

THE VALUE OF INNOVATION

Ingenia 21 featured the 2004 Hinton Lecture by Nicholas Donofrio, IBM's Senior Vice President of Technology and Manufacturing. Here we report the subsequent floor discussion on global collaboration, pure research, wealth creation, innovation and America's engineering initiatives.

Nicholas Donofrio © Mark Crick



**Dr Dougal Goodman
(Foundation of Science & Technology):**

I really enjoyed your talk and found it inspirational. Towards the end, you said 'make the US a magnet for talented people'. In the UK, we say 'make the UK a magnet for talented people' and in France they say the same. Isn't there an issue about how we collaborate and do things together? In the age of global collaboration where it is so easy to collaborate with someone in California if you are in Cambridge, or with someone in China if you are in Bristol –

Nicholas Donofrio:

I did say it was a National Innovation Initiative [NII] in the States, didn't I?

Dr Dougal Goodman:

But it is how you phrase a global innovation strategy rather than a national innovation strategy which I believe is the issue.

Nicholas Donofrio:

I could not agree with you more. I want you to know – and this is not the NII speaking now, this is me, IBM speaking – that we have launched our own Global Innovation

Outlook, our GIO. We do Global Technology Outlooks on an annual basis but we decided that, since innovation is such a powerful idea, we will launch on our own. So we have our own thing going in addition to this NII, and it is all about the global collaboration and the global nature of things. After all, our first name is International and it has been that for 80 years, so you would expect us to think and behave in this way. I cannot speak for our country. I have argued this point but most of the people who buy into this initiative do so for the betterment of themselves first. If things get better elsewhere, that is terrific. 'As long as it is getting better for me first', that is pretty much the way the bulk of them think. Perhaps that can change.

I do agree with you. We have argued this point, but remember that we are only one piece of what must be 50 companies that are trying to craft this thing. I am not trying to make excuses, but do not expect it all to come out perfect, is what I would say. Therefore you are right, we recognise it. By the way, we hosted three events: one here in Europe, one in Asia and one in the United States. We will reassemble those events on the sole issue of global innovation: the need for collaboration, the need for optimisation. Then we will write our own report about that. We are walking both sides of the street, and we are almost talking out of both sides of our mouth at the same time. I worry about this and try not to get

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Professor Michael Kelly, Executive Director, The Cambridge MIT Institute © Mark Crick



Professor Malcolm Mackley, University of Cambridge © Mark Crick



our Chairman in trouble, because he co-chairs this National Innovation Initiative. Yet he has been here to talk to your Prime Minister, he has been to Germany to talk to the Chancellor, he has been to Japan to talk to the Prime Minister, he has been to China to talk to the President. Therefore, we are all over the place and we are trying to encourage this locally as well but, in the end, your point will out, that is what will happen.

Lord Broers:

Surely, we must innovate. The people who collaborate most successfully in an innovative sense cannot go into the Far East and exploit low cost labour. Many people have that idea that we will do our innovation here, we will be the intelligent people doing the innovation and they will do the manufacturing for us.

Nicholas Donofrio:

We have eight research laboratories, 3000 people in pure research, with five outside the United States, two here in Europe.

Lord Broers:

Would you like to comment on that? You pointed out that IBM is one of the only companies that is doing pure research and we have virtually none in this country. That is one thing that has moved – do you want to comment more on that?

Nicholas Donofrio:

I do not want to keep grinding away at it but we have 3000 scientists and engineers in research, whom we believe to be some of the best and brightest in the world, and about 25% of what we spend in research we spend on what we would call pure research. It may be maths – I am sure you remember Benoit Mandelbrot fractals. I am not sure that they sell computers, by the way, but it was a good deal, the next step in geometry.

My wife would argue that the world has enough geometry, but we did that, we did all this work with the scanning tunnelling microscope, not knowing what would come of it. We did the basic work on high-temperature super-conducting materials that has at least prodded some other people to do even more seminal work in that area. We will never capitalise on that to be candid with you, but that does not bother us, because smart people like to be near smart people. We have a very simple philosophy. If you have one or two Nobel laureates, I do not care whether they are working in that area or not. If they go to the cafeteria and people say, "I saw her", or "I saw him", it is great,

they are close by, they can talk, they play together, they eat together. Whether they work together is totally immaterial so far as I am concerned.

