

# LEADERS IN COMPUTING

Changing the digital world



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## Changing the Digital World

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Published by British Informatics Society Limited (BISL), a wholly owned subsidiary of BCS The Chartered Institute for IT First Floor, Block D, North Star House, North Star Avenue, Swindon, SN2 1FA, UK.  
[www.bcs.org](http://www.bcs.org)

PDF ISBN: 978-1-78017-099-2  
ePUB ISBN: 978-1-78017-100-5  
Kindle ISBN: 978-1-78017-101-2

British Cataloguing in Publication Data.  
A CIP catalogue record for this book is available at the British Library.

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Typeset by Lapiz Digital Services, Chennai, India.

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# FOREWORD

## GETTING TO SPEAK TO WELL-KNOWN FIGURES

Like most journalists I suffer from PIT (pre-interview trepidation) – the people I have the privilege to interview are often at the top of their professions or disciplines, renowned, much-decorated, very very intelligent. Will they disappoint me, turning out to be pompous or overbearing? Or, worse, will they find me out – effortlessly exposing my limitations with one well-turned phrase or insight?

I'm pleased to report that those we've interviewed over recent times, many of whom are at the leading edge of computer science are, to a person, thoroughly decent coves. And interesting.

The likes of Linus Torvalds and Sir Tim Berners-Lee rarely speak to the media, so it's great to get in front of them, if only for a brief time. With others, who perhaps I hadn't heard of initially, like Grady Booch and Karen Spärck Jones, you find out fascinating things, get background on technologies we now take for granted and even enjoy the occasional laugh (check out Grady's Quick questions).

Others' interviews here have been done by my colleagues and they too have fed back to me their fascination with their interviewee and commented on the sheer enthusiasm that genuine experts have. These range from the well-known names – Jimmy Wales, Steve Wozniak – to perhaps less widely known, but just as vital figures.

The combination of the personal and technical insight that a good interview can provide is a heady and revealing one. Enjoy.

**Brian Runciman**

*Publisher (Editorial)*

*BCS, The Chartered Institute for IT*

# 1 THE ART OF COMPUTER PROGRAMMING

Donald Knuth, June 2011

**While he was over in the UK for a book tour and lecture series, Professor Donald Knuth, the author of the hugely respected *The Art of Computer Programming* book series, made time to talk to BCS editor Justin Richards about his life and works.**

**You're probably best known for your book series *The Art of Computer Programming*. In 1999, these books were named among the best 12 physical-science monographs of the century by *American Scientist*. How did these books originally come about and how do you feel about the *American Scientist* distinction?**

The books came about because, in the 60s, when I began, everyone was starting to rediscover things because there was no one good source of what was known and I had enjoyed writing all the time. I was involved in newspapers at school and magazines and thought of myself as a writer and I realised there was a need for someone to get down all the good ideas that had been published and that we were already forgetting.

This was back in the earliest days, when the number of people actually studying computing was probably less than a thousand. I didn't see it as affecting the world, but I still thought it was pretty cool stuff and ought to be organised.

Then I thought about who else could write such a book and everyone I thought of I thought they'd probably only mention their own stuff and I was the only guy I knew who hadn't invented anything himself, so I figured I could be neutral and I could be a spokesman for the other people. And really that was the original motivation.

I started writing the book and, naturally, because I was trying to combine the ideas of many different people, I would see where one person had analysed his method in one way while another, for a competing method, had analysed it another way. So I had to analyse method A according to author B and method B according to author A.

Therefore I ended up creating an original work just by analysing these things and pretty soon I realised there were a whole bunch of interesting scientific approaches here that hadn't been part of my own education that were really coming together. Over and over again I was really seeing this way of thinking as necessary in order to get the story right.

So, to make a long story short, pretty soon I had my own axe to grind too; I started discovering things too and I couldn't be an unbiased writer anymore.



However, I still kept to the original idea of trying to summarise everybody's ideas in the fairest, most reasonable way I could.

Now, to be put into that category of one of the best books of the century, that's a little bit embarrassing as they rank me with Einstein and Feynman. I'm not in that league really, I just didn't have as much competition. They had to have a token person in computer science! But still, I worked hard and I think it was necessary to comment on the research so far, but it's a bit like comparing apples to oranges when they chose me to represent computing.

**What is it about computer science that drew you to it?**

I was born to be a computer scientist – I have a way of organising stuff in my head that just seems to make me a good programmer. I think everybody can learn to use computers, but only about 1 person in every 50 is a geek in the same way as I am. That means we can push the envelope and can resonate with the computer. The way we think helps to make it easier for us to know how to construct a machine.

**Why do you think computer science is so important?**

Computer scientists are important because of the way they affect communication and, I'm sorry to say it, also finances. Unfortunately, the world measures what my colleagues and I do by how much our work affects Wall Street. I'm jealous of astronomers, for example, because people respect astronomers for doing astronomy because it's interesting just for its own sake. I studied computer science because it's interesting to study computer science.

The term IT doesn't resonate with me so much – it's the science that interests me. To me the IT is very nice, but it's not something that I'm particularly good at. My wife can figure out what these icons mean and what to click before I can, but there are so many scientific challenges in order to get machines to do complicated, sophisticated things. The ideas are subtle, the questions are fascinating. There are many questions I never thought I'd know the answer to, but gradually we've learned how to solve them. For me I would do it even if there was no money in it.

**So you have a passion for it?**

Yeah, it's like I wake up in the morning thinking I've got to write a program.

**Do you have a muse?**

Yeah, well some days she talks to me more than others. There was a period when I almost thought there was a muse dictating to me.

**In your opinion, what do you think is your greatest achievement in the field of computer sciences?**

I guess the first thing I did well at was when I worked on the theory that goes on behind how compilers work. I worked on the theory that underlies algebraic languages, and, as I was writing *The Art of Computing* book (Chapter 10), I was describing what everyone else had done, but then I realised that there was a way to bring these things together. I didn't know how to explain that in a book, it was too far out, so I published that theory in a paper and other people figured out

what I meant and this became the theory of parsing that's used in all algebraic compilers now.

But I feel the biggest thing that I developed was the mathematical approach to compare algorithms in order to find out how good a method was. I worked out quantitative ways you could say that one program is going to be, say, 2.3 times better than another one and the mathematics that goes with it and it's called the analysis of algorithms. It's what I'm most proud of – in developing an academic subject – but it's key to the successful use of the machine.

When I came up with this approach, I said to my publishers 'let's rename the book and call it *The Analysis of Algorithms*' and they said 'we can't, it will never sell!' But that's really what my book is about – it summarises the work of all these people, but it also helps us decide, in a quantitative manner, how good each method is.

**You've said on your website, in response to the question 'why don't you do email?' – 'Email is a wonderful thing for people whose role in life is to be on top of things. But not for me; my role is to be on the bottom of things.' Can you explain your stance on email and what you meant about being on the bottom of things?**

Someone has not to be tweeting all the time, someone has to be thinking about things which need a long attention span and trying to organise material and build up strong foundations instead of rushing off across the frontier. It takes a long time to put out something that has the right style; I have to really think about it and if I'm going to do it right I have to spend a lot of time focused on it. And I was being treated like an oracle, lots of people from around the world were asking my opinion about whatever, so after 15 years of email I decided that was a lifetime's worth.

**A previous Turing Lecture speaker, Grady Booch, was very much an advocate of making coding simpler and, according to a blurb regarding your winning the BBVA Foundation Frontiers of Knowledge Award in the Information and Communication Technologies category, you are too. Can you explain why you think code should be kept simple, compact and intuitively understandable?**

I guess you have to go back to Einstein who said 'keep it as simple as possible, but no simpler'. It's an illusion to think there's going to be some sort of 'royal road' and everything is going to be easy to understand, but almost never do I find something that can't be simplified if you have the chance to rethink it again. So every once in a while people have to say 'well, let's chuck everything we have and start over again, in view of what we know now'.

There's a project at Stanford that started a few years ago called the *Clean Slate Project* that said 'let's figure out a better way to do the internet'. Things just keep getting added on and accumulate and you realise that there's plenty of baggage which there's no reason to have anymore.

It's like the appendix in the human body, there was probably some purpose for it at one time, but not now. So I think there's the potential, although I think maybe it's not possible because the world is so dependent on it, for someone to come along and say 'let's start again with the way programs are loaded into machines'. It's like when Linux came out – that was an attempt at the simplification of operating systems.

**Another ideology that you share with Grady Booch is that you have both said that you can appreciate the beauty within coding and programming – what do you mean by that?**

I'm thinking of it in several senses of the word 'art', but in general the word 'art' means something that is done by human beings and is not a part of nature. But then there is fine art, which brings aesthetics into it as well.

In many ways beauty is in the eye of the beholder, but you do something because it's elegant and hangs together and is a pleasure to read as well as to write or to see someone else's work; you feel that you've got it and you can take pride in it having achieved certain criteria.

Maybe Grady and I don't agree on the criteria. I mean no two people agree on what's the best kind of music in the world, but musicians certainly know what they like and what they don't like and they know when they've done something well and that's the way I look at a program.

**I guess it's down to personal opinion at the end of the day?**

Yes, indeed. There's no algorithm that you feed in and say 'isn't this beautiful or what?' Although people did try – there was a book that came out in the 1930s by one of America's greatest mathematicians, George [David] Birkhoff, called *Aesthetic Measure* and it was filled with all kinds of formulas and there was a page filled with all kinds of Greek urns and next to each one would be a number which would say how beautiful the urn was.

He classified a whole bunch of different design systems; it's kind of interesting as number two or three in his list of 100 was the swastika – he was a kind of Nazi sympathiser. I guess it has a greater religious significance in Hindu, if it's reflected left-to-right. I don't believe there's a way to measure it, but he did and some people have tried.

**So no one has written a program to work out the beauty of a program yet?**

No, not really, although there's software engineering that tries to do this because they have to measure something – I don't really know. You know that, as a writer/reporter, you just have to find quantitative numbers to accompany the text – *X* number of people have died in Cairo, you have to know whether it's 300 or 315, that's part of the news story. Qualifying things adds quality. I try to find reason for numbers too, but software engineers are trying to measure how good a programmer is; their bosses know better!

I think numbers are there so people can do a mental comparison and think 20 people have died in that event and 50 in that event so, by contrast the latter event must have been worse. But it's like comparing apples with oranges, because when you do something to a number then you can start to play games and make the number high even though the thing isn't right.

You can take education and an educated student and think, well, how are they going to do on this test and out come the books on how to pass this test rather than how to learn science. It's all about how to get a good score on a science test. And that's the problem with these numerical things; they don't always capture

the essence of it. Once you have a way to quantify something then, if your goal is to cheat, you'll figure out a way to cheat, when the goal really is to learn.

**You've said in the past your work is basically about finding a way to sort out the things that are going to last a long time (in computer science) instead of changing rapidly. What do you mean by that?**

Every day I get about one journal in the mail, not including *ITNOW* (laughs), but including *The Computer Journal*. About eight of them arrive in my mailbox every week. So there's an enormous amount of material out there and it's good stuff. So how am I going to decide what to put into *The Art of Computer Programming*?

I try to avoid the stuff that's quickly going to become obsolete and concentrate on the stuff that's going to have lots of applications. I try to find the facts that aren't too hard to learn, that are going to be useful for everybody's toolkit. What should all programmers of the next generation remember? I don't pretend that I'm right about everything, but I try to sort out the ones that stand out to me, that are unforgettable and that our children should remember.

**So I guess the building blocks of computer science and not so much all the more transient add-ons which tend to follow?**

Yes, but there are still thousands of add-ons that are describable in a couple of paragraphs, and learnable. If something takes 10 pages to describe, then it's very hard to get it into my book. But if something only takes three pages, is intrinsically useful and I can see how it physically fits in with other stuff, then it's more likely to go in. For example, we all learned how to add numbers together when we were young. If you think of all the uses to which that skill has been put – it's incredible. We all use addition every day, in different ways and continue to do so every single day. But still you learned about adding – you learned the concept of adding. There are loads of little concepts like that which go into my book and that's what I'm looking for. They haven't all been discovered yet.

Even with adding and computing there's now 'adding without carrying or nim-addition', which is something that was invented in England 100 years ago. It began as a game, which computers can do well, and we could combine this addition with ordinary addition, so one of the things in my new book is to explain to people why we might even want to be teaching fifth graders a new kind of addition because it's turning out to be quite useful. But it's not so simple that you can say 'everything I need to know I learned in kindergarten' – we keep learning little things that help us take giant steps as we go.

**In 1999, you were invited to give six public lectures at MIT on the general subject of relations between faith and science. Over a decade on, have your views on the relationship between science and spirituality changed and if so how?**

I'm just glad to see that people think there's more to life than things we can understand and it just seems that, at the time I gave those lectures, it was just coming out of the closet, saying 'well, computer science is wonderful, but it's not everything and don't expect me to give you any answers – let me explain why I think it's good to still have some things that are mysterious'.

I think there is the tendency as we discover more and more science that we tend to think that now we know everything. But as we think about it more and more

we're just getting started, I think. The amount that is changing is happening incredibly fast, but still I can see that in 100 years' time there's still going to be much more to learn. So there's plenty of room for humility, but we have still learned an awful lot of stuff we can be proud of.

I had this invitation to MIT and I thought, well, once in my life, if I ever wanted to reflect on this, this was going to be the time and the place to do it. I don't pretend to be an expert on it; I just didn't think people were spending enough time thinking about it. I was glad to see how many people responded to it.

### **Were the lectures well attended?**

Well, that's the thing – it was standing room only! It was a big lecture hall, too. There were six lectures. After the first one it was carried on on Dr Dobb's telewebcast and it was downloaded an incredible number of times over the next five or six years. So it was definitely meeting some kind of a need. I wasn't necessarily providing the answers, but I was providing some of the questions that I thought were part of our life – why not discuss these things in public? I was very pleasantly surprised at the numbers who came.

A few years back I gave a talk at Google and again it was standing room only, and again it was about this very subject. And it was a 'question and answer' talk like I'm giving for the Turing Lecture. That's the thing I enjoy, somehow responding to what people ask me more than having a canned thing.

### **I was going to ask you how you cope with a challenge like that – for a lot of people not knowing what they were going to be asked would be extremely daunting...**

(Laughs) It's not so hard – if I make a mistake, so what? It's not stressful compared with, say, if you think about Prime Minister's questions. I think Barack Obama could do something like that, but I don't think George Bush could have!

### **In 1975, you published a booklet called *Mariages stables*, which is a gentle introduction to the analysis of algorithms, using the theory of stable marriages as a vehicle to explain the basic paradigms of that subject. Why did you use that analogy?**

It's a gimmick, but once again it was a series of six lectures that I gave in Montreal. And the theme of those lectures was not faith and science, but looking at the analysis of algorithms and I based it around a mathematical problem I called 'stable marriages'. You could also think of it as a game between boys and girls where they each have their own preferences and each boy ranks the girls and each girl ranks the boys. And we ask ourselves 'how can we pair them up according to a number of criteria so that their relationship would be a stable one?' It's unstable when there are people who prefer each other rather than their own current partners. There's always a way to match the boys and girls up in a stable way.

There is good mathematics that can explain why that is true, but also different ways to do it and I can say what method is better than the others and I can introduce the analysis of algorithms into that. And I guess the thing I'd most want to be remembered for (going back to that earlier point) is this methodology of understanding the way these algorithms work. So here was a cute question about matching girls and boys up, which we could solve through concrete mathematical problem solving.

**So basically it helps people visualise your ideology in their heads?**

Yeah. I could see the average boy is going to have to propose a certain number of times, so it's not going to take long before we have a statistical probability for an outcome. You can ask a number of questions so the girls get the best deal or the guys do. Good mathematics comes up in the process of trying to deal with this one problem.

It was something I could talk about over the course of six lectures and interact with the audience there. The book (of the lectures) was in French, even though I gave the lectures in English and I don't know French; they decided to make the transcripts of the lectures in French. So this book came out in French and was translated into English 20 years later. I now know what it's like now to write a book in a language that I can't even speak!

**You've been asked to do the Turing Lecture this year – is that something you're pleased about?**

I'm at a turning point in my life right now where I'm celebrating the conclusion of two big projects, each of which have taken many years to do. So it's the perfect time for me to be giving this lecture and I told them two years ago that two years from now would be a good time for me – my defences would be down and I'd be retooling ready for the next big project.

I've finished Volume 4A of *The Art of Computer Programming*, which I just got my first copy of less than two weeks ago, which is something that I'm proud of and I also finished the eighth volume of my collected papers. All of the papers I'd written over the years were packed into books by topic. For example, one was on typography; I did research beforehand on software for making books beautiful. Another one collects the papers I did on the analysis of algorithms. Still another one has the papers that I wrote for general, non-specialist, audiences about computer science. Plus the last volume of this eight is about fun and games. I was saving it for dessert because these were the papers that I had the most fun writing and that I did purely for the love of it. I love this book on fun and games – I'm not entirely sure why.

