly.

Michael Gough

The BCS do have a code of conduct for IT professionals and it's a very valid one. The question probably is how that is interpreted and applied within organisations engaged in software development. And, yes, there are difficulties, certainly in documentation. Half the problem with legacy systems is that they are undocumented and therefore difficult to replace. We ought indeed to have solved this problem long ago.

Alastair Macdonald

Until a few days ago I was President of the BCS. The question picks up a point made earlier on, that one of the disappointing aspects of the industry, as it is today and as it's been for up to fifty years, is that not enough people have felt either as suppliers or as users that information technologists should be professionally qualified. Very rarely would major companies go to their greengrocers for accountancy advice, even though it might be very good advice. And yet a great number of users, and in particular government users, have been quite happy to have systems designed and implemented by people who palpably have not got relevant professional qualifications. That's obviously a regret to us in the BCS and the IEE and many other institutions. And I think it is one of the yardsticks by which the contribution of the industry to the community as a whole needs to be measured. But as Mr Morriss said, these are still early days, we've only had fifty years. Let's hope that by the next meeting like this, in twenty-five or fifty years time, there will be a change of culture and people will be professionally qualified to do the task that they are offering to their clients.

Chris Yapp

It's quarter to six. James, Michael, Keith, Peter and Roger, thank you for your contributions. It's been a very wide ranging discussion. Thank you everybody for your attention and your contributions, and enjoy the rest of the conference.