That kind of thinking, by the way, is not something for which we will take credit. We have to give that to Mr Watson Senior, that was his idea, it was what he believed made sense – and this from a guy who never graduated from high school! He saw the value in this and we have just propagated it inside IBM. It worries me greatly that we can keep these people doing the things that we need to do, the leading edge things. Our biggest losses are usually to the federal labs. We lose someone, we lose them either to the federal labs or we will lose them back to academe. They will be with us for three or four years, they will get their bona fides up and then they will go back to colleges and universities from around the world.

I do not know what to tell you the counter to that is. It will be an issue here in this NII. Can you rely on universities and colleges to do all of that work all by themselves? I have a feeling that the answer is no, you cannot. There is a difference between what you do in industry versus what you do in academe, and we need to find a way to get more people excited about reinvesting from a research and development perspective.

Ms Ellie Runcie (Design Council):

I am responsible for a national initiative called Humanising Technology, which is working with early stage emerging technology start-ups and bringing design thinking, design skills and methods in to help them commercialise their science.

I have just been to the West Coast US and we are looking at how some of the most leading technology companies out

there are using design work within R&D – and I am not talking about aesthetics here, but about design as a social skill, bringing social and cultural understanding into highly scientific, highly engineering-based R&D environments. You mentioned at the beginning that innovation will be dependent on people and understanding culture, but you also said that IBM research is made up of 3000 mostly pure research people, most them working in science and engineering. Do you invest any of that 25% in more ethnographic, anthropological and design research related skills, because if it is about releasing value and about collaboration, that is surely what design is very good at?

Nicholas Donofrio:

Sure, we do, and we are very proud of the design group that we have and the investments that we have made. We have grown that skill. We have design, in the way I believe you are talking about it, as part of our marketing discipline to be candid with you, and it does an effective job at bridging the gap between the engineers and scientists and what the marketing requirements need to be. Therefore, I believe that we have done a pretty good job of reinvesting in our design skills in IBM. It was a dying breed and was atrophying very quickly. When you are dying as a company that is one of the first things you throw out. Everybody wonders what the value is, and it is either black or white – how many people need to worry what it looks like? That has changed greatly, especially as the world becomes more pervasive and the devices become more pervasive. What does it mean to remove once and for all the whole issue of computer literacy, and how do you do that and make devices that are non-intimidating, not just simple because technology overpowers them but how do

you make devices that make a lot of sense, service and support for a lot of these devices? Many of our ideas come from the design community.

I would direct your question a little differently. We are not a marketing-based company. I do not know how many of you here think about marketing but that is something that we are striving to become. There is a science to marketing you know, not just Marcom – I am not talking about ad agencies and so on, as we do that pretty well. However, the real science of marketing is something that worries me greatly, because more often than not that is how you become irrelevant. You do not understand the requirement, you do not see it, so, therefore, it is not manifested in design, it never shows up in design, or you miss the standard and what is evolving. Therefore, we are working hard at trying to build up our bona fides as a marketing-based company. I believe we get pretty good grades as a technology-based company, even pretty good grades as a sales-based company, but I do not think we get good grades as a marketing-based company or design for that matter. We used to pay the least amount of attention to it, just enough to get by, but I believe that that has now changed.

Professor Michael Kelly (Executive Director, The Cambridge MIT Institute):

I wonder if I could introduce you to my colleague Ed Crawley who runs the MIT end, because although we have been going for about four years, everything is now crystallising into three themes and you have hit on all of them tonight.

The first one is education for innovation: what can we do in the undergraduate curriculum to put innovative thinking higher up in the value that we impart to our

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students. The second one is knowledge integration communities, which is where we are building end-to-end stakeholder engagement so that around aircraft we have everybody from the pressure group to Rolls-Royce and everybody in-between. Also, it is having the students and the academics not just being engineers but social scientists, economists and people involved in public policy. Thirdly, in an attempt to reach out to industries that do not typically have detailed interactions, we do not normally associate the Wal-Marts and Tescos as major sponsors of university work but we have a few tricks up our sleeve which may change that. Ed Crawley at MIT is your man.