On the very same day I finished that book and sent it off to a publisher, *The Art of Computer Programming* book was also sent off to another publisher and then I received my free copies during the same week – it makes me very happy to have them, in both cases. To have completed them, to have gotten through them without getting sick, a world war breaking out or anything like that, is very gratifying. It's also nice to be able to draw a line under those projects.

**Do you think the IT profession has a bad reputation being full of geeks and nerds?**

That's interesting because I was actually proud to be given the name 'geek of the week' by a British writer<sup>1</sup> who has a blog called *Geek of the Week* or something like that. I can't remember his name though. This was about two years ago. They talk about 'geek chic' – the word is becoming more acceptable and people aren't afraid to admit that they're a geek. Nerd is a little different.

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<sup>1</sup> The *Geek of the Week* interview was actually done by Richard Morris on 26 November 2009. [www.simple-talk.com/opinion/geek-of-the-week/donald-knuth-geek-of-the-week/](http://www.simple-talk.com/opinion/geek-of-the-week/donald-knuth-geek-of-the-week/)

My sense of it is that, now that people are identifying themselves as geeks, that word has now brought us to an era where I can say it and people can understand the kind of peculiarities I have. It certainly wouldn't have been that way several years ago.

People who work with words often can't explain why some words rise and others fall, but this one definitely seems to be in ascendancy right now. I might be wrong about it, but one of the chapters in my book on fun and games is called 'geek art' and it just seemed to me to be the right title for it, because it talks about the kinds of art I like to have around in my house.

**What, for you, have been the most important developments in the computer science arena over the last five or six years?**

To me it's the fact that thousands and thousands of people are working together. At the end of each year you can ask yourself what the greatest breakthrough discovery of the year was and you can't come up with anything really, but after five years the whole field has changed. And the reason is, it's all incremental.

There are occasionally things that are recognised later as being major changes such as the creation of the World Wide Web or something like that, but the year that it happened no one would have recognised it as being so important. Actually it's more like building the Great Wall of China, with each workman contributing bricks and it's a teamwork effort where so many people are involved. It's all about pushing the envelope and learning from one another, so I think that's the way I perceive it.

**Looking forwards, what do you perceive are the biggest issues/challenges computer science faces, now and in the near future?**

The challenge of how we can go to sleep at night when there are so many things left to be done! As an American I'm a big admirer of (and also slightly jealous of) the British health care system, from what I know of it (my grandson was born here), but I think so much more could be done by having better health care records and better ways of describing and visualising combinations of symptoms and combining statistical methods as well as visual methods. This would help doctors to understand things more clearly and quickly.

Not to mention the ways in which computers can help biologists to design better drugs. Everywhere you look there's something to be done which needs a good programmer to help achieve it. There's no shortage of challenges and little chance of ever running out of them.

I started off by saying that 1 person in 50 is a geek like me, but I think there might be a geek shortage in years to come. I might be wrong – the next generation could be 10 per cent geeks, but I doubt it. In order to do these things that computers need to do, we're going to need the people to program and run them who have these weird talents.

**Do you think the old artificial intelligence chestnut will ever be solved?**

I don't think we're anywhere near this singularity, but there will gradually be a coming together of men and machines. I must say that my colleague,

John Hennessy, the president at Stanford [University], has said he thinks there's going to be a computer meltdown in five years, like the financial meltdown, because we've become so reliant on them; people are relying too much on them. There's definitely going to be a time where people have forgotten how to do things, all because of relying on machines. We'll forget how to do stuff without machines and that's going to lead to some crashes.

**You once said 'Everything about computers today surprises me; there wasn't a single thing that I could have predicted 30 years ago.' If you were to set yourself up as a sci-fi author, what predictions do you think you'd make about life in 50 years' time?**

I'm glad you found that quote. Anyways, it's true!

Pessimistically, I don't see how we're going to solve the energy situation unless there's something like breeder reactors that dispose of waste properly. There's something called the Jevons paradox dating back to England in the 19th century. [William] Stanley Jevons, I think his name was. Someone worked out how to run the railroads 10 times more efficiently than they had done in the past and as a result they used 100 times more coal because everyone then started to use the railroads to transport things. In other words, once you made something more efficient, then people used it much more.

You don't just say we need  $X$  amount of oil to do what we want. What happens is that if we had more oil, we'd be doing more with it now. And what happens is our appetite is never satisfied. Hence I don't see how our energy requirements will ever be met.

The optimistic scenario is that everyone enjoys doing analysis of algorithms and enjoys doing beautiful computer programs – wouldn't that be a great future!

### Links

Donald Knuth's Homepage [www-cs-faculty.stanford.edu/~uno/](http://www-cs-faculty.stanford.edu/~uno/)  
Turing Lecture 2011 [www.bcs.org/turing/2011](http://www.bcs.org/turing/2011)



## 2 THE MIGHTY BOOCH

Grady Booch, October 2007

**A reality TV show for developers, life-saving software and the discovery of fire... BCS managing editor Brian Runciman speaks to IBM Fellow Grady Booch, who gave the Turing Lecture in 2007.**

### **Perhaps you could tell us what you are working on currently?**

There are two areas that I'm giving my attention to. The overarching thing that brings them together is addressing what one can do to improve the efficiency of developing, delivering and evolving complex software systems.

There is a gap between vision and execution; we can dream up many things that have a software element to them, but to turn that into running systems is a challenge. Pure computer science can limit us, so can social, legal and moral things. But where most organisations stumble is at the cusp of design and organisation – those are the two places where I'm spending my attention.

In the area of design, one of the greatest advances in the last 10 years is the observation of design patterns, the ability to look at things at a higher level of abstraction that transcends the original programming language. Not that languages are unimportant, but to address complexity we have to move up levels of abstraction.

The Hillside Group, of which I'm a founding member, has begun to catalogue several thousand design patterns, so that's a maturing discipline. We know to express patterns we needed to catalogue in the physical networking domain and the abstract logical domain. Where we lack is in our ability to describe significant or architectural patterns.

In civil engineering, there is a history of architects learning by studying the works of their masters – Frank Lloyd-Wright, Christopher Wren, Frank Gehry. There are books that catalogue the different genres of buildings and observe the common kinds of architectures. No such reference exists for software engineering.

In software, people tend to be brought up in one domain with almost no knowledge of others. Nor have they studied the masters. I've found that only one or two institutions in the computer science world have a reading course. This is much more common in other disciplines.

So my goal is threefold: first, to build a handbook of software architectures with the idea of codifying the architecture of a number of interesting systems – historical,

economic or technical interest. Then to extract the patterns we find, because every system has an architecture, even if just accidentally, and the systems we have today have their architectures for historical and technical reasons. The third goal is to provide a reference to move us up a level of abstraction so that people who wish to become architects can have a reference.

That's one area. A lot of what I do for IBM is to mentor, to work with organisations to define and transform their architecture and thus their organisation along the way. The other area is the problems of organisations. Most economically viable software is not written by an individual or even a small team, but by many code warriors working with other stakeholders who are often geographically and temporally dispersed.

The geographical is obvious, but the temporal distribution is under-served and little understood. I may build something, and there are people that follow, maybe even a generation later, that may want to modify or adapt what I have built.

We know that code is the ultimate truth, but not all the truth. There is entropy, a loss of information, from vision to construction, so even though I may stare at some code I don't have access to the rationale or the patterns that sweep across the individual lines of code.

So we have information loss. So I have tried to define what we can do to improve the developer experience using a thing that Alan Brown and I have called collaborative developing environments. It's not a killer app, but a weaving together of a hundred small things – the things we know from social networking sites like Facebook, Slashdot and Sourceforge. So we want to produce technology to help us deal with the geographical and temporal distribution.

### **What do you think we get wrong in software development at the moment?**

It's the design and organisation struggles I've mentioned. If I have built something a hundred times, it's relatively easy to build it the hundred and first time – but most organisations are building novel things and we don't have good models for how we should build them.

There have been few studies of what hyper-productive teams really look like. Most organisations tend to build systems that model their organisations and their organisations tend to model their systems over time. Therefore, when someone wishes to innovate, there is resistance to change because this has been ossified by the form of the organisation itself.

I wish I'd been trained as a sociologist or a psychologist because many of the problems I encounter are not technical problems; they are social ones with a deep technical element.

### **Usability is always an issue. Will we get the raising of abstraction to a level where people can intuitively use software?**

If I took somebody from the 1800s and put them in this room now, they would have incredible cultural difficulties because they wouldn't understand the things around us – your iPod, the projector and the like. But we are now

birthing a generation of people who never knew a time when the internet didn't exist.

So while someone in the 1800s may know about the care and feeding of horses, for example, so it is true with someone born in this generation who grows up surrounded by computers. There is a raising of the tide so that for the next generation texting, browsing the web and booting a computer is like turning on a coffee machine – feeding a horse, as it were.

So in every generation this culturisation happens. It's part of a given environment. Is it the right one? Are the interfaces we see on the web and the like the perfect ones? There is no such perfect thing in engineering discipline, but what we have is a result of historical, hysterical and emotional confluence. What it is, is what we have.

Software becomes part of the atmosphere and the usability we struggle with today will just become second nature.

**BCS is pursuing professionalism in IT. What are your thoughts on this?**

My life was saved by software. When my nephew died at age 20 I had a CT scan, which revealed I had an aneurysm. If I had been born a generation before, there would have been no such diagnostic tools. So I relied on the skill of the medical staff around me and the technology. The CT scan and the software inside it saved my life. I probably wouldn't have felt comfortable if that had been developed by a hoard of people who are just script-kiddies for which there was no intentionality in building that system. I'd probably be dead.

I'm a frequent flyer too. Most of the planes in which I fly and the air traffic control systems I depend on would cease to exist without software. So on a daily basis I put my life in the hands of people who have written software. We are in an age of increasing, if not total, dependency on software. As that increases it calls on us to show increasing professionalism in our space. It would be unthinkable here in London to have regular reports on buildings falling down – and yet that's what happens in the software world. There are economic pressures that push organisations towards building software that is better, faster and cheaper. But we can do better.

In a way it's like what we saw at the beginning of the railway industry and utilities, in which there were lots of people pursuing it because of its potential for making money but not a lot of professionalism in the process. As an industry we've struggled to define what it means to be a software developer. There are a lot of amateur developers, and I don't mean that in a derogatory sense, but there is a lot of software produced by people that haven't been trained. We owe it to the community to capture best practice. This will increase the level of trust the world has in our products. So professionalism is key.

It is a tremendous privilege and responsibility to be a software engineer. It's a privilege because the things we do change the world; it's a responsibility for the same reason. The world relies upon us.

**What about certification?**

I'm mixed on the area of certification because we don't have a good grasp on the body of knowledge we wish to certify. There was an attempt at this with the software engineering body of knowledge by the ACM and others, but I left it disappointed because we couldn't even agree on what simple terms meant. The International Association of Software Architects, of which I'm a board member, is attempting to find this body of knowledge.

**BCS is celebrating its 50th anniversary this year. What development in computing do you think was the most exciting or groundbreaking in the last 50 years?**

I can't pick just one. The public may identify one thing, such as the web, but as an insider I think the progression of our field has been the progression of science. More evolutionary than revolutionary. People may point to the development of the web, but that is not a point in time. I had my first email address in 1979 via the Arpanet and Arpa published a little book, perhaps 15 pages, which gave everyone's email address in the world. We couldn't quite do that these days.

The web has been evolutionary. Similarly, let's go back in time. I was at Bletchley – first can I say thank you to the UK for inventing the computer? – and if you look at Colossus we can look at the things going on around it and it's still evolutionary, not revolutionary.

Design patterns are the most important for me in the last 5 to 10 years. The development of software has parallels to the development and maturation on other sciences.

**Which past discovery would you have liked to have made yourself?**

Fire.

**We have a problem attracting students into computer science – I understand it's the same in the US. What can we do to try to reverse that trend?**

Earlier this year I gave the keynote at the ACM Conference for Science Educators and that very question was asked. I have tracked what the ACM, IEEE and others have done in terms of recommended curriculums for universities and it's clear that the problem starts very young. We in some ways alienate kids from interesting stuff in software and warp their minds.

Software in schools usually means knowing how to surf the web, get a broken PC up and working or install the latest patch on Windows. This is not computing. We are missing teaching the notions of awe and beauty, especially with regards to women in computing. Let's teach them how to program a single person shooter game – well that's not exactly thrilling to half of our species. So we have to start early to teach, not just skills, but the joy, beauty and awe of software. I love what I do – I don't need to do it, but I love it because of the joy and awe and beauty.

**Vint Cerf thinks we don't celebrate the role models in computing enough.**

This goes back to the handbook of software architecture. Along the way I'm interviewing the architects, because there's a tremendous human story behind all of this. In my life I could count maybe a half dozen people that I consider world class architects – people at the Gehry, Lloyd-Wright, Wren level, and yet most of the

world, or at least most of the people in our space, don't even know them, let alone celebrate them.

Microsoft had a self-serving book a few years ago called *Programmers at Work* in which they interviewed a variety of programmers who were mostly building Microsoft products. It was fascinating. There's a similar book out now called *Beautiful Code* from O'Reilly, which begins to celebrate the lives of individuals.

There's this horrible stereotype of these geeky, smelly, poorly dressed people that sit in dark rooms in front of sticky keyboards. Maybe we need a TV reality show about developers and how wonderful they can be. Pitch it to the BBC.

**I interviewed Linus Torvalds recently and we got onto the subject of Ray Kurzweil's singularity idea. He thought it was over-hyped. What do you think?**

I agree with Linus. In a recent lecture I projected ahead to 2031, coincidentally the 50th anniversary of the founding of Rational. In it I said that we as an industry are the antithesis of high energy physicists.

Richard Feynman did incredible lectures about what they do in their community, which is to tease out and make visible the rules and laws at a tiny level. In software we have intense complexity and are trying to squeeze it into a space so that it is invisible. The opposite.

So as I look ahead there will be increasing dependency on software but we want to make it disappear. Development isn't getting any easier. But looking at Ray's issue, I don't know if consciousness is an accident of biology, but can I achieve the illusion of intelligence? Probably. Less so in where Ray is headed, but more so in Marvin Minsky and Rodney Brook's direction, that one can achieve amazingly complex behaviour from a few simple things.

Will that cross the threshold into that singularity? Maybe, but it will probably take longer than what Ray has in mind. It's going to be subtly different. I have more computing power around me now than existed in the world about two decades ago. I have half a terabyte of storage either on my body or beside here on my laptop. It's not going to go away – that will increase over time. I expect there will be a point in time, evolutionary again, where they become more tied to me.

Perhaps I'll carry glasses around with me that will record what's going on, maybe with facial recognition so that when I see you again I'll know who you are. These things would become an extension of my consciousness. I just won't see the boundary between me and these devices anymore. Will we have computers that by 2031 will pass the Turing test? My guess is probably not, but we'll be pretty close. We'll be able to build programs that will be able to simulate stupid presidents.

**Brian Eno gave a speech on generative music a few years ago. He liked the complex things arising from simple rules too, interestingly. Do you think we use software well in the creative arts?**

It's created opportunities for new mediums of expression. My wife is a fabric artist and she increasingly uses her Mac and Photoshop to create her designs.

We are seeing a generation of folks who are discovering the computer as a creative medium. In Austin, Texas, there is a museum of digital art.

The software inside synthesisers has created the ability for untalented performers, such as Britney Spears, to produce vapid music more rapidly. Good side, bad side. But it's also allowed us to produce music that's quite interesting and striking.

Creative types will navigate to whatever medium allows them to do creative things.

I contacted Frank Gehry's company, who do some incredible buildings, and asked if they copyright their designs. They said no. They trademark them, but don't copyright because they make their money because they can build these buildings when no one else can. Gehry has a software company and they sell software to their competitors. His buildings could not be built without the software. They have 3-D modelling programs and programs for doing wind, earthquake and water analysis.

**Who in the IT industry, or outside it, inspired you or was a role model for you?**

There are people in the industry who inspired me. When I was 10 or 11 there was an article in *Life* magazine about a robot called Shakey, and in it they highlighted the work of Marvin Minsky. I thought this was so cool. I knew at that point in time that I wanted to go into computers.

So I scoured the literature, of which there was not much in 1966, and I read several books on digital electronics. There is a British computer scientist called George Walter who built these little robots, so I was influenced by his work.

