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Summary of Conference Day by Dr Justin Hayward, Director CIR Ltd

Approximately 130 business people attended the fourth CIR HVM Conference in the East, on 11 November 2005 at New Hall in Cambridge. The day was pronounced a success by the conference Chairman and by CIR. Panel Sessions, numerous case study talks, networking and general increase in awareness and improvement in the image of HVM in the East were afforded by the conference. Feedback forms also suggested that it was a success, with one respondent saying that it was perhaps "the best lineup of speakers I had ever seen". Speaker presentations were given the highest praise within that set of feedback scores, across the board.

The day was divided up into 4 main sessions, with a lunch networking break and two half-hour breaks mid morning and afternoon, and a final networking session over a glass of wine, early evening, before departure.

Everyone agrees that the HVM events constitute "power days", wherein if you are not tired at the end of the day, you have not been listening! There is an enormous amount to get through, and not a minute should be missed.

The sessions in 2005 were entitled: Introduction & Growth; Macro; Micro; Strengths & Actions respectively. The day went on in the manner of a business meeting, starting by defining its goals, making definitions of the subject matter High Value Manufacturing (HVM) and defining the participants in this field. There was a talk positioning the UK in HVM. It went on to give some generic case studies that defined growth and success before a first panel session.

In the second session, companies whose businesses involved complex assembly of large or 'Macro' products took the stage and described their business cases and experiences. They clearly described a new 'industrial revolution' for the printing of three-dimensional and complex technology products with enthusiasm, depth and belief. Following this, there was a panel session and before lunch.

The third session, after lunch, focused on small, or component HVM products or materials, that are along the supply chain from those companies in the previous session. Companies again described their business cases and experiences, with a similar brief. The third panel session followed this, and then there was a mid-afternoon break.

The final session drew together the generic success and early stage HVM case studies and the defining first session. There was a talk from an archetypal tech cluster HVM company, Cambridge Display Technology, who were also showing out for the first time their laptop-sized 14" OLED display in the conference networking lobby. There was then a talk on government manufacturing strategy, and a mention of the need to communicate the importance of HVM to future engineers, scientists and technologists, as well as business people.

Lord Sainsbury then gave the 20 minute HVM Address, stressing how important the HVM movement is and what government is doing to assist manufacturing, science and technology.

There then was a final panel session with all the participants in the final session. Professor Mike Gregory summarised the day as Chairman, and Dr Justin Hayward (CIR) thanked participants and made announcements of future events as conference manager.

These summary notes are meant to be just that: they are not a complete, structured, grammatically-perfect set of chapters. If any point is not clear from the text, please call CIR for clarification from the original tapes and texts. Although in many cases, it is possible to determine who has said what is written below, this will be more difficult for those unfamiliar with the event itself. The general style is one of anonymity, with all comments supporting the overall picture, but generally unattributed, except for Lord Sainsbury´s speech.

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First Session Notes (GROWTH)

Introduction

Five years ago, a lot of people thought manufacturing was virtually dead in the UK. Most people would think we don't make anything in the UK anymore. That is untrue. But we need to make people aware that manufacturing is important and why. It is important because it is at the heart of where a lot of innovation goes on.

Some innovation comes from great science laboratories, or universities, but what is often forgotten, is that a lot comes from the very act of making things. By making things you learn how to make them better and how to different things, and more cheaply so that you can make a business out of them.

We think of manufacturing as a cycle: understanding the markets, designing them, distributing and servicing them, and the core bit, making them. Knowledge of physical production is absolutely critical. Whilst we might not be able to do that where there is a high labour cost in the UK, it is essential we have control of the IP that underpins that activity.

Why HVM?

As people come to recognise the importance of manufacturing for the economy, we must ask ourselves, how to make it work. Government strategy evolves around high technologies, service industry and innovation: That is, Chinese Government Strategy!

This is something they are getting annoyed about: using up all their raw materials, polluting their country, while others are branding things and making all the money. So the idea that we can get away with this, is not going to last much longer. They will come to understand branding, and can buy brands much more easily than we can build manufacturing capability. The long decline in terms of percentage of GDP of the manufacturing sector as a whole was noted. We must do more to improve the image of the future of manufacturing, HVM, to increase the interest in it from our children.

Talk 2

Global communications are such that nowadays, the poorest people and nations in the world are aware of how the rest live. They can learn quickly and more often now copy quickly what the luckier ones are doing. For example, if we believe that the Indians will not notice European initiatives around renewable energy, such as wind farms, we will be surprised to see even bigger such facilities there already. The

argument that "it is their turn to pollute, and that the West cannot insist on lower emissions since it has had its day", will probably see a surprising answer.

We will continue to live in a world where the oil price is likely to be high and possibly escalate higher, making other forms of energy more viable and in any case, essential.