Nicholas Donofrio:

We were just at MIT by the way, Mike, doing this NII. They just did one of their technology review cycles on innovation and we were there to talk about this, but we take all the help we can get. In fact, Chuck Vest is one of the members of this Advisory Council that Sam chairs as well.

Dr William Cavendish:

I work at the Prime Minister's Strategy Unit in the Cabinet Office. We have been working recently on a wealth creation innovation for the knowledge economy. What you described would be familiar to many people who have looked at the knowledge economy. That is a world in which technology is changing, the customer base is changing, service is changing and the value chain is changing. One of the interesting things is the way in which US companies have become much better at re-engineering themselves and developing product offers in this world which create value compared to other countries. The US in that sense looks extremely well-positioned to take advantage of this new world you are describing.

I wonder whether you could comment on why you feel that has happened, why you feel that US corporations particularly have been able to do this and what lessons there might be for other countries' corporations in adopting that model?

Nicholas Donofrio:

I have thought a great deal about that and thank you for the question. I am not exactly sure I have it all figured out as, if I did, perhaps I should be running for President! Some of it has to do with the overall culture

of the country. There is still that drive there, there is a still a feeling that you can do anything. We talk about the American Dream being over but I am a second generation American, my parents were born in America but my grandparents were all born in Italy, so I keep asking if I am the last of those who had to become a drive-driven type of professional. However, I still see it. We have a fast-growing population in the United States, which is our Hispanic population. It is driven by this need to do better and to do more. I do not believe we have heard much yet from that population but in 10 to 15 years it will become the majority of our country. It is all driven the same way, out of this need to be better and to do better – to be better educated and to know more. Therefore, we are driven in that way and we are also less risk-averse in our country. We are pretty good risk-takers when all is said and done, which are important ingredients when you are dealing with this issue of innovation. People are not afraid to try it and fail.

You know that we are rapidly becoming a society in which the whole workforce is mobile, and not just mobile in a company but mobile company to company. Projections say that in a lifetime you will have worked for five or six companies, and you may have the same projections here. Look at me – 40 years with one company, what do I know? In IBM we have 325,000 people and 60% of them are with the IBM company for five years or fewer. It does not mean that they are all young; it just means they are with the IBM company for five years or fewer. The biggest part of our population is new to IBM and, if it does not work, they just go, they are not afraid. Perhaps if things slow down, it will become different. Those may be the reasons.

We are not smarter, that is just not true. You are smarter in many ways than the average worker in the United States but I have a sense for this drive, this ability to take risk and we are starting to build a system. We are starting to build an ecosystem that literally says 'You are supposed to have five jobs, what is wrong with you?'; 'You are supposed to work for 10 different people in your lifetime, so what is wrong with you?' We encourage this now with portable pensions and we will eventually have some form of healthcare, portable or otherwise, and that is happening by the way.

Lord Broers:

It is a culture that likes the new, which is a huge driving force.

Professor Malcolm Mackley (University of Cambridge):

You have just touched on a key issue of risk and you said that technology was secure but innovation involves risk. With your IBM hat on, if you were running 10 innovative projects, how many of those would you expect to deliver at the moment? In terms of risk, how much risk would IBM be prepared to take in relation to 10 projects all costing significant amounts of money?

Nicholas Donofrio:

I do not know the number so I am really guessing but I would say that 80% should succeed, so out of 10, eight should succeed and two fail.

Professor Malcolm Mackley:

What would that number have been 10 years ago?

Nicholas Donofrio:

In IBM? That was a bad time for us.

Professor Malcolm Mackley:

Alright, 20 years ago?

Nicholas Donofrio:

Let me just tell me what I mean. We spend \$6 billion in R&D today and you will be amazed when I tell you that, going to 1990, we spent almost \$14 billion in R&D with something less than a third of the researchers and developers. So we were spending poorly and we did the numbers because we had to re-plumb the entire system. It was something like less than 70% effective. We were barely scraping 60% of the projects which would get through the system. You cannot do that for everything. We could break research apart and let research have a higher failure rate but you cannot spend \$5 or \$6 billion and expect the failure rate to be 50-60%, your shareholders would fire you. Therefore, I would say that 80% would be a good mean average.