Age 12, I built my first computer, scrounging parts here and there. And here's the postscript: I convinced the Computer Museum that they should include software to preserve source code for future generations. So I relayed this story to the board of the museum and the curator said, 'turn around and look in the box behind you'. It was the original Shakey that had inspired my work.

Dr Minsky, Dr Brookes, Dr Hoare, Edgar Dijkstra – these are my heroes.

**What recent developments by others have impressed you most?**

I am continuously delighted by Apple and their ability to build wonderful products. At home I have banned PCs because I prefer to use operating systems that work. I have only Linux or Macs in my home network. I have a 2 TB file server, two T1s that come into the house, devices that allow me to look at my security cameras from a distance... so I'm very, very wired.

**If not in IT, what would you be doing?**

I would have been an itinerant musician or a priest. I play a variety of musical instruments. My first instrument was an accordion, which, at 15, I learned are not babe magnets, so I switched to guitar. I built a synthesiser and got into that until the mid 90s when I realised I was tired of booting my instruments to make music. So I abandoned all of those and went acoustic. I've gone to the Celtic harp, the hammer dulcimer, the flute, the harp and I sing.

**What books have you read recently and, without wishing to encourage stereotypes, who are your favourite science fiction authors?**

I'm a voracious reader. Recently I built a house with my wife because we rented a room for books. On my latest trip I've read *Middlesex*, *The Girls of Riyadh*, *Unveiling Islam*, *Myths of the Ancient Greeks*, *The Gods Must be Crazy* and I read a book on Colossus.

In terms of science fiction, I love the classics; Asimov and the like, and Terry Pratchett. I'm a Monty Python fan too. I also read physics books and maths books for fun.

In films, I'm a James Bond fan, I also love a good chick flick and a good cry. I was delighted last time I was here because Drew Barrymore and I shared an elevator.

**Just going off at a tangent briefly – Asimov posited the science of psychohistory, predicting the behaviour of mass populations statistically. Any chance?**

There was a play called a *Search for Signs of Intelligent Life in the Universe* with Lily Tomlin, where she has this line 'reality is just a collective hunch'. So, insofar as we can identify what that collective hunch is, then we're well on our way.

**Quick questions**

**Mac or PC?**

Let me think... I was an Apple 2 user and I have never willingly bought a PC.

**Are you a geek or a nerd?**

I don't the know difference between the two. I'm a renaissance man because I have a lot of interests. I think I was born in the wrong century. I think I would have flourished in the time of the Renaissance – of course I'd be dead by now, but I would have had a smashing time.

**Smartphone, PDA or iPhone?**

I carry a Samsung phone because I travel so much internationally and I need a quad band phone. I would love an iPhone, but it doesn't serve my needs for travel. I carry a Palm as well, and I used to carry a device that fused these together, but the technology changed at different rates so I decided to get a good separation between the two devices.

**How would you like to be remembered?**

Apart from for the invention of fire? As a kind and gentle man – that's enough.

**One piece of careers advice?**

I've mentored six people in IBM, so I do this a lot. What I say is follow your passion, because if you don't you won't have any fun, and if you're not having fun you should be doing something else.

**Links**

Grady Booch's blog [www.ibm.com/developerworks/mydeveloperworks/blogs/gradybooch/?lang=en](http://www.ibm.com/developerworks/mydeveloperworks/blogs/gradybooch/?lang=en)

Turing Lecture 2007 [www.bcs.org/turing/2007](http://www.bcs.org/turing/2007)

Brian Eno's generative music [www.inmotionmagazine.com/eno1.html](http://www.inmotionmagazine.com/eno1.html)

Ray Kurzweil's singularity idea [www.youtube.com/watch?v=cc5gIj3jz44](http://www.youtube.com/watch?v=cc5gIj3jz44)

Computer History Museum [www.computerhistory.org](http://www.computerhistory.org)



## 3 TALKING TO TORVALDS

### Linus Torvalds, September 2007

**He hates cell phones, but thinks that acceptance of the open source concept is now taken for granted – in a good way. BCS managing editor Brian Runciman interviewed Linus Torvalds, software engineer, BCS Lovelace Medal winner and, most notably, initiator of the Linux kernel.**

**Let's start by clearing this up: Lie-nux or Lynne-ux?**

It is Lynne-ux, because I was working on Minix, it sounds similar.

**Isn't your name pronounced Lie-nus – like Linus from Peanuts?**

I was partly named after him, but in Finland it's pronounced Lee-nus anyway – so it doesn't work that way either!

**BCS is pursuing professionalism in IT. What are your thoughts on this?**

Well, I'm self-taught. The Linux community itself has been self-organising and most of the early people involved were students, not even programmers. Many were from a physics background, using Linux for calculations and physics problems. So I don't really have an opinion in this area.

**Linux hasn't made huge inroads on the desktop. Is that a worry?**

Well, the desktop is not really a huge market for Linux. It's hard to get hardware manufacturers to support it. They won't even tell us, for example, how their new graphics chips will work, so it's difficult to write code for them.

The desktop is special, there's a huge inertia for people because it's the only place we are really aware that we are using software. In things like iPods the software is almost invisible – it's updated behind the scenes, it only has a limited interface.

For Linux it's been easier to be in servers or embedded systems because all that matters is that it works – people don't care about what runs the system, only about the output. The desktop is a more direct interaction.

**Looking back on 16 years or so of Linux, is there anything you would do differently given the chance?**

I think it's the 16th birthday in a couple of weeks. Realistically I wouldn't have done anything differently. A few technical choices weren't always right, but they are easily solved. But things like the community set-up and the licensing approach worked out really well, spot on.

**Did Linux develop as you expected?**

No, I expected it to be much smaller, just as something I would use – the commercial side wasn't planned at all. I did it for fun because I was interested in software and interaction. Now I do it mostly for the social side – I never thought of myself as sociable in that way, but it's fun to interact via email.

How people use Linux now was also unexpected. For example, it's used a lot in third-world countries, although I'm not involved personally in that, and that's good.

**BCS is celebrating its 50th anniversary this year. What developments in computing do you think are the most exciting in the last 50 years?**

What I think about is IT's ubiquity. I don't like the word, but when I started out programming was viewed as odd and computing itself was expensive. But now interacting with computers is so much a part of people's everyday lives.

That has produced changes in the way we program too. Because of the power of hardware now we do things that wouldn't have been possible even 5 to 10 years ago – things that then would have required real high-end hardware to solve problems that would have seemed unrealistic. So the growth of computing power and its availability have been the big things for me.

**There are concerns in the industry with getting people into IT in a serious way, not just superficial usage. How can we do that?**

I have this problem with my daughters now. They use computers, but to make the leap to real interest in technology and programming, I don't know. My eldest daughter is doing a Lego robotics course this year, which involves a little programming. She uses Linux, but only to play games, surf the web and email.

Personally, my interest started with a small computer club – there were only two of us, those who actually had computers. I had a Vic 20, and my friend, a ZX81.

**Who in the IT industry inspired you or was a role model for you?**

No one from the industry. My role models were always scientists. In fact, I use this as an analogy for open source: it's science versus alchemy or witchcraft. I've always felt that the way to progress is to 'stand on the shoulders of giants' and that needs openness, not a form of witchcraft where how you do things is hidden, where you protect your knowledge.

My inspirations were people like Einstein and Newton.

**What recent developments by others have impressed you most?**

One of the people I'm a fan of is Richard Dawkins. He's very famous in the US and UK for his anti-religious stance, but I've found his books on biology and genetics much more interesting. I find biochemistry fascinating.

**Will computing and genetics ever truly overlap then? I'm thinking of Ray Kurzweil's views, for example?**

I think the singularity idea is over-hyped. It's a cool vision, but whether it will happen in reality I'm not so sure. But both sides can give to each other.

To make AI really successful it requires an understanding of neural networks and how the brain works. And genetic research today is possible because of the processing power we now have. The protein folding stuff is very processing power intensive.

**How do you feel about the media's approach to open source?**

It's been very easy. Journalists tend to be very interested in communications and openness, so I found it very easy to explain the philosophy behind open source. Most of my family are journalists, so I've noticed how my interviews have changed over the years in this regard. I don't do many interviews; enough to see the changes, but not so many that I can't see how they've changed.

In the early days, there was scepticism about why doing things openly would help or even work for programming and code. But now it's absolutely taken for granted that this is a good way of doing things. People know it's a great model. So the questions I get have changed because the assumptions have changed.

**What are the biggest challenges open source faces in the near future?**

I'm not that worried because it is just a better way to do things. People think of open source as a philosophy of freedom, but I think it's just a great way to get things done.

There are some worries; software patents are number one, but that doesn't just affect open source, that's a problem for all development. It's just a bit more obvious for open source.

**What one piece of careers advice would you give to someone going into the industry?**

What I saw a lot when I was at university was people getting into programming because they saw it as an up-and-coming area and a good opportunity to make money. It's the worst reason to get into anything, but especially programming, I think. If you don't enjoy doing it you'll never be as good as someone who does. So you'll be second rate and unhappy. That applies to anything. You need to like what you're doing.

**Quick questions**

**Mac or PC?**

Who cares? I have both, they both run Linux.

**Are you a geek or a nerd?**

I use geek, but I'll answer to nerd.

**Smartphone, PDA or iPhone?**

None, I hate cell phones, I find them really annoying – why are people disturbing me? I used to have one so that my wife could contact me, but I work from home now anyway.

**How would you like to be remembered?**

I think as someone who made a difference. A positive one, of course.

**If not in IT, what would you be doing?**

If I was in high school now, I may well want to be a geneticist.

**Links**

Linus' blog <http://torvalds-family.blogspot.com/>

BCS Lovelace Medal [www.bcs.org/lovelace/medal](http://www.bcs.org/lovelace/medal)

Ray Kurzweil's singularity idea [www.youtube.com/watch?v=cc5gIj3jz44](http://www.youtube.com/watch?v=cc5gIj3jz44)

## 4 APPLE TO THE CORE

Steve Wozniak, October 2007

**Steve Wozniak is the other Steve who founded Apple Computers in the 1970s. Although he no longer works for the company, he spoke to BCS assistant editor, Henry Tucker, about Apple, professionalism, nerds, geeks and robots making coffee.**

### **What are your thoughts about professionalism in IT?**

Well, there's a lot of cases where lack of professionalism arises and grows and doesn't get noticed, partly because a lot of the work in IT is strange and foreign. It's almost like a language of its own and the normal people in the company, the executives and so on, can't understand the technical aspects. Even if you're creating a web page, it's easy to hack around, play around and get a job done, but not really follow standards. In my case, for example, I didn't have a college degree yet, but we started the company.

### **Apple has been going 30 years. Looking back would you do anything differently if you had your time again?**

I was the technician mainly – I was an engineer and there are a couple of things that I might have done differently, but they are rather small things. I judge the work by quality and innovation and everything I did in the Apple days was A plus. I don't really feel that I had any places where I would do things differently.

### **How about since you left, are there things you would like them to have done differently?**

Even when I was there, Apple, other people were doing things. It's questionable, but the trouble is you don't want to look back and say 'oh, we should have gone a different way, we should have done this differently, we should have licensed so and so', because you can never really tell the results. Apple is such a strong and successful company as it is, it's difficult to poke a hole and say it would have been twice as large or 10 times as large.

### **There was a time around 10 years ago when Apple's fortunes weren't as good as they are now. Did you ever imagine that it would come back quite so strongly?**

No, actually I am kind of surprised. I think it's delightful and largely it's based upon finding more than one industry, basically diversification.

### **The iPod has spawned so much else.**

Yeah, and I think the iPhone is so excellent, it's going to be the same.

One of the things with Apple is that it makes attractive devices and it's been an important part of the company since day one and we did lose the way with this

for a while. We were just making computers to satisfy the Macintosh re-buyers, but we didn't have something you'd just say 'oh my god, that's so compelling, I have to have it'. That was the case of our early products. We got back to a lot of our early goals, values and culture.

**What would you consider to be the most significant and groundbreaking technological developments over the past 50 years?**

Obviously personal computers and cell phones and flat panel displays.

**What are your thoughts about the internet and global communication?**

Actually, yes, even back when we were starting Apple, that was being done at a relative low cost for such things as wired teletype – text only. It was being done, but not on an 'available to everyone' basis. But companies could buy into it and universities were doing that sort of thing.

In fact, in our club, out of which Apple sprung, we pretty much talked about being able to quickly leave messages on a master bulletin board type computer and then thousands of people could read it at once. Some of these concepts we had, we just had no idea how efficient and widespread the internet would wind up being. And that other things that we spend time on, such as music, television, animations, videos, that those sort of things would become part of the internet, we had no idea.

**And are there any discoveries that you wish you had made?**

Everything that Apple has done! The internet really sprung out of other things, early efforts to link universities such as Arpanet and that was one of my driving forces that really got me absolutely straight in line to building a computer. I had to have one of these machines that could talk to computers far away.

In my world, a lot of things were changed from analogue to digital – I wish I had been involved with DSP modems and then vector technology and others of that type, and I wish I had been involved in inventing modern LCD displays – but you can't do everything in life.

**What can the industry do to improve its image and the way that it's portrayed in the media?**

It's always been geeky and male-orientated and there have been successful times for those sort of people. I think that IT doesn't necessarily have to be so geeky, but it has become one of those areas.

I think it's because it's esoteric and it's not in the common realm that a lot of the people who are driven to it are different – maybe they are social outsiders? When they are young, they are driven in that direction because it's something that they can understand and talk about, and it's strange and it's something that internally makes them feel validated and worthwhile.

**Apple is obviously a cool brand, but then not everyone who works in IT can work for Apple.**

That's right and even with Apple, we seek the best whether it's programmers, engineers, that sort of people and sure, we have an awful lot of people who would be called geeks.

**But then is it a bad thing to be called a geek?**

I would say that it's always been a bad thing. I don't know if it's the same in the UK, but we have two words, nerd and geek. A nerd follows technology, but a geek is almost a word that's negative and implies a bad look – it's like geeks from the circus, strange looking weird characters – and it's partly true as well!

It's the sort of person who cares more about IT and technology and they don't do a good job socially, thinking about others. That's one of the problems, the engineer doesn't do a good internal marketing job, understanding the actual user of what they are working on.

I think the communication channels need to be improved, always, between not only the IT folks and customers of what they are doing, but between the IT folks and even the executives they are working for. It's very often easy to give an example in IT terminology that doesn't really make sense to a common person, they just sort of throw up their hands and say OK, just do what you need to do.

Although mostly the structure of a company and management is such that you still get a lot of the failures in IT. Products that we get that don't perform the way we would like them to or that have bugs or flaws or missing elements is largely because a manager didn't pay enough attention to testing and making sure that everything works absolutely right. More important they say 'it seems to work, let's ship it'.

**Who in the IT industry would you say has inspired you most and has been a role model for you?**

Obviously Steve Jobs. I worked closely with him. From day one, I admired how important a person of his type is to the industry.

**What's your relationship with Steve Jobs?**

We're good friends. We don't go out and do things together – we have different lives. We've always been good friends, we've never had any arguments or fights.

**What developments by other people in IT have impressed you lately?**

A lot of the nano-technology work is creating materials and molecules that are going to push the state of the art in terms of speed of chips, strength of materials, quality and low-cost of displays, alternative materials that can be better adapted, such as plastics that conduct and that sort of thing.

I think photonics is one of the big areas where you can put light switches on silicon, on the micro-scale; this can allow a lot faster processing without the great heat that we have today on chips.

I think that there's a lot of work that needs to be done in the area of artificial intelligence, getting closer to the job that a complete brain does for such things as robots of the future. So robots can be programmed to do normal tasks in the home. And we're not even close, we haven't taken any real steps ever, ever in artificial intelligence. A robot that can make a cup of coffee will never happen. This is because we're so far from all of the different steps being applied. All the different disciplines need to be applied together so that a robot can come into my house and make a cup of coffee.

One of the most important things that's missing is that a robot hasn't lived a human life of having used coffee makers, of having lived in houses, of having learned from experience. It's not the sort of thing you can just program a solution for. You've got to program it to be like a human and humans learn by watching others and by making mistakes.

**How do you feel about the way that IT is reported in the mainstream press?**

I think that it's reported pretty honourably, like IT is a learned discipline akin to doctors, lawyers – it's a profession.

**Do you see IT as an intrinsic part of business?**

I think it's like you need a car – people who make cars are experts in that area and they are professional and sure, it's just a tool or an enabler if you want to look at it like that way, but it's a part of life. Lawyers are on the whole paid more than IT people and that implies that they do it because they love it and that they are more ethical.

**What do you think are the challenges facing the IT industry over the next few years?**

Innovation and growth. Computers haven't changed a lot in 50 years. I mean, we still have a keyboard for input at some level and something we can see. Computers haven't really replaced, for example, humans as a teacher.