While products are globally mobile modulo some fair trading issues, people are less so; this is why a 10 minute taxi ride in London may cost more than an entire chauffeur-driven day to the IT and biotech business parks around Bangalore.

There was a (CIR) definition of high value manufacturing based upon products such that there is (are): improved time-to-market; intellectual property strategies; investment of profits and other funds in an ongoing pipeline of R&D; design inputs to make technology connect to people. There was mention of technology sectors where this was often most applicable.

Where can the UK compete in HVM? HVM means new markets and new designs. These were noted as involving risk. That 'HVM' must be long term, exciting, and investors must see it as a good source of risk, which is high margin.

Talk 3

It was argued that we need not "give up" in manufacturing and see loss of GDP, jobs and productivity and competitiveness as inevitable. The British 'play fair' in terms of international trade, and should continue to do so, but should think of keeping know-how as it is generated, so that companies can grow from this, rather than always giving away that 'recipe' to other nations, a point made in the introduction.

Government reacted to the manufacturing situation in 2002 with its Manufacturing Strategy: GMS. This mentioned seven pillars of wisdom. It was praised at the conference as having "got off to right start with what we need to do". In 2004 Nick Brayshaw reviewed it. MAS received praise all round. Key Performance Indicators for manufacturing are now beginning to be published. The government established the Manufacturing Forum, aiming to bring together all aspects and attitudes of manufacturing.

In 2005, the government's 5 year plan was written down.

There is an important model: government, academic, financial institutions working together. No single body has the answer. 'Partnership' is the key word as we move forward. Innovation and investment must be rewarding in the long term.

As we move to HVM, we need small companies coming together to form teams. KPIs show that UK reduced level of R&D expenditure by over 0.5%. Korea increased it by 40%, the Swiss even by 10%.

We also need to follow through with performance. The 5 year plan is based on increasing the percentage of R&D going forward.
We are people who have to take HVM to where we need to be! Many senior people have benefited in the older generation from increasing asset prices (houses); from fairly decent pensions; from good salaries. We pass down a different story to our children, if we are not careful. They will work longer for less, have lower house price rises, pay more for healthcare and have lower pensions. Demographic changes make all this less favourable for those who will become old in 20, 30 years or more.

Recommendations of centrally shareable high tech manufacturing facilities have been advised and are indeed needed. The reports are good, but they need to be invested in.
We must have a taxation system that rewards innovation going forward. Need to educate artisans and technicians as well as professors.
Industry must not step back and let government do apprenticeships. Industry must do that, given government level strategy.

Talk: Summary
The business plan should not be based on short term strategy, but more around customer feedback. Focus on what your are good at (core competencies), then segmenting the marketing and then taking the competencies to the segments. This massively reduces the risk.

1) You need to measure innovation and write it down.
2) You need to be introducing more products and producing them quicker. Measure it.
3) Build the capability to introduce new products. Find a partner / marketing strategy / a company that can help promotional strategy. Look out for large organisations, which are sitting on mounds of IPR, they will never develop.
4) Funding is never the showstopper for new product development, so find the right people to talk to.

Talk: Why does manufacturing matter to the UK economy and what are the driving forces?

1) It is an important part of the UK economy, about 16% in terms of GDP; over half of our exports and services; and 15% of the jobs in the UK (3.5 million jobs) and one of the largest employers of unskilled labour in the UK. About 50% have no vocational skills at all – historically employs the “rejects” of the system something which it won’t continue doing.

However, measuring manufacturing in terms of GDP is not particularly representative, since we now outsource many of the services, such as cleaning, the services, that we used to class as 'manufacturing'. For every 3 people directly involved in manufacturing, there are another 2, whose jobs also directly relate to it.

2) Manufacturing is the key driver of economic growth.

Manufacturing creates the greatest value per individual per job. It is about 50% higher than the whole economy, and almost double that of the services sector. It is capital intensive. Manufacturing product, using machines, leads to high output per individual. And the growth in productivity of the manufacturing sector is about double that of the whole economy. In government terms, if you want living standards to grow, the GDP of the country needs to increase. You can do that in three ways: 1) get more people to work (and in the UK we have the highest employment rate of all the developed economies – not a great pool of people who want to work, so you are back to immigration (unpopular); 2) get those in work to work more hours 3) improve productivity (and the most productive work in the UK is manufacturing). Though the government is unlikely to actively promote increased employment in manufacturing, it would want to stop the decline, which is reducing the value-added of the whole economy.
Manufacturing in absolute terms (not as a percentage of the economy, but in output terms) is about 20% higher than at the start of the 1980s i.e. about 1% a year growth. But this is now declining due to exchange rates, and advent of low-cost economies, such as China.
However, we have been out-performed by other countries. The US, France and West Germany are perhaps the only economies who produce comparable data. The growth of output in the US has been double ours in the last 40 years, as has Germany's and France's has been three times that of the UK. In terms of employment, the US, Germany and France