We watch this all the time. We had to change our development process in IBM and we now have a much more thoughtful and integrated development process in IBM. From time to time, we go as high as 90% effective in a year, but even the failures are

not failures, because we constantly learn from them and you will see us come back again or get out. Sometimes the best thing to do is to stop and say we are not built that way; we are just not going to do this any more. I cannot begin to tell you the things that we have created and invented that we do not do any more. We invented the one-device cell, the DRAM business, but we do not do that any more. We invented the hard disk-drive but we do not do that any more. We perfected the TFT (thin film transistor) but we do not do that any more, and we will not do that if there is no value.

Lord Broers:

You said ratios are different in research.

Nicholas Donofrio:

Yes, in research we could tolerate 50%. Twenty-five percent of the money we spend in research we are not sure will ever give us a return; that is the pure research money, so we just let it go. We understand what we are doing and we just let them go. We monitor them, of course, and we measure them. Research is one of the only entities in IBM that has its own pool how we pay our people and has its own scoring mechanism, which has very little to do with revenue and profit for the company. It has about 72 variables, and you have to take the root mean square of this and integrate that and on a Friday you have to flip it back around the other way! They take what they do seriously and you cannot measure research on financial outcomes; you cannot measure them on profit and loss. Then you do something like play chess with Gary Kasparov and you cannot imagine the value that that generates even though that was not our purpose. Or you create a Blue Gene petaflop computer and you cannot imagine the value that it generates.

BIOGRAPHY – Nicholas Donofrio

Nicholas Donofrio is the leader of IBM's global innovation strategy and is responsible for the career development of IBM's 190,000 engineers, scientists and technical professionals. Over his 37-year IBM career he has held numerous technical management and executive positions, and has led many of IBM's major development and manufacturing teams. He is a champion for education and is passionate about the integration of diverse cultures and ideas in both technical education and the technical professions.

Sir David Davies CBE FREng FRS (Past President, The Royal Academy of Engineering):

I have spent quite a lot of my career teaching engineering at university and looking back at where I believe we went wrong then and possibly still do. We taught problems, but they were almost entirely very narrow technically and had a single answer. Very few real problems have a single answer and may not even have an answer which you can judge.

Nicholas Donofrio:

I have to agree with that. That is an excellent perspective and you probably captured my thoughts better than I did, because the real world is almost like an open set of solutions. You are picking the best one at that point in time. There is no closed form answer to anything. We can make bad things good and we can get value out of bad things. We have a capacity for doing this. We can put enough energy behind it. You can argue that some of that push mentality was bad not good. Did it really do anything to solve anybody's productivity equation, or did it really generate real value? That is the danger when we think we have trained them well. There is a lot of partnership that needs to be done here, there is much work that needs to be done here, and the faster we admit we do not know all the answers and that together we have to find them, whether it is country-to-country – to your point – or whether it is industry-to-government and industry-to-university, we are up for that. All of that and more will be required in order to succeed here in the 21st century.

Lord Broers:

Thank you, Nick, for your lecture and for answering the questions in the way you have, and for giving us a real glimpse of the

leadership that is making IBM what it is today. It is an inspiration for all companies like that. I imagine that the 175,000 engineers and scientists are pretty secure in IBM. I know that I have tried to hire a couple of them away and our pay scale is really terrific here!

Nicholas Donofrio:

I know one of them by name by the way.

Lord Broers:

Yes, you mentioned him earlier. At any rate, thank you very much for a marvellous lecture and you have given us a great insight in these questions and answers. Thank you very much.

On 16 November 2004, IBM joined a number of leading businesses, universities and government organizations to discuss the findings of the Global Innovation Outlook (GIO), a very different approach to understanding the changing nature of innovation and the many opportunities and challenges it presents for business and society during the early part of the 21st century. A series of presentations and panel discussions explored the many factors affecting global innovation, particularly the three dimensions of the human experience: healthcare, government and the relationship between work and life.

Enclosed with this issue of *Ingenia*, with IBM's compliments, is a copy of a booklet documenting the 2004 GIO findings.