Computers are a nice animated book, but somehow it doesn't walk up and notice your facial expression and tell if you're having a good day or a bad day, or ask you a couple of questions about your family or know when to slow down and break just from the way that your face looks. So computers haven't really done the job that a human would do. In education that applies a lot.

It would be great if we could make one low-cost computer a teacher, and then every student can proceed at different paces. Every student could then easily say 'I want to learn subjects to the ultimate of professionalism, to the top level and I can go at different speeds to my fellow students if I want to – but I'll get through it all and get the learning done in the end.'

But you would need a computer that intrigues and pulls the student in, in the way a human would. I think this is possible and reachable, but will take an awful lot of work in areas of AI.

We try to run artificial intelligence projects in university research environments where it's normally the size of the job one person can do. This one almost needs a hundred very intelligent people working well together to solve a lot of the different aspects of everything from understanding a lot about vision, and what it means and drawing conclusions about it.

You can't even go on Google yet and say 'find me a picture with a blue bowl'. But these are things that normal people would ask. You can find any web page that ever wrote the word blue bowl, but you can't pull it out of pictures, you can't pull it out of audio recordings yet, we have to take those kind of steps to understanding the human side of the world.



**When you were working at Apple, did you ever imagine that computers would be so all-pervasive as they are now, not only in business but also in the home?**

It's hard to say. We spoke of it, but we didn't realise, even after we started the company, we didn't realise that we would have music on a computer or a photograph or a video – be able to store them or manipulate them.

Even in the late 80s, when it was getting close to the point when 1MB of RAM was affordable, we didn't think that. We didn't look ahead and think this is going to be the tool for editing video. A few of us were trying to get companies to go in that direction but it's very hard to see beyond a couple of years.

**Quick questions**

**Mac or PC?**

Mac. I always like to joke that I'm not very PC, that I don't like PC people, but that also means politically correct.

**Geek or nerd?**

I would call myself a nerd, and a bit, when I was growing up, I would say geek.

**Smartphone, PDA or iPhone?**

I love the iPhone. I threw away every PDA I ever had, but that's largely because none of them lived up to Apple's original Newton message pad, which operated more in the way that my brain works. I could think of something and write it with my own hands and the Newton would do it.

I could write 'Sarah, dentist Tuesday 2pm' anywhere and it would know that I am typing a command for a calendar and it would bring up the calendar and bring up the entry. I didn't have to think out a set of steps to do it. Whenever you've memorised a set of steps to get something done, it's like you're a slave to other people's procedures.

**How far away do you think we are from a different type of interface?**

I think we're very close, for example, a lot of the stuff on Google simulates what I just described. With Google calendar you can actually type in phrases – time and date and places – and it figures it out for you. Of course you have to already be in the calendar mode.

[The iPhone] has a type of intuitiveness that is very human, that we so often lose with technology and it just looks like the world we are used to on our normal computers. The gesturing with the hand actually becomes such fun.

Almost everything that Apple's done has really been based upon finding the normal human metaphors, the things we do in normal life, and applying that to computers. Right from calling a screen the desktop, because everyone already had a desktop, or shaping the mouse like a nice smooth stone that you might find in a creek. All these sort of aspects, right down to the shape and feel of an iPod compared with all the other music players that are around.

**How would you like to be remembered?**

I would like to be remembered as a brilliant engineer – number one. Also as a humanist who cared about other people. I did a lot of work in Cold War peace areas. I was a teacher, but I hid it from the public. I had a goal in my head to teach 10 year olds, and I'd had that goal since I was very, very young.

**If you didn't work in IT, what would you do?**

I think I would have been a teacher. Since I was young I respected teachers, I felt they were very important, as low paid as they are. I might have been some kind of social worker.

**If you could give one piece of careers advice what would it be?**

Try to know inside what your internal passion is. The thing you would do if you had no pay and no job. What would you do that makes you feel good inside? And that's what you should do – you shouldn't follow a formula from others saying this is the way you should go and this should be your career path.

**What gadget do you think you'll buy next?**

I buy all the gadgets so I'm trying to think of what gadget I don't have. I buy more than I actually use as I like to play with them in my hands and come to my own conclusions about what's good and what's bad about it. And I don't even pre-rate Apple products as 'for sure' good, until I have them in my hands. Just because they are Apple is not enough to sell me.

**If you don't like something, would you tell Steve Jobs?**

Yes, but I told him more in the past and things would get fixed very quickly when I reported them. But every once in a while they would fix part of something but blow up another part of it. I'm more interested in fixing the little flaws in computers that are obnoxious and annoy people.

Computer companies like Apple and Microsoft are more about pushing forward with the new than fixing the old stuff to be more human and more intuitive – the way that GUI computers were supposed to make life.

**Links**

Steve Wozniak's personal website [www.woz.org/](http://www.woz.org/)

Steve on Twitter <http://twitter.com/#!/stevewoz>

Computer History Museum [www.computerhistory.org](http://www.computerhistory.org)

## 5 CERF'S UP

### Vint Cerf, December 2006

**For a series of interviews with key figures in the IT industry for BCS's 50th anniversary, Brian Runciman spoke to Vint Cerf, Google's chief web evangelist.**

**What developments in computing do you think were the most groundbreaking or memorable in the last 50 years?**

We've gone from simple switching in the phone system to tubes to transistors to ICs, and that sequence has had a profound effect. It's produced powerful, small devices using very little power.

Sometimes people think Moore's Law has been outgrown and pursue new technology like gallium arsenide, but we keep finding yet more ways to tweak CMOS technology to make it run faster with less power, and its potential isn't exhausted yet. We will eventually run out of capacity for that technology of course.

An interesting example with regard to capacity – in 1979 I got some rotating magnetic memory, 10MB for \$1,000, but recently I bought a terabyte for the same cost. To buy that in 1979 would have cost \$100 million. I can assure you that I didn't have that kind of money then and, if I had, my wife wouldn't have let me spend it on a terabyte of memory anyway.

The other dramatic change is in widespread high capacity networks. Computers used to be standalone, but today we have computers in our pockets, embedded in cars, in the house and so on. The internet now has 400 million machines connected to it – not including laptops, PDAs and the 2.5 billion internet-enabled mobile phones.

So we have, conservatively, two billion devices on the net, but only one billion users. If we extrapolate that, we will soon have billions of devices interacting with an unpredictable effect on the network because they'll need to communicate with each other more directly than they do now.

**What recent developments by others have impressed you most?**

Other than using radio as an alternative to hard wiring, I think it's been very high-speed broadband delivered via optical cables or digital subscriber loops or cable that is available at consumer prices.

With regard to computers, one of the most interesting developments is dual core processors, because that makes it possible for one processor to watch another in a single computer. This is not just an issue of doubling its computing capacity,

but one processor could alarm if it detects anomalies in the other, producing a security effect.

Another important area of progress is that we now have a heightened understanding of the threat bugs in the digital online environment. The fact is that we can't write bug-less code and don't even know how to predict the number of bugs there may be in a certain number of lines of code and test for them. This is a high risk area for networks.

We've even taken language from biology to analogise threats – worms and viruses – and also mythology – Trojan horses. But we've not done a great job of responding to these security vulnerabilities.

It's not suitable to take one approach and assume it will work. For instance, we could encrypt everything at internet level, but then a virus in an email would be encrypted before it was sent and then decrypted at the end, intact, and the virus will still do its damage. Security is a many-layered problem in IT architecture.

I'm disappointed by our inability to produce more effective software, it certainly hasn't kept up with hardware development. Even things like Python and Java are a two- to five-, at best 10-fold, improvement in code production. For example, two laptops could communicate with each other and a server and we won't know the configurations of the machines and the software versions they are running, so it's like we are running an experiment every time we connect. Sometimes it fails.

Another security issue is physical. Someone can easily bypass firewalls by simply walking into an office with a memory stick. It's a very fragile world, very dependent on software working correctly. We should be asking the research community, and BCS can help here, to do a better job of improving software productivity and establish disciplines to improve the end product.

Why isn't software as reliable as hardware? It's down to complexity. Hardware is constrained because, although registers can have large values, the transformations are limited by the instructions of the computer. However, software programs are vastly more complex.

### **BCS is pursuing professionalism in IT. What are your thoughts on this?**

It's a very laudable position. The mechanical engineers here in the US are licensed, so if a bridge falls down they accept liability – their reputations are at stake too, of course. Something similar is needed in software, although not necessarily professional liability because of its complexity as we mentioned earlier.

In mechanical engineering, software is used to model and test designs, but in software we don't have empirical testing tools. However, software engineers should still be asking 'what can I do to ensure this works?' I'm not sure how it would work, but taking responsibility is what it's about.

**The UK has a problem attracting students onto IT courses often due to a geeky image. What should the IT industry be doing to improve this?**

It's interesting that you should ask because I was at a lunch meeting a few months ago, hosted by Cisco CEO, John Chambers, where Tony Blair was talking about this. We have the same problem here in science generally.

I don't think we celebrate successful scientists and engineers enough. Children are natural scientists, they explore, experiment, try things out, but our rote learning approach seems to drive this out of them. We need to rethink how we teach and celebrate science and technology and make successful scientists and engineers more visible to the public. We often don't know who invented so many things. This is not just about PR, but dedication in the country in finding ways to make these subjects interesting and important.

I can give you a personal example. In 1957, the Soviet Union got Sputnik into orbit, which provoked a massive reaction here in the US. Eisenhower asked how they got there first. This galvanised the country, launching the Advanced Research Projects Agency and NASA. The National Science Foundation started a huge educational programme for kindergarten to 12th grade students – I was affected directly. I thought I was going to be a nuclear physicist for a while, but I hit a brick wall with some of Einstein's stuff and ended up in computing.

**So in 2006, what's our Sputnik?**

I think it could be global warming. It's a threat to literally hundreds of millions of lives and it could happen rapidly. Ice sheets the size of Rhode Island are breaking off Antarctica. In Greenland the permafrost is thawing. The glaciers in the Himalayas that supply fresh water to 2.5 billion people in China and India are threatened.

We need to respond to this like we did to Sputnik, with a massive programme rooted in science and technology. We could address the use of petrol in cars, look at alternative power generation and so on. In France, for instance, 78 per cent of their power is generated by nuclear power stations, but the US hasn't built one for decades. If we don't do this the increased heat will release CO<sub>2</sub> from the oceans, which will exacerbate the greenhouse situation, producing more heat, and we'll end up in a vicious circle.

**Looking back on your long career in IT, is there anything you would do differently given the chance?**

With the design of the internet, there are several things I would change if I could. The 32-bit design was insufficient. We are now addressing this with the 128-bit address system, which will last till I'm dead, then it's somebody else's problem.

Authenticity as a principle would have been nice from the outset of the design. In 1978, public key cryptography wasn't generally available, but that would have helped.

As industry and business took to the internet so quickly, much clearer notions for virtual private networks would also have helped. And with the mobile internet world being so popular we could have done a better job of enabling mobile access.

**Does the web still need evangelists? How do you see your role?**

Very much, yes! In the beginning I asked for the title Archduke, but someone pointed out to me that the last one was assassinated, so perhaps it's just as well that it didn't fit with Google's approach! But we definitely need net evangelism. Even though there are a billion web users, that means that there are still many billions that aren't online. We have a long way to go for everyone to have access.

**BCS has a disability specialist group. Wikipedia said you suffer from a hearing problem. What should the industry be doing to improve social inclusion?**

There are many kinds of disability: physical, cognitive, many levels of visual, hearing and motor impairment, so no single trick will do it. To run a web page in audible form, for example, is very difficult as they are designed to be visual. Audio is serial, vision is parallel, so what should an audio output read first, and then next?

We need to re-examine the design of information systems and develop standards so that tools can help us create fully accessible content. At the beginning of the web, when people first put magazines online they presented them like they appear in print, but it just didn't work – that illustrates the problem, because ways of using information differ so much.

To address this we need a deeper understanding of the full range of impairments and a very deep understanding of how graphical user interfaces work. The Bobby standard is a good example of something going in the right direction.

**Which past discovery would you have liked to have made yourself?**

That's a very interesting question. I don't really have discovery envy, but I was quite impressed with the man who figured out how short-term memory works and what changes happen in the brain with the passage of ions in and out of the cell membrane, which makes a permanent change in the configuration of the surrounding molecules.

He said to me that he realised what was happening at three o'clock in the morning and was amazed to think that he was the only person in the world at that point who knew this. I wish I could say that. We don't really understand the brain and I'd like to know what the mind is.

**Who in the IT industry inspired you or was a role model for you?**

It's no one person. It was more a question of being immersed in an environment where science and technology was interesting and important.

We need to distinguish between inspiration and encouragement. I had endless encouragement from teachers. Once I complained to my fifth grade teacher that maths was too boring; he responded by giving me a seventh grade textbook to work through. I was very grateful for his willingness to challenge me.

**You're called the father of the internet, Sir Tim Berners-Lee, the father of the web – so what's your relationship to the web? Father-in-law? Uncle?**

That's almost like saying that in academic circles students are children of their professors and their students are grandchildren. The web is one application of the

internet. A rough analogy would be to say that Bob Kahn and I have built a road system and Tim and his colleagues have built the cars. Both have contributed to the infrastructure at different layers of a multi-layered cake.

Saying 'father' is not crediting others for their work – like Larry Roberts' and Bob Taylor's work on Arpanet. There's lots of credit to go round. I wish that more of the people that had worked so hard had had more credit.

**What's your favourite website, other than the obvious?**

It is the obvious – not because I work at Google, but because it's the tool I, and many others, use. I continue to be really amazed by the amount of information on the net. It's proof that people get satisfaction from knowing that others have benefited from information they've posted.

And the fact that some have monetised it interests me, because that allows for sustainability. Some of my favourite websites are the Smithsonian website, Nasa and, as I'm a science fiction fan, I download e-books too.

**What are the future problems for the net?**

Imagine it's 3000 AD and when surfing you come across a PowerPoint 97 file. Does Windows 3000 know how to interpret this? This is not having a go at Microsoft, because a lot of software support is retired.

So what can we do with unsupported formats? How do we get permission to run software on the internet? What if we need a different operating system to run it? We have an intellectual property challenge to preserve the interpretability of the bits themselves and we have the problem of the digital storage medium.

**What advice would you give to a budding IT professional to get the best out of their career?**

There are enormous research problems to be addressed, then lots of general things for designing applications for these systems. The thing I found most attractive about software development is that you can create your own universe. Software is a malleable clay to create and invent.

Is the phrase 'a career in IT' the correct formulation? What drove me was making computers and remote computers do things via programs or a network. It was fascinating to me to know that you could invent things that have a consequence for other machines or tens of millions of people.

Creative people are generally not driven by a desire to change the world, but are intrigued by a particular problem – what if I did this? What if I connected these? It's a curiosity itch. If you think IT is the career for you, you need to ask 'what is it I love to do?' Interest should be the prime driver.

I think software has the highest potential for a career because it's an endless frontier for invention and we need an increasing amount – particularly for mobile devices. It is also the most difficult area – who was it that said 'opportunity lies on the edge of chaos'?

### **What is Google getting by buying YouTube? Silly home movies or something web-changing?**

The internet is shifting video production from the entertainment industry to consumers, but the quality varies greatly. There are more editing tools now, though, so that will improve. For Google, the YouTube acquisition is an opportunity because it's a medium with a substantial clientele. Advertising revenue will work well in this medium and that will grow our footprint, but it was also a defensive move to keep competitors at bay.

### **Do you think development of the semantic web is the next big thing for the net?**

This is a conundrum. Sir Tim is very eloquent on the utility of semantic tags and I agree with him. Google could do a better job of presenting relevant search results with them, but where will the tags come from? What vocabularies shall we use? Who supplies the tags and will it be done manually, which has a scaling problem, or automatically? Hopefully the latter.

Today HTML and XHTML is usually generated automatically so we can imagine the same with semantic tags. But we don't have them right now. Meta-tagging has been abused by web page publishers to draw people to sites under false pretences, which has meant that some search engines ignore meta-tags. This is about getting authenticity into the web – digital signatures would be a partial help there.

### **Wikipedia mentions a rumour that the term 'surfing the net' originated from the first data sent across the network by you. Is that true?**

It is not true. It comes from the idea of surfing an ocean of information. Back in 1989 the San Diego academic community CERFnet, was going to be called SURFnet, but a company in The Netherlands already had the name, so they couldn't use it. They called me to ask if I minded if they could use CERF for the California Educational Research Foundation. I wondered whether if they messed up it could be embarrassing, but parents name their kids after people, so I thought 'why not?'

The epilogue to that is that the company was eventually acquired by AT&T and when I asked if I could have my name back they said no, although a little more strongly than that. Perhaps now I'm at Google they'll say yes, or maybe just quote me a big number.

### **As if the internet weren't big enough I believe you're involved with the interplanetary internet?**

This has gone very well. We started this in 1998 with engineers from the Jet Propulsion Laboratory so we could support any space exploration going on around the world, not just US projects. At the moment space communication is done via point-to-point links and is very slow, so we wanted to introduce the flexibility of an internet-style approach.

However, the internet's standard protocols are not a good tool for interplanetary communication – when you consider that it takes a signal, even at the speed of light, 20 minutes to get to Mars, for example, and then another 20 minutes back. You could go to lunch after clicking a link.



We can use standard internet on the spacecraft and planetary surfaces, but we have had to design a new set of protocols to link these independent internets together across interplanetary distances. NASA is now planning a new architecture for deep space communications with new standards to get interoperability between old and new mission assets, with the interplanetary internet underpinning it. That means we can accrete an interplanetary backbone.

### **Quick questions**

#### **Open source or proprietary?**

Generally open source – it doesn't necessarily mean free, it's just that you can see the content of the software. I will say that OS is not the solution to everything if it isn't being maintained. It needs a support mechanism.

#### **Blackberry or PDA?**

I'm using a Blackberry, although I consider it to be a PDA. I also have a mobile phone.

The latest PDAs have very high-resolution screens, but the type is very small – maybe anyone over 26 needs a magnifying glass. It does lead one to think about voice interfaces.

#### **Apple or PC?**

Both. I have Macs at home and an IBM ThinkPad – although I am a fan of Macs.

### **Links**

Vint Cerf [www.ibiblio.org/pioneers/cerf.html](http://www.ibiblio.org/pioneers/cerf.html)  
[www.icann.org/en/biog/cerf.htm](http://www.icann.org/en/biog/cerf.htm)

Vint Cerf's Top Sci & Tech Videos by Five year's Channel on YouTube  
[www.youtube.com/playlist?list=PLE393E6A9AACD5554](http://www.youtube.com/playlist?list=PLE393E6A9AACD5554)

Recent BCS interview with Vint Cerf [www.bcs.org/vintcerfvideo](http://www.bcs.org/vintcerfvideo)

## 6 COMPUTING'S TOO IMPORTANT TO BE LEFT TO MEN

Karen Spärck Jones, March 2007

**Karen Spärck Jones is winner of the 2007 BCS Lovelace Medal. BCS managing editor Brian Runciman interviewed her.**

### **By way of introduction, can you tell us something about your work?**

In some respects I'm not a central computing person. On the other hand, the area I've worked in has become more central and important to computing. I've always worked in what I like to call natural language information processing. That is to say, dealing with information in natural language and information that is conveyed by natural language, because that's what we use.

I think that what has been happening is that those kind of things that were initially thought of as external applications, rather like accounting packages, are becoming more central, and not just because more people are using browsers and search engines, but because the information itself they are working with is becoming much more central to what people do. You could argue that this natural language stuff is the material of an information layer, part of a computing system, not just on the periphery.

I can see systems, even operating systems and security, making use of the information that's in that layer. It may be informal information and not nicely coded up, but it may be usable all the same. Natural language isn't coded up for us, but it's there and we use it. What's surprising looking back on the 50 years of BCS is how old some of the ideas are.

### **What recent developments by others have impressed you most?**

I'm not an IT professional, but a researcher. I don't use a lot of things that people swear by now because they're not particularly pertinent to my work. But I do think that the web has made a difference and, in my own area, progress has been made. In AI, we may not be able to do some of the things that were originally hoped for, like the ideas from the Dartmouth conference in simulating humans. But it's done other valuable things on simulating.

Progress is sometimes made in ways that people didn't predict. Basic ideas can develop slowly, but sometimes things come along that are effective, yet were unpredictable. Many people say what's exciting now is images and video, but I think that's very overrated. It's nice to see them, but if you want to talk about them, what are you talking with? Words.

Nevertheless, what is important is that research and professionals are connected; computer science produces the stuff that professionals use. One thing that gets me steamed up about teaching in schools is that they don't realise what work goes into producing the stuff they use. Take spreadsheets – it's hard work to produce a good spreadsheet package, but if people only learn how to use them, and not what's behind them, we're missing a trick.

**BCS is pursuing professionalism in IT. What are your thoughts on this?**

I certainly think that professionalism is very important. I took part in one of the Thought Leadership Debates, about security and privacy, and I was having an argument with a young fellow there. He was slightly surprised that I said that, to be a proper professional, you need to think about the context and motivation and justifications of what you're doing.

A true professional will think like that. With ID cards, for example, I was concerned that people would treat it just as an opportunity to do a good software job, if the government's got a sufficiently good idea of what it wants. But things like that have a fundamental effect on people's lives and being a true professional means that you must contextualise your work.

**Is there an ethical dimension there?**

I think there is. This chap, who in many ways was thoughtful, said that his organisation only thinks about what the spec is and whether they can do a good job of it – what I call the first layer of being professional. But the second layer is the rationale for what you're doing.

You see, I could probably write a very good program for choosing people to be killed for some reason, selecting people from a population by a particular criterion. But you might argue that a true professional would say, 'I don't think I should be writing programs about this at all.'

The point is that there is an interaction between the context and the programming task itself. And as we know with the privacy debate, getting the system architecture right is extremely difficult. You need a deep understanding of what the whole thing is about to get that right and to appreciate that it still won't be perfect.

You don't need a fundamental philosophical discussion every time you put finger to keyboard, but as computing is spreading so far into people's lives you need to think about these things.

**The UK has a problem attracting students into computer science courses often due to a geeky image. What should we be doing about that?**

There is more than one reason why people aren't attracted. One of them is that teachers say they are fed up with the emphasis on what you might call shallow IT skills in schools. Focusing on whether you can use a word processor or spreadsheet, so that you completely conceal what the actual things you use are like.

A very good example of that happened 10 years ago, but still applies. We were trying to get at girls in schools and we knew we had to get to the teachers first.

We found that the spread of computing in administrative and secretarial world has completely devalued it. When one of the teachers suggested to the parents of one girl that perhaps she should go into computing the parents said: 'Oh, we don't want Samantha just to be a secretary.'

That's nothing do with nerdiness, but the fact that it's such a routine thing. Then there is the nerdy thing and also people don't see the challenge of designing, building, implementing, testing and evaluating programs. There are plenty of things that are very, very hard to do. Think about someone who wants to model climate change – you've got to do more in the program than just take a few equations and churn them.

Nerds often don't do proper computing either – it's more geeky one-upmanship. Then there's this endless dreary games playing. They talk about the wonders of modern graphics, but if you look at screens with games on them they're not really very realistic.

People, because computing is so routine, don't think about the whole social context. Think about the NHS stuff – if that worked it would affect how the entire health service ran, from the nurses to the consultants and all points in between. People have got to understand that these systems are embedded in our lives. It's getting across the challenging, fascinating, technical things to do. How do you capture a problem so you can write a program about it?

**This year BCS is trying to improve the public understanding of IT. What do you think we should do to achieve that?**

It's interesting – the challenge is to convey why things are worth doing and why it's hard in a simple way. Like tracking a patient through their entire medical life: what's important, how do we relate items to each to each other? It's the technical challenge of understanding the task and its social context.

**How do you feel about winning the Lovelace Medal?**

I was stunned. I looked up previous winners and thought 'what am I doing in this bunch of people?' But I was especially pleased to see that I was the first woman to get it. Very nice. I really appreciate it.

**Looking back on your long career, is there anything you would do differently given the chance?**

It's hard to say. You can't predict in the beginning what's going to happen anyway. There's unpredictability for a variety of reasons. One is that people find out that they can or can't do things that they thought they were going to be able to do and so that tends to cause people to change course. Alternatively, something can come along from the side and it can blow away what you were doing, or blow you away in another way, and you realise that's the really interesting stuff.

As a researcher, you don't usually jump from one thing to another. But there are adventitious factors. When you're older you can choose to an extent what you do, but when you're younger, if there's no money, then you have to go where the money is. Many computing research areas suffer from a dearth of money.

For example, the funding agencies in the US cut out everything to do with translation for rather bad reasons in the mid 60s. Researchers don't throw away what they've done, but cut their cloth accordingly and make a shift. It's complicated. Research is amorphous and has overlapping threads and sub-areas and people move for a variety of reasons.

### **What impact would you like to see your research having on everyday life?**

One thing I did when I was working on document retrieval in the 60s was to work on automatic classifications. You found classes of words to make matches, but some of the experiments we did didn't work out as we thought and we were trying to understand why it was happening.

This caused me to develop the idea of weighting words statistically – looking at word frequency and in how many documents a word occurs. Because in general, if a word appears in a lot of documents, most of them are not going to be of interest, so you think of inverse document frequency weighting and I published a paper about that in 1972.<sup>1</sup>

This was put together with another type of weighting, which was how often a word appears in a document. At that time there was no immediate application in operational systems. There were bibliographic services, where it could have made a difference, but they were hooked in things like Boolean searching and thesauri and so on. The library world is very conservative and they only slowly picked up the idea of natural language searching. Researchers were convinced by the 1980s that statistical searching was a good thing to do and by 1992, 20 years later, two things happened. Firstly, a large research programme was started up called TREC (Text Retrieval Conferences) and that attracted attention because the collections were so large that people thought statistical techniques would work.

More importantly, what came along a little bit later is the web. It accumulated a lot of information and the point of the web was that it was the computing community not the library community running it. Mike Burrows, who originated Alta Vista, had a large usenet file that he wanted to retrieve from and I and a colleague had written a little paper called 'Simple proven approaches to text retrieval' in 1994 which contained all the basic ideas of this research and the theories underpinning it. Mike asked Roger Needham about retrieving from his usenet stuff and Roger gave him the paper.

Mike read it and started from there. So he didn't read a lot of library stuff; he took the paper and started the first of the modern search engines. Pretty much every web engine uses those principles.

There was no way these things could be implemented in a useful way in 1972, but by 1997 it was working with the full text it needed. So these statistical ideas that I've contributed to in one way or another are spreading around in this modern computing world.

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<sup>1</sup> Karen Spärck Jones, (1972) 'Statistical interpretation of term specificity and its application in retrieval,' *Journal of Documentation*, 28:1, 11–21

**Who in the IT industry inspired you or was a role model for you?**

In a way my first employer – I worked initially for the Cambridge Language Research Unit. It was run by a lady called Margaret Masterman, who was extremely eccentric and was the person who started CLRU with some rather original ideas about how to do machine translation. She got a grant and employed people. Roger Needham worked there too, during his PhD.

She'd been a student in Cambridge and had suffered from all the chauvinism of the Oxbridge model of academic life and she was a firm believer in making sure that women got an opportunity. She had no prejudices about these things, but de facto she encouraged me because she hired me.

She was not a role model in the way she worked and I disagreed with some of her ideas, but she was a role model in that she showed me there is nothing to stop women working in this area. At that stage there were no opportunities for women. You have no conception of how narrow the career options were.

I think to some extent my husband Roger (Needham) has been a role model too, but in a very different way. What he did was encourage me. When you're on your own in a subject and living on soft money, as I did till I was over 50, that's very valuable. He was always encouraging me and I could always talk to him about my work.

**What are the biggest challenges facing your discipline?**

The main challenge in text retrieval is that it is a very large area: on one hand represented by people like Google; on the other hand by all the skilled professionals that still use these specialised classification languages and things like that to do very specialised searches.

The main problem with web engines is that you don't get anything much in from the user. Typically, if you search for a topic you don't get far with a collection file of billions of documents from a two word query. People have tried all sorts of carrots to get searchers to put in better queries or interact a bit more – like using feedback to bootstrap a better query. All it requires is for individuals to mark what is useful so the next batch of documents are new.

The other challenge is how to integrate image retrieval. Speech retrieval is not such a challenge because it can be transcribed well enough to do retrieval. But image is a different ball game. How can you find images 'like this one' if you haven't got one to start with? Many people are trying to tag images with text, but it's very difficult to evaluate the efficiency of different methods.

People build systems and throw them at the user and say, 'isn't this fun?' But that's not the same as demonstrating that a system is better. Controlled experiments are difficult to do with real, live users and they are expensive. Evaluation of ideas in any field is important. For example, we can all have an opinion about a translation and spot a good one or bad one. But you could have two equally good ones – does that make a difference? Maybe one is better than another. How can we find out?

### **What are your thoughts on the semantic web?**

I think the semantic web has modified its meaning, but the all-singing, all-dancing version, which is a model of the entire world of everything, I'll stick my neck out and say I think is fundamentally misconceived. It's something that philosophers thought they could do in the 17th century, and Leibnitz was no slouch, but they couldn't do it. For good reasons, too: you can't code up the world, it's not tidy like that.

What you can do is code particular worlds for particular people and purposes. That's what biological taxonomies are about, but that's for experts.

In some respects there's an analogy with expert systems; people say if only we could get the expert's knowledge out of his head and coded up; and you can do that for a closed world. But you're likely to find yourself walking over the boundary of a closed world without realising it.

Say you want a specialist database on blood, a fluid. You don't include in that a lot of stuff, like if you drop fluid from a height it breaks up into drops. There's a lot of general information about fluids you wouldn't want to put in a haematological database.

But at some point people are assuming you know it. What's happening is that the semantic web stuff is going into knowledge representation, but there is a limit to what you can code up about the meaning of an ordinary language word.

We can't model everything. Many of the semantic web people are now thinking more about an upper layer and they are rediscovering some of the stuff that the AI people have already done. The model now is that you will have your specialised world models for specific domains and then a relatively solid bridging layer; a top layer that provides enough resource to get from one domain to another, but even that's hard to do.

It's hard to plug specialised knowledge bases into a general overarching layer. My model is to say you can have your specialised areas, but bridge in a lightweight way through words. Take blood again. Let's just follow the word, don't go via blood is a fluid, blood is red and has a temperature of  $X$  degrees – the upper layer should be a much lighter connective structure, essentially a natural language approach.

Different domains do share vocabularies and words can mean different things, but they are similar enough that we can communicate.

### **Using speech applications seems to have applications for those who are disabled.**

These things are fine. Everyone thought things would be revolutionised in IT applications when we had speech recognition. But they didn't appreciate how slow speech is. You can use transcribed speech faster than speech is uttered. I can scan a document very quickly, but if I read it to you, it would take far longer. So the idea that we can throw away boring old text is completely unrealistic.

But that doesn't imply that speech interfaces aren't very useful for the disabled and people also want to transcribe speech – like the intelligence agencies. If I wanted to rent a car abroad, it would be jolly nice to pick up the phone and have my speech translated. All that's cool, but that's not the same as throwing away text for speech as the answer to everything.

### **What's your view on women in computing?**

I think it's very important to get more women into computing. My slogan is: Computing is too important to be left to men.

I think women bring a different perspective to computing, they are more thoughtful and less inclined to go straight for technical fixes. My belief is that, intellectually, computer science is fascinating – you're trying to make things that don't exist. In that respect it's like engineering, trying to build new things. Take skyscrapers – they had never existed and provided fundamental engineering challenges: weight, windforce and so on. We need women to see the intellectual challenges and social importance of computing, all of the things that computer systems are used for now and why it matters to society.

It seems to be a problem, perhaps more with girls than boys, that you've got to get them hooked young enough, then keep them hooked. If they are not interested by the time they are 13, you've lost it – I'm talking about girls who may go into the subject in some depth.

ID cards are a very good example of this. It's a fundamental notion – it will cause a person as a legal entity to have a particular definition. Think about the implications of CCTV, another example, or health and education. Should we do all of our teaching via IT? What's the function of education – can this be achieved with IT? What about climate change and sustainability? Think about the fact that most women drive – traffic modelling is a growing area. What is it? How should it be factored in charging for where you go, convenience of route and so on? All these things are part of the fabric of one's life.

So I've always felt that once you see how important computing is for life you can't just leave it as a blank box and assume that somebody reasonably competent and relatively benign will do something right with it.

**Thank you.**

### **Links**

Karen Spärck Jones obituary [www.cl.cam.ac.uk/misc/obituaries/sparck-jones/](http://www.cl.cam.ac.uk/misc/obituaries/sparck-jones/)

Karen Spärck Jones' Lovelace Lecture 2007 [www.cl.cam.ac.uk/misc/obituaries/sparck-jones/video/](http://www.cl.cam.ac.uk/misc/obituaries/sparck-jones/video/)

Cambridge Computer Laboratory [www.cl.cam.ac.uk](http://www.cl.cam.ac.uk)

BCS Karen Spärck Jones Lecture Series [www.bcs.org/events/ksjlecture](http://www.bcs.org/events/ksjlecture)



BCS Lovelace Lecture 2008: A tribute to Karen Spärck Jones [www.bcs.org/lovelace/lecture/2008](http://www.bcs.org/lovelace/lecture/2008)

BCS Thought Leadership Debates [www.bcs.org/thoughtleadership](http://www.bcs.org/thoughtleadership)

Dartmouth AI Project Proposal [www-formal.stanford.edu/jmc/history/dartmouth/dartmouth.html](http://www-formal.stanford.edu/jmc/history/dartmouth/dartmouth.html)

## 7 ISN'T IT SEMANTIC?

### Sir Tim Berners-Lee, 2006 and 2009

**In two exclusive interviews in 2006 and 2009, the inventor of the web, Sir Tim Berners-Lee, spoke to BCS Managing Editor Brian Runciman about the development of the web, his view on the advent of artificial life forms on the internet, the biggest barriers to enabling the information society for all, where the mobile web is going and more.**

#### 2006 interview

**Looking back on 15 years or so of development of the web, is there anything you would do differently given the chance?**

I would have skipped on the double slash – there's no need for it. Also I would have put the domain name in the reverse order – in order of size, so, for example, the BCS address would read: `http:uk/org/bcs/members`. This would mean the BCS could have one server for the whole site or have one specific to members and the URL wouldn't have to be different.

**What subsequent web developments by others have impressed you most?**

The Google algorithm was a significant development. I don't want to name too many, but in general I like the fact that I've had 'thank you' emails from people whose lives have been saved by information on a medical website or who have found the love of their life on a dating website, which is great. The important thing is the diversity available.

**If there was one 'quick win' that could improve any aspect of the web right now (other than the semantic approach, more of which later) what would it be?**

Something that looks easy – browser security. Most browsers have certificates set up and secure connections, but the browser view only shows a padlock – it doesn't tell you who owns the certificate. Just having the browser tell you this makes perfect sense – it's a little thing but 'duh'. We have a working group now at W3C looking at that kind of thing because it's got a lot to do with user interactions with systems.

**What are the biggest issues the web needs to face now and in the near future?**

There are three main areas. Firstly, security – phishing is mostly done via email, but it involves HTML so W3C will address this issue. Secondly, the Mobile Web Initiative is important – information must be made seamlessly available on any device. And finally, web services, where re-engineering and enterprise software are key issues.

**I saw your interview with Mark Lawson this year – he seemed to be trying to lay the blame for the negative aspects of web content at your door. How do you feel about the media’s approach to the web?**

That was atypical. People actually emailed to apologise on his behalf, but I think he was just trying to make the interview more interesting. In any case, we shouldn’t build a technology to colour, or grey out, what people say.

The media in general is balanced, although there are a lot of issues to be addressed that the media rightly pick up on. For example, intellectual property is an important legal and cultural issue. Society as a whole has complex issues to face here: private ownership versus open source and so on.

**Will software patents have a negative effect on the development of the web?**

There are major issues here. Eolas, a spin-off from the University of California, claimed ownership of a unique combination of embedding objects into a web page so that it happens automatically through use of compiled code. This is an example of a random patent of a combination of existing technologies.

The claim was based on that fact that it’s done by compiled code, but any good software engineer will tell you that a compiler and an interpreter are interchangeable. Programming is always about reassembling existing stuff – novel ideas are rare. Even the development of the web hypertext was already there and so on.

A bright idea is OK, but getting people to adopt common standards is impeded by patents. At W3C, we have a working group that had to stop work on a project for 18 months (a lot in web years!) to answer a patent issue. This affected the livelihood of people in companies that were doing really good work.

Often, the cases we’ve seen involving patents on web technologies have been spurious at best. There are many cases in which a patent’s novelty is extremely unclear, but the legal costs of discussing it would be prohibitive.

Patents are often used by large companies who can afford the legal fees, or some one-man-bands who have nothing to lose and hoping for a pay-off from a larger company. They are often defensive against other patents. Because of this W3C now has a patent policy.

To be fair, most larger companies have now had a serious change of understanding and see that for the market to grow web infrastructure must be royalty free.

**Project failure is a big subject in the UK and you’ve been involved in a massive ongoing IT project. What have you learned from it that could benefit our members?**

This is a huge area. An answer would fill several books, but I think IT projects are about supporting social systems – about communications between people and machines. They tend to fail due to cultural issues.

For example, moving control of data from someone with 20 years experience of working with it to someone else can lead to problems, as a company you lose with this approach. The original idea of the web was about supporting the way people already work socially, but this doesn’t happen with a lot of IT projects.

The view we are taking with the semantic web is interesting here. In the past scientists have been trained to do things top down. In the business world projects are often the boss's vision made flesh.

Even software engineering is about taking an idea and breaking it into smaller pieces to work on – but the software project is itself part of something larger. To make this better we need web-like approaches. I'm not talking about HTML here but, rather, an interconnected approach.

The semantic web approach can be visualised as rigid platelets of information loosely sewn together at the edges – rich in local knowledge, but capable of linking to things in the outside world. That approach would benefit the social aspects of projects.

**In your book *Weaving the Web* you mention the aim of making the web operate more like the human brain in making unusual and richer connections between data. Doesn't the web perform that function better in a way now because of the tangential returns you get from searches? Wouldn't the ontological approach make the web less like the human brain?**

Well, the semantic web is about data. The web of human ideas is served by the hypertext web, but the semantic web helps with machine analysis. Take the current concerns over bird flu. Is it only around agricultural areas?

Suppose we have shared terms (URIs) for latitude and longitude and time. That would allow so many forms of public and private data to be correlated. We could also combine any, say, medical data, with socio-economic data from the World Bank – land use and so on.

This could co-relate bird flu information and export it to a spreadsheet and lead to serious analysis. So, where HTML provides information in a way easy for humans to read, the semantic web will enable much better analysis of it.

**Brian Eno gave a speech a few years ago on generative music – he said that he likes the economy of it, that just from a few simple rules, complex and fascinating things can arise. How good an analogy for the rise of the web from a relatively simple approach – hypertext and links – is this?**

This is where web engineering, physics, web science and philosophical engineering meet. Physics was actually called 'experimental philosophy' at Oxford. The web is now 'philosophical engineering'. Physics and the web are both about the relationship between the small and the large. In physics, to take the behaviour of gases as an example, you visualise them as billiard balls, model the rules they follow and then transpose that to a larger scale to account for the effects of temperature and pressure – so physicists analyse systems. Web scientists, however, can create the systems.

So we could say we want the web to reflect a vision of the world where everything is done democratically, where we have an informed electorate and accountable officials. To do that we get computers to talk with each other in such a way as to promote that ideal.

**GUIs are a big influence on an individual's web experiences. What improvements do you think we need there because, with the best will in the world, a beginner still cannot go online and work a browser/editor intuitively?**

There is always work to do on interfaces. I've been playing with Ajax technologies to explore that space because it can be a lot better. I like to use a really big screen – lots of pixels.

Even when I do things on paper, I like to use an A0-sized piece of paper and felt-tipped pens [Sir Tim shows me notes from a recent meeting – huge piece of paper, lots of colours]. The internet is a technology to help you get hold of a lot of data, so you should be able to see it.

At the moment a lot of company knowledge is held on spreadsheets and PowerPoint slides, because companies need to see summaries. But the data has lost its semantics, so it's not usable.

For the web, people make extensive use of the favourites menu or the history, but there's still a long way to go in collaborative data. Blogs are editable in a limited way, HTML is too complex, but at least blogs allow people to be a little creative.

**Why is a web year 2.6 months?**

It's about the pace of change. I don't know who made up that number. It was an expression of the acceleration people felt during the early 1990s. Compared even with the development of the phone or TV, the web developed very quickly. I think it is now coming to the end of its adolescence, maturing after a phase of testing its boundaries. Even phishing and spam have been part of its education.

In the past you'd have restrictions, like finding books saying that you needed to design websites that fit an 800 × 600 pixel screen. Now that people understand standards and business more they know there's always another browser round the corner and the view of web and its technology is maturing accordingly.

**2009 interview**

**I interviewed you in 2006 and we talked about the semantic web. I expected to hear a lot more about it in the media, in the intervening time, but haven't really. How are things going in that field?**

Well, what has happened is that we've realised that the data layer of the semantic web is the one that we need to focus on (for most people), so people in IT really need to use it for sharing the data. Semantic web is basically data integration technology where you don't just integrate across the company, but you can integrate across the whole organisation and integrate across the planet and not just within a domain, but between different domains.

So we focused on the data and, as that layer is really very simple, we've been calling it linked data and this is the Linked Open Data Movement, and so really linked data is easier to understand. The semantic web has a lot of technologies and it's got query languages, which of course you need; imagine doing databases without SQL. When you integrate that data, you use Sparkle. Our ontology language is quite complicated, but, in fact, people use very lightweight ontologies when they're surfacing their data.

Just to say, by the way, when we say latitude there and lat here we meant the same thing; that is amazing. What it does, the Linked Data Movement has been picking up on and if you look at the Linked Open Data cloud and you watch how it's been going over the years, it is very satisfying.

**We noticed when we were doing research that you have an Engineering and Physical Sciences Research Council (EPSRC) grant. I think it is called *Enacting the Unbounded Data Web*. Is that linked in with that? Could you tell us more about that?**

Yes, that's research to look at situations where we've got a bunch of data linked together, to see what we can do with them. This research looks at the second level questions such as how can you make a really good user interface to it? How can you, when different people have resolved and surfaced different things separately (which is the way to do it by the way)? Then afterwards obviously you think, oh well, where is the best place to sew these sets of terms together, what is it worth and what is the best way of figuring out how to convert data dispersed in that vocabulary into another vocabulary.

In managing a vocabulary socially, there are all kinds of really interesting questions which will arise in the future and will arrive when we have got masses of data. To be responsible you have got to look ahead and search out when all this will happen and when this work is done, look toward the secondary issues.

**We posted some comments on Twitter when we knew we were coming to see you, and got some interesting questions back, plus a couple of odd questions. HTML 5 came up. People want to know how you envisage that changing things as it seems like a sea change in the HTML sphere. What do you see?**

In one way, it is not really a sea change at all. HTML has progressed over the years and every now and again it needs new things as a mark-up language, but really the big difference with HTML 5 is that the people who are most excited about new features in it are the people who are using it for whatever web platform.

So, in fact, it is a user interface platform and the switch from looking at a web page, which is static and has gone through a content management system, to looking at a web page, which is actually a program and which gives you access to a whole new world out there, that of course is a sea change. So that's the change of attitude. It's still HTML, in fact it's the same language core that is being used for both web applications; it's not just HTML spec, it's lot of web application specs around it that make it into a powerful programming environment.

**It seems, when I was reading up about it myself, that more of the media approach is being taken into account with the language, like embedding video and audio. Is that to respond to the huge growth in social networking and that kind of thing?**

There are all kinds of places where you use video. However, it's impossible to embed into HTML, but to have a video tag is a clean and easy option and makes it easier to be able to say what controls you want and people do that a lot. I think that really comes from the fact that bandwidth is getting to people's homes; it's straightforward because people do use it a lot for social networks and all kinds of sites. Public relations sites use it, when you are buying a car, all kinds of things. Video is ubiquitous in a sense; it turns up on all kinds of sites, but remember, of course, there are people who don't have broadband and just use their mobile devices.

**One of the more strange questions that came from Twitter was this one: do you think that artificial life forms may already exist on the internet? A bit of a philosophical one really.**

No, I don't. I think a lot of people have been trying to make things which have life-like properties. If you want a strict answer to this, you could say anything we produce is alive, so in that case a virus is an artificial life form.

But I think what people mean when they talk about whether something has an emergent intelligence or not is 'have we got so many computers "talking" together'. Like in the famous Arthur C. Clarke story *Dial F for Frankenstein*. He imagines all the traffic lights going red or going green, because the 'baby' has woken up and it's crying and is learning to use its new sense of outward peripherals, it's figuring out what they do.

I think there is nothing which you'd call a 'thinking thing', like a mind, out there. However, there are lots and lots of really interesting emergent properties, the whole blogosphere and all kinds of social systems, which happen because they're intermediated by machinery on the web. These social machines help people create new democratic systems. For example, they let them do peer review journals or let them do a peer review on each other's comments.

I think it is not artificial intelligence really, but there are very powerful systems which do more than an individual person could do; if you like, a collective intelligence. They're always asking the question 'why can't we make a group of more than one person smarter than one person?' I think we need to do a lot more in that area.

**I'm glad I asked that question from Twitter. How do you feel about those kinds of tools? You do have your name reserved on Twitter at the moment – Tim Berners-Lee – and the chap's got your name posted as 'waiting for the great man to come along'. What do you feel about that thing?**

Twitter, in general, is interesting. Both from the architecture point of view and from the computing point of view of course. Twitter is one of the centralised sites. I actually have 'timbl' on identi.ca, another twittering, microblogging site; it's actually open for software.

There are 30 odd clones of it around and anybody can start a Twitter site. They're looking at the question of 'how, if I'm tweeting on one site, do you follow me from a different site?' The really important thing about the web is that it is decentralised, that anybody can start a site server. The question is 'how can we make protocols so that you can follow me on other sites?' I will probably get hold of, thank you, whoever is holding 'timbl' for me on Twitter. I don't have 'timbl' and that's what I use and I miss that on Twitter.

**What are you currently working on yourself?**

There are lots of things happening. I'm director of the World Wide Web Consortium, which is doing more and more stuff everyday. We've talked about HTML 5. There's the push for mobile internet, which is still very important of course. There are all kinds of technology and all kinds of semantic web technologies. If you go to the W3C site at [www.w3.org](http://www.w3.org) you can catch up with what I'm doing.

I do encourage people, whether they're from light companies or from a background of programming in their garage, to get involved with the W3C, if they're interested in the standards. I'm involved with that. I'm involved in web science. In the case of the Web Science Research Initiative, we're now making it into a registered charity, the Website Trust, and that is trying to get people to look at the web as some big system we really need to study.

We've talked about 'What are the emergent phenomena?', 'Are there good things?' 'Are there bad things?', 'Is it stable?', 'What properties does it have?', 'What properties do we need from it?', 'What is happening out there or what could happen?', 'What could we do?', 'How should we change web protocols or invent new web protocols, so as to make new really interesting and valuable things happen with all the people connected together?'

The web connects to humanity and humanity is connected by the web. The Web Science Trust is trying to promote and coordinate and make websites happen. The goal of all these things, I suppose, is that the web should serve humanity. In fact that is a very broad goal: to serve humanity. And thinking about that goal we realised we need something broader than just the web science.

We now have the Web Foundation, which I'm a founder of; I'm still on the board. It's now run by Steve Brunt, who used to be CEO. W3C, however, has a very much broader scope and way of doing things. In realising that 80 per cent of the world doesn't use the web at all, we had a look at a bit of Africa, had a look at the way people use the internet and are looking at projects to tweak the technology so that it is more appropriate for use in developing countries.

So I'm involved with all those things, plus I'm a full-time professor here at MIT and I'm a professor at Southampton. I've got quite interesting projects going on at both sides of the Atlantic, collaborating on a good day, and we've got students doing all kinds of things. My particular interest, for the past few years, has been the user interface to the semantic web, looking at how there's a lot of stuff out there and how you can make best use of it all.

**Let me just pick up on something you said there: about 80 per cent of humanity not having access to the web at the moment. One of the goals of BCS, as the Chartered Institute for IT, is to get society web-enabled internationally. Is the biggest obstacle to this goal the fact that there is still a huge chunk of humanity that still doesn't have access to the web or are there other challenges?**

The fact that there is a large amount of humanity which does not use the web is a drawback; it's something that is changing and we've got to be aware of what is going to happen, as a very much larger number of people get on board and start producing content in various different languages and for various cultures.

I think there are a lot of other things that we have to think about as well. I think some of the existing things that people are experimenting with across the web – with different types of self-governments or different types of governance in different organisations – I think it's exciting, because maybe they will find ways of building organisations which are somehow fairer and more effective.



Maybe they'll find democracies or meritocracies that work well? We hope to see people working together more respectfully, more internationally, crossing borders and so on. There are a lot of things which are social and technical about the web, which are very important.

**You seem to have a very positive view of the way the web enables people, seeing it as generally a strong social tool?**

It's designed to be a neutral social tool. It is designed not to try to constrain what you do with it. What you do with it is up to you and so what humanity does with it is up to humanity. There are of course good and bad uses for any powerful tool, and out there you will find stuff that enthralls you and stuff that you abhor. But, in the end it's all about humanity, and it's humanity I am optimistic about.

By the way, there is one thing I am working on which we didn't mention, which is particular to this year. 2009 has been the year not just for putting data on the web, but particularly in pushing government data on to the web. So we've got this project where the Cabinet Office has put data onto the web in the UK, which is really exciting and there are lots of people in UK government and around the government who get it and they know and are excited about linked data.

As we talk, we are accumulating data sets linking them together. I think that's very exciting: it's very nice that there is a mirror initiative, different, but also very strong, in the US. The Obama administration has made it mandatory to put government data online and there's data.gov and recovery.gov, which are places where the government has been transparent about what it's doing by putting data out there.

I think the value of having government data out there in the end will be huge and people will use it, not just to hold the government accountable, but because it's valuable data. It's useful data for industry, so I'm hoping that, once government has put data on there, industry will realise 'actually, if we put our stuff on there as data, the whole market will run much better, the whole industry will run more efficiently'.

**I want to ask you about the mobile web a little bit more, because obviously there's a huge demand for web on the move and that's only going to increase. Are we getting our approach right?**

Well, we have got a mobile web initiative at W3C, which has been looking at the question of when you have this huge diversity in devices, of people looking at the web on their wrist watches, more or less, and looking at them on screens which are becoming bigger and bigger. It is very different from the days when people were misled into putting 'please adjust, you should be using a 800 × 600 screen to look at this website' messages on their devices.

Life is not like that; not everyone has the same sort of computer. That's been the general situation with the web, but now it's very acute and it's very important in developing countries where often a mobile is the only device somebody has. If they can't figure it out on their mobile device, there's no laptop to go to.

The art of how you take the same information and make it available to people on all these different devices, or even to people who are illiterate for example, who need it to be read to them or need to watch a video, that is something that we are only starting to understand. To a certain extent the semantic web helps you think at the logical level or conceptual level that this is not a web page about a flight, this is flight BA124. This is a particular flight and when I bookmark it, then I'm bookmarking a flight. Depending on when I de-reference the bookmark, I get the details on my laptop; I might get a map as well. When I do it on a huge screen (which are getting cheaper and cheaper), then I may not just get the map, I might get a picture of the plane, I might get a picture of the people on the flight, a list of friends on the flight and so on.

The concept that is important is the idea of the flight itself: that's where the bookmark helps with that, but it's early days and there's lots more work to be done. The mobile initiative is in its second phase, which now continues.

**How do you access the mobile web? I imagine you must do. Are you an iPhone man or Blackberry?**

I'm still director of a consortium which is neutral, so I don't generally compare the various devices, but I do enjoy being able to access the web from a little device that I've got in my pocket at the moment.

**That's very neutral, very good! I asked about the iPhone because all the apps are so interesting. This new development of having apps on all the different platforms is really quite cool, isn't it? It's fun to play with. Do you have time to play?**

I do play with things, but remember that what is really important from the point of view of the long-term growth and a healthy market is that you can buy your connectivity from one place, then you can buy your phone from another place and buy an app independently from a third place. It is really important that whatever you use as a platform (this is very important to me for my computer) is that I can install, I can buy an app from anywhere, rather than have to go to the phone manufacturer or rather than have to go to the operator who is giving me my connectivity.

I want it to be an open market for connectivity, where I get the best plan for me at the best price. I'm prepared to pay a lot of money for a phone, if it's a nice one, but I want, on that phone, to be able to write my own app without having to ask any central authority and also have to pay tax.

**Interesting, thanks for that. One question I got asked by Twitter is whether bandwidth will keep up with the demand because the more things we use, the bandwidth seems to be eaten up more and more. Will it keep up with demand?**

The person who sent you that message used a bit over 140 bits of information to send you that, so it's worth remembering that actually, apart from video, everything else, once you've got video and got fibre around the country for video, then everything else is lost in the noise. The idea of actually paying serious money to send an SMS from a phone is ridiculous. If you work out how much it costs to get video and divide the price you're paying for a month by the number of bits you can get that month, you'll find the price of bits is very, very small. The idea that you have to pay to send an SMS internationally is a little bit weird.

There are many, many things that are very exciting and don't actually use a lot of bandwidth. Those will not use up the bandwidth. Video is always going to be the thing to push it up. You got video, people will want HD, then they'll want stereoscopic, then they will want 3D, then they will want total immersion. I can see that will go on just pushing and pushing.

**It's about 18 years or so now – isn't it? – since the development of the web as we know it. Are you amazed about where we've got; are we behind in some areas or ahead?**

I had it all planned really!

I've always been amazed by the amount of diversity of stuff out there, the things that people think up, the creativity that people show when they get a domain name and a website to play with; so that continues to be wonderful.

I think the way in which I'd hoped the web would go was that it would very much be a collaborative design space. I feel that the tools we have to play around together, doing a design together, working on a political problem together or just planning a family holiday together – they're really crude compared with what you can imagine. For example, I should be able to move my photograph about, so you will see it moving around in real time. Any document I edit, I should be able to share it with you so you can edit back in real time, changing it where it's a document on the web.

There have been exciting things happening ever since the dawn of the web. There is still a huge amount of challenge out there.

**Sir Tim, thank you for speaking to us.**

My pleasure.

### **Links**

Sir Tim Berners-Lee [www.ibiblio.org/pioneers/lee.html](http://www.ibiblio.org/pioneers/lee.html)

BCS video interview with Sir Tim Berners-Lee [www.bcs.org/video/tbl](http://www.bcs.org/video/tbl)

Web Foundation [www.webfoundation.org](http://www.webfoundation.org)

W3C [www.w3.org](http://www.w3.org)

## 8 SHARING KNOWLEDGE

Jimmy Wales, February 2010

**Co-founder of Wikipedia and Wikia, Jimmy Wales spoke to BCS editor Henry Tucker about politics online, the future of paper, why not everything should be on the internet, large video projects and the power of mobile carriers.**

### **Why Wikipedia?**

I was really fascinated by the growth of the free software movement or open source software and really was thinking a lot about collaboration and how people were coming together online to create big projects and that was really the basis for it.

It's not just the idea of an encyclopaedia; I loved encyclopaedia as a kid. I really felt like the internet is this great tool for us all to come together to share knowledge and I said, 'why don't we do that, it sounds like a good idea'. So that was really the core value that got me started.

### **What do you think is the public perception of Wikipedia?**

I think it is changing over time. Basically, the truth about Wikipedia is that it's pretty good in parts and lots of people use it and test it everyday. Of course there are errors; there are errors in every reference. You know the best study that we had so far was in *Nature* a few years back, comparing Wikipedia with Britannica and finding around three errors per article in Britannica and four errors per article in Wikipedia.<sup>1</sup> Three errors per article in Britannica is a bit shocking to a lot of people; we think of it as being perfect, but it isn't. Britannica is very, very good – there's no question about it. Just doing good quality reference material is very hard, so we shouldn't expect an error-free Wikipedia.

What we should expect is that it should improve over time. I insist that it needs to be better, always, and I hope that it's getting better always. So I think people, once they understand the medium's strengths and weaknesses, they feel reasonably comfortable.

### **What's your view on the future of publishing?**

I think there's a lot of interesting things going on. Obviously the newspaper is very much under assault, but magazines are feeling some pressure too, because the amount of content that you can generate with a top-down model in a monthly publication on paper is really quite small. It's an expensive medium compared

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<sup>1</sup> This report was published in *Nature* 438, pp. 900–901 (15 December 2005), doi: 10.1038/438900a.

with what you can do with people sharing with each other online. That doesn't mean there are no advantages. Paper medium has a lot of advantages, and so I really think that we're not at the end yet of this transition era.

I am not predicting that the magazines are going to go away completely, but I am predicting that many magazines are going to go away completely. It just depends on whether they're meeting the needs of the readers ultimately, because people are able to share information with each other in a very effective manner online. There's not as much of a need for information from magazines. If you can get deeper, richer, more accurate, more up-to-date content by going on the internet and seeing what other people are saying than you can from paying for a monthly subscription for a small paper magazine, then magazine subscriptions don't seem necessarily as interesting any more.

### **Do you think that politicians should make more use of the internet and social media?**

I definitely think there is no serious politician, going forward, who can afford to ignore the internet. Well, maybe in some districts, some of these gerrymandering districts, where you were re-elected with 93 per cent of the vote last year, you're set for life, but in a seriously contested election, I think engaging the public is extremely important.

Of course, as time goes on, the age demographics of the internet are beginning to even out and so we shouldn't think about the internet as a place to reach out to those crazy college kids anymore. Everybody's on the internet, more and more, and engagement for all segments is important and you can do so many interesting things on the internet that is not possible on other media, so I think it's definitely the future of political campaigning.

One of the things that I think we should keep in mind is that the government produces vast amounts of information for its own consumption, or whatever, and we should really be insisting that, if you are producing information, put it online, make it accessible and make it really open. You know, sometimes I talk to people in the government and they said, 'well we want to make this database available, but we realised it was going to be a \$12 million dollar project to build a gorgeous, beautiful website that the public can come and browse and so on...'. I said, 'don't worry about it, just stick the data online and forget aesthetics. Just stick the data online in the most raw, ugly form and entrepreneurs will find it or hackers will find it. People will find it and build amazing things out of it. It doesn't have to be the job of the government.' The job of the government is to be transparent. Give us access to the data, let things bloom. Don't try to still have a search interface that controls everything. So I think there's progress being made in this area.

I just had a meeting recently in Chicago and there was someone there from the city government who was sort of complaining. This guy was on our side, but he was saying, 'the problem is I go to the city council and I say "we need to be putting all our data online" and they say, "what, we already put the data online, we publish all these pdfs, right?"' and he's like, 'we take the database, make these newsletters out of it, we publish pdfs and then people outside government are having to parse the pdfs to get the data back out'. It's like a whole other new step,

to say, 'you want to have a whole lot of people to have direct access to read the data'. Interesting, you know, and that's kind of the era we're in today.

### **What about information security?**

There are some issues that do have to be taken seriously. I mean one of them is privacy. The government has an enormous amount of information, which they have for more or less innocent purposes; you just have to be a little sceptical of the government, they always want information that is personal to certain people. I certainly think it's not wise to start thinking about putting everyone's information on Google, especially health records, or even tax records. This is personal information and there are certain fields where I think it is worth taking a second look and thinking about what we really want to do as a society.

One example, there's public information, where I live in Florida, about everybody's home and how much they paid for it and even the floor plan of the house. Well, I think it's perfectly great for that kind of information to be public in a certain sense, but I think it is a little unnerving that it's actually on the web.

I think the same thing about some of these questions around say, criminal offenders. It should be a part of the public record that someone's been convicted of an offence. I'm not so sure that it should be the first hit on their name when you Google them.

How do we navigate these waters, how do we think about the issue of someone with an unusual name who is convicted for sticking up a liqueur store when they're 19 or when they're 21? How do we feel about that being the only thing you see when you Google them when they're 45, or when they're 65? That's interesting because, although that data has always been public information, it's down at the court house, it gets forgotten, the newspaper doesn't print it everyday. Google prints it everyday, in a certain sense, so I think there are fascinating questions to explore, going forward.

### **What kind of projects are you working on at the moment?**

I think the main thing that I'm focused on these days is Wikia. I'm also still doing my Wikipedia work with the community and things like that. With Wikia, what we are really focused on now is making the Wiki editing experience accessible to a wider range of the population, so it's easier to edit. We just changed it. What we used to do when we tried make a Wiki, we would check and see if was a good idea or not.

Finally, it's just like an auto-create process. So you can create a Wiki and if it's completely horrible, then someone deletes it eventually, but in general we find actually there is a huge explosion of creativity and massive uptake in the number of Wikis being created, so we're excited about that and really focused on that.

### **What future trends do you see?**

I think one of the things that we haven't seen yet, that we're going to see more of, is a large, community-driven video project. When I talk about video and I talk about community, I don't mean the YouTube experience. The YouTube experience is not much different from the 1999 experience with text.

People post individually made videos. It's either a clip from a show or some funny thing they've made themselves. People do a little bit of remixing and sort of pranking on each other and things like that and it's funny and it's great. But what we're not seeing is large collaborative projects; it's all individual works for the most part. We're starting to see a few projects, but still more very isolated things where a group of people come together, they conceive of a concept and they film a full film and they're working all through the internet. And I think we're going to see that kind of thing begin to emerge – some really interesting projects.

I have this idea for a documentary, which if I keep talking about, somebody will do it, then I won't have to do it. Imagine if you had some question, a global question of our times, and you wanted to do a documentary where you're gonna visit 90 different countries, speaking 90 different languages and you are going to get a one-minute film clip from people on the street and you're going to compile this into a film. Just think of the work involved in doing that – to get 90 good clips, you're going need to film 900. To get subtitles, you're gonna have to find translators in 90 languages. This will be an enormously expensive project to do in the old-fashioned way when you're sending film crews everywhere, dozens of film crews everywhere.

But when you step back and you look at it, you go, actually the community can do that very quickly, because it's a one-minute film clip, where you're asked a question and I say to you, 'how do you feel that climate change has impacted your life?', and you'll get some funny answers, some sad answers, some thoughtful answers, some really stupid answers and you could weave this into a sort of humorous narrative.

You could have a community go out and do the translations, and that could happen. It would take a large group of people coming together with a commitment to do it and a social structure and a set of rules and so on, and it can't be produced in any other way. That's the kind of project that I think is really interesting for the future and that's just one of a million examples.

### **How do you think we should go about enabling the information society?**

We have to start with access, start with poverty. Right now, depending on the metrics you're looking at, there are 1.1 billion people online – it depends on the estimate, more than a billion – but how many people are on the planet? I don't know the number – six billion? seven billion? – the number keeps going on. What that means is, even in the next 5 to 10 years, when it's pretty easy to forecast, when it's pretty easy to see when the next billion are coming online, that's still leaving three, four, five billion people who won't have access.

How are we going to get to them? Well, the same way – cheaper computers, bringing people out of poverty. Mobile devices are going to be really important in both those things, a very big deal. But it's going to take some time. As we are developing things, I hope that Wikipedia can be, in some way, a prod or something useful that actually encourages people to get online.

Right now, if you're speaking certain languages, there's nothing for you online, except for pictures. The more content there is and the more languages, then it

becomes worthwhile for people to get online and, as they come online, they will get educated in the tools and they will start using them and have democratic impacts everywhere and all those things. I'm optimistic, but it's going to take some time.

In terms of technology, I don't think there is a single solution. You know, when I think about a project like the One Laptop per Child project, I think it's interesting. I'm not sure it's the right answer – it may be a piece in the right answer for some people, but there's a million other things going on and I think we need thousands of ideas tested.

### **What are your thoughts on the fragmentation of the internet?**

I've never thought that there was much of a threat of that, not really concerned about that. I do think it's possible. I'm concerned about ICANN, I'm concerned about domain name proliferation, which I think is a really bad idea, and I think we see a lot of proposal for new top-level domains that should really, with all possible respect, be given a proper burial, with much ceremony and love, never to be seen again. So I'm not sure what the overall impact is gonna be. I've never been very concerned about the fracturing of the internet. I just think the incentive to stay together is much too strong.

### **What about mobile technology and access to the internet?**

If I have one complaint, it is that I need a global data roaming plan at a reasonable price, because I can't justify how much it costs to get online, except when I'm in the US. Inside the US I have a flat rate plan, so it doesn't bother me.

But I think we are now at the point where, on certain smartphones and certain advanced feature phones, browsing is kind of useful now and getting to be a viable experience and I think we're going to see a lot more of that in the coming years.

We have a lot of barriers in the mobile space, because of the structure of the industry. We see very clearly the monopoly powers of the carriers having a huge impact, and a very unfavourable impact, on the development of mobile. They much prefer if they could have an app store to charge us all, you know, per bit, everything that comes across our phone. They really want to realise that revenue stream in a way that we would be shocked if we imagined our ISP, or Dell or Microsoft, trying to sort of control every single thing we do in order to monetise every piece of it.

And if we did have that on computers, we would be 10 years behind where we are and that's why mobile is 10 years behind where it should be in terms of access to the internet. So that structural problem, that the carriers have a bit too much power, is something that we still struggle with.

I think that's changing for a couple of reasons – for one, competitive pressure between the carriers is starting to loosen things up, and two, I think they're starting to feel a little heat. I think the iPhone – although I wish Apple would throw their weight around a little more – has made some inroads in terms of the brand image and the brand space.



Most of the people who use an iPhone they think of themselves as using the iPhone; they really don't care who the carrier is and of course that's frightening to the carrier as they want people to be 'I am an AT&T guy and I'm going to get the latest AT&T phone, and I'm going to pay 50 cents for SMS' – that's what their dream is.

The reality is, it's time now that we start disaggregating this thing and saying 'actually, you know, I am a Symbian guy, I use a Symbian phone, and they come from different manufacturers and I don't care which carrier it is'. The carriers compete on doing a good job of carrying, so I want the signal to be strong and I want it to work everywhere and I want reliable upturn every time.

For the software, I want good software; for the phone, I want a good device. These are separate things and when we've had them bundled the way we have it's been unhealthy.

### **What excites you online?**

What's excited me the most that I've seen online lately? Recently, I've got a new view of the internet through the eyes of my daughter and I'm really intrigued by games, collaborative games, and online games for education. I think there's a huge opportunity there, so if you go and you look at something like Club Penguin, which my daughter loves, but it has very, very close to zero educational value. They really haven't designed it for that, but that's fine, there's nothing wrong with kids having fun, like everybody else.

At the same time though, it's such a powerful medium for implicitly transmitting knowledge that with a little design ahead of time, a little thought from us, we can have children learning things without them barely even noticing. That is very powerful and I think we should see a lot of activity in that area in the coming years.

### **Links**

BCS video interview with Jimmy Wales [www.bcs.org/content/conWebDoc/34595](http://www.bcs.org/content/conWebDoc/34595)

Jimmy Wales' blog <http://jimmywales.com/>

Jimmy Wales on Wikipedia [http://en.wikipedia.org/wiki/Jimmy\\_Wales](http://en.wikipedia.org/wiki/Jimmy_Wales)

Jimmy Wales on Wikia [http://en.wikipedia.org/wiki/User:Jimbo\\_Wales](http://en.wikipedia.org/wiki/User:Jimbo_Wales)

## 9 SHAPE THE FUTURE

Dame Stephanie Shirley, March 2007

**We should be proactive and shape the future, rather than suffer it as it comes, believes Dame Stephanie (Steve) Shirley. Her career spanned successfully founding the company that is now Xansa plc<sup>1</sup> and being the first female president of BCS. She now runs her own charitable foundation and spoke about her activities and ideas, past and present, to Helen Boddy, BCS assistant editor.**

### **What made you decide to join the BCS 50 years ago?**

I joined the BCS on its foundation. It was a clear declaration to my employer that my future was in computing and not in mathematics. Originally a mathematician, I had then fallen in love with computing. There is no other way to describe it – it was overnight: this is what I want to do. It proved to be the right choice for me.

### **Why was computing more appealing to you than mathematics?**

I'd always wanted to be a mathematician, but it was soon clear that my intellectual capability was insufficient to solve Fermat's last theorem (then one of my aims), whereas computing was new, a virgin field. Ten years earlier or ten years later I wouldn't have been able to contribute to computing. So it was all a question of timing.

And I was able to contribute. Following the late Professor Mumford, I got more interested in the social and economic aspects of computing, than in the technology per se. And in doing that could move things forward and get the satisfaction that innovators have of being the first to see or do something.

### **What was BCS like in the early days and how were you involved?**

When the BCS started it had an age qualification and so although I had been working for four to five years – I started work at 18 – it was only possible to join as a student member. I was irate about such ageism.

I attended BCS's inaugural conference at Cambridge and, without exception, all its monthly meetings, which were in London. So I must have gone to 10 professional presentations every year – lectures in all sorts of things, from a thesaurus in computing to computing in aerodynamics. That excellent professional development was the only training I had, apart from actually working in the field. In those days there were no programming manuals, it was untrodden territory.

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<sup>1</sup> Xansa plc was acquired by Steria SCA in October 2007.

So BCS was important. We all learned from each other. Some of the early members have become icons in the industry.

BCS was also useful for networking, particularly once I'd started in business. People knew and therefore trusted me enough to give work to the fledgling company.

So IT, or computing, has been very important, not just to society, but to me as an individual. As now a Life Member, BCS has been very much a part of my life. It has been an enormous privilege to head my professional body. To become its President in 1989–90 was a most wonderful opportunity and I was thrilled to receive its Lifetime Achievement Award in 2004.

**What have been the main changes in the BCS over the years?**

The move to professionalism was important. It was the early 1980s when we really started that idea, when I was the BCS Vice President (Professional) and we were restructuring under Past President Professor Frank Summer.

I like to believe I introduced the concept of continuous professional development, the idea that you shouldn't just be qualified once, but skills should be kept up to date. Professionalism and continuous professional development were movements over time.

As President, I deliberately introduced marketing concepts to the BCS, which had started off very academic.

To a certain extent BCS has grown less dramatically than I'd hoped, but it is still there and doing good stuff and will do yet more over the next 50 years. In the early days it had a sort of senior common room concept. It was the elite. Such elite bodies will not exist in 50 years' time. You can already sense the tensions between the professional and the hobbyist.

The shift is toward the guild concept with overlapping Venn diagrams. With the Worshipful Company of Information Technologists, for example, there are practitioners, journeymen and apprentices.

**When you were BCS President, did you have a particular mission?**

Very much marketing, and moving IT into the boardroom. I personally commissioned some surveys that absolutely shocked the largely academic Council of the day – about 40 strong then. I probably didn't do then what I could do now in making Council more effective via a different corporate structure. All societies need to reinvent themselves every now and again.

**Was there still prejudice against women when you were President?**

Most people were clearly astonished to have a female President. Women have operated as a minority for a very long time. Even as we began to get opportunities, we didn't behave as if we were 51 per cent of the population. Some of us did achieve, but we were the fighters, the feisty ones. We tried not to upset too many people, but we obviously did.

**Did they purposely seek a female President?**

No.

**What do you think has been the most groundbreaking development in IT or computing over the last 50 years?**

Miniaturisation was the thing that I lived through. You have no idea how big computers used to be, you could warm yourself on them in the valve days. Physically smaller, functionally more powerful, plummeting costs.

**What has given you most satisfaction in your career?**

My company, now called Xansa, began as a manifestation of me as a mature, rounded person, a fighter for all I consider just and true. It started so small that most people would say my main achievement was its economic survival through the 70s recession. The credit for the later development of the company must be shared with many people.

But what I am most proud of is conceiving and taking it into co-ownership. At one time, 65 per cent control of the company was held by staff. Over the years, decades, that holding is much reduced, to below 20 per cent, still extraordinarily high for a PLC. I'm very proud of that. Pioneering at that corporate level gave me enormous satisfaction.

**Would you have done anything differently looking back?**

At any age one can only do the best of which one is capable of at the time; there's no point in looking back to wish I'd done something else. It would have been wiser had I mastered finance earlier. It was over 20 years before Xansa got a finance director, so I kept matters simple in order to understand them.

**What sort of measures did you take in setting up your company to be family friendly?**

The whole concept of Freelance Programmers,<sup>2</sup> which I started in 1962, was based on an employment policy of providing 'jobs for women with children'.

As I became conscious of professional development, training and career development, it soon changed to 'careers for women with children', and later on, as a lot of women were looking after not only children, but disabled partners or elder-care, it became 'careers for women with dependents'. So it was a social mission, a crusade, something to do nationally to get women opportunities in life generally.

I even investigated whether to set it up as a charity – sensibly, and thank goodness, it became a commercial organisation. Originally it didn't pay my expenses and it was several years before it paid me a salary. It was 25 years before it paid a dividend, so you can see how slow its development was. But it had a big impact on work styles and the position of women, particularly in high tech, in Europe.

It now has 8,000 employees – more than half in India – it has moved on.

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<sup>2</sup> Freelance Programmers became F International in 1974 and FI Group in 1988. In 1991, Steve Shirley sold a controlling interest in FI to the workforce. In 2001, the company's name was changed to Xansa.

**Are you not concerned that outsourcing could threaten jobs in the UK?**

Xansa was one of the first to outsource software development – it was very deliberate – and outsourcing is now one of the many things that makes Britain have five per cent of the world's GDP for one per cent of the population. Each party concentrates on its own skills and learns to partner with the other so that outsourcing brings the desired benefits. When we first talked about outsourcing (in 1978) it was quite clear that India would provide cheap labour. But by the time it happened it had a skilled labour force in short supply.

Today, Xansa has more people in India than in the UK. Is it what I expected or planned? No. But it's good on an international basis, and the City seems to have adapted to it well.

**Did your family-friendly practices inspire staff loyalty?**

Yes, there was mutual loyalty. I supported them and they trusted me. It wasn't just that they contributed to the company's financial success, but they were essential to the company's development. To ease cash flow – which cripples many start-ups – we geared payments, so that a freelancer was only paid when the customer paid. Things like that made it a collaborative, even collegiate, culture. Is that a female thing? I believe it was just my style to work in teams. You and I each gain when we respect each other's area of expertise and together produce better work than individually.

I also led the way in terms of managing flexibly so that time spent by programmers, analysts and consultants was always their best quality time, rather than 9–5. In those days all computing was very creative. You need people's best work if they are to innovate.

Our productivity was significantly up on others, even though home-working had inefficiencies because of not working through a central office. IT now facilitates all that. We did a lot of self-management and could genuinely say that we delivered on time to cost. Those are weaselly words. Because through early risk analysis we were looking at work still to be done, rather than thinking this is 100 units of work, we've done 3 so 97 to go. We would re-estimate all time, so that one could shift targets and therefore do things differently rather than rigidly plodding on predetermined routes.

The other thing is that since no one else was employing professional women, we had the pick of that workforce. IBM, one of the largest employers, didn't allow part-time systems engineers, as they called them, and so were a wonderful source of well-trained, marketing-oriented women.

We also were training women in the career gap of what we used to say was seven years. At one time I was conscious that we then had people leaving. But I looked round the sector and realised that nearly all the female managers were trained by us.

**How do you rate family-friendly ideas today?**

Some of the ideas are mainstream now, people talk about 'family friendly', but we're still counting few women on PLC boards, so it can't be taken for granted in

any way. Women have a lot more confidence and are performing better in schools, in universities and in some sectors, like medicine and law, they outperform the men. But in most career patterns that is far from the case. And it doesn't seem to be happening in information science.

I admire BCS past President Prof Wendy Hall for really taking up the theme and pushing it forwards. The mere fact that someone needs to do that says that I only nudged it forward a bit.

**But presumably in your time that was quite a quantum leap?**

Oh yes!

**What advice would you give women in a male-dominated IT environment?**

Simply to go for it! Aim high, nothing is closed. Nothing in the industry is dependent on physique or the timbre of our voices, or innate physicality in any way. It is a personal choice whether to pursue a vigorous professional career or just fiddle around.

**You are now involved in much charity work, some in the IT arena. What made you decide that your Shirley Foundation would support the Oxford Internet Institute?**

The Shirley Foundation decided to concentrate on the two things that I know and care about, and one of those was IT; the other was my late son's disorder of autism. £15 million has gone to IT in big strategic slugs, for example to The Worshipful Company of Information Technologists of which I am a Past Master.

With the Oxford Internet Institute our patronage was reactive. Two fellow liverymen came to me with the idea and asked for support. With philanthropy you get as much as you give, and I wanted to remain linked to the industry from which my wealth came. By being one of the initial two sponsors (with HEFC) I have been able to remain, at a strategic level, close to the sector.

How tremendously fortunate I am that 40 years after the brilliant idea of starting what is now Xansa as a company for women to be involved with, such a different start-up organisation – a multidisciplinary research institute – is concentrating not on the technology, but on the social, economic, legal and ethical aspects of the internet. It is very appropriate for me.

I am on the OII strategy board, which meets every few months; was engaged at a corporate level in the initial set-up; and continue to be proud of being involved with people doing extremely exciting things, yet things that I can understand. Such as? Oh, eGovernment, the concept that humour on the internet is different to hard copy and so on.

The Oxford Internet Institute has now become an important part of my life and many of my thoughts have been triggered by those clever people at the OII.

The hard part of the sector is not the technology – though I admire people who can do it – but to make the consonant changes in institutions and social structures to synchronise everything. One can see that the internet can be dangerous, in the way of the asymmetric threats of terrorism.

**Is it involved with other initiatives such as the Web Science Research between MIT and the University of Southampton?**

Yes, the OII is partnering with them, and has been involved for two years now. One of the OII professors, Jonathan Zittrain, is on its advisory board. What the Oxford Internet Institute is strong at is in validating the importance of social research. I suppose its future and underlying aim is to get the social, economical, legal and ethical issues as mainstream, not something that is thought of afterwards or not at all. Its mission is all the non-technical issues.

**Do you think other charities are currently using IT to their full potential?**

I notice that IT is only just starting to be used in fund-raising. It has a very important future there, not only in qualifying potential donors, but also in giving over the web, so people can make small donations. In financial terms it is ineffective to rattle a tin in front of people, although reasonable for promotion.

The Worshipful Company of Information Technologists, which was initially sponsored by the BCS, is a centre for charitable activities in the IT field. It has a number of major projects, which it has initiated or picked up from government. If only I could list them all now, but they can be seen on its website.

**What has been the success of the web service autismconnect, which your foundation supports?**

autismconnect grew out of Autism99, the third ever virtual conference on the web (the first concentrating on disability), which 16,000 people 'attended'. At the end of the conference, a good bibliography in the field of autism had been built up, which led to setting up the portal. With now 30,000 registered members it hasn't been a resounding success, but it is international (only in English, unfortunately), and people from places so remote that I have to look them up in an atlas, access it as the only independent site of its kind.

Nothing stands still, and my interest has morphed into research into the causes of autism, and autismconnect is likely to extend in 2007 to include researchers worldwide as users and have a research bibliography. Research has to translate into the real world, the sooner the better, and categorising good research quickly and exploiting it is important as is, conversely, making sure the bad research gets thrown out.

**Is there much research into autism worldwide?**

The vast bulk of it is by governments worldwide. Overall still far less than that dedicated to less frequent disorders such as childhood leukaemia or cystic fibrosis. Autism Speaks, sponsored in the UK by the Shirley Foundation, is the largest private funder.

**Can IT help research into autism?**

Focusing on autism, a neuro-developmental disorder affecting 1 in 166 children, IT is very important for research into causes. There are two particular things: the human genome project and the ability to data mine.

I was still in the industry when data mining appeared, but now we are mining down into vast databases to find the susceptibility genes for autism. There are

major projects involving 170 researchers in 80 research establishments and when you can use their data intelligently, things move forward faster than perhaps we ever dreamed.

**Does the Shirley Foundation have any more IT-related projects in the pipeline?**

The mission of the Shirley Foundation is now more focused on autism, so probably not. The rationale is that my co-trustees and I felt there were lots of generous people concentrating on IT projects, and we could make more impact in the autism field. There are hundreds of small disparate organisations working in the autism area, but no other charity putting serious money into strategic developments.

**What do you think could be the next major leaps forward for computing?**

I believe the best way of predicting the future is to invent it. Nothing is inevitable or predetermined. The future will be shaped by the actions of the computing industry.

Yes, we can see a few months ahead, but our predictions may be wrong. Last time I seriously tried to predict the future, it turned out nearly everything already existed in BT's research laboratory. The technology is all there – it's about what we do with it.

It can take generations for new technology to be implemented in society. We used to talk of a paperless society, but it's still not here. Telephony took nearly 100 years to be implemented in society. Every innovation brings new social issues. Unless we work for a better future we are destined to endure what the future brings.

**Are there specific developments you'd like to see pursued in the next few years?**

The internet has transformed how organisations know their customers and treat them differently. But that has not happened generally in government. An exception is in transport areas such as Transport for London.

Different approaches are needed by government to its e-services. A prime example is the ID card. Could not mobile phones be used in some way as an ID card? You can tell who and where I am with a mobile phone, and 40 per cent of the population have one. I'm not saying that it would work – just that innovative thinking is needed.

I also see the need for the computing industry to be the infrastructure – less visible and more critical – to everyday life. You can see technology changing, going forward, going backward. When people lived in small villages we knew our neighbours, but technology allows you to redefine who your neighbours are. Outsourcing to the unpaid consumer is everywhere. You can see work going back into the home.

At one time I would have said everything would be easier thanks to technology, but in the past we predicted a decline in the working week, and yes, we do now have more leisure time, but many people work multiple jobs. There's also a sort of harried leisure class, which isn't what we thought would happen at all.



As individuals or groups in society, we should concentrate on pro-active activities, so that we make the future, rather than suffer it as it comes. BCS should be frontline in that area.

**Links**

Dame Stephanie (Steve) Shirley [www.steveshirley.com/](http://www.steveshirley.com/)

Worshipful Company of Information Technologists [www.wcit.org.uk](http://www.wcit.org.uk)

The Shirley Foundation [www.steveshirley.com/shirley\\_foundation.asp](http://www.steveshirley.com/shirley_foundation.asp)

autismconnect [www.autismconnect.org.uk](http://www.autismconnect.org.uk)

Oxford Internet Institute [www.oii.ox.ac.uk](http://www.oii.ox.ac.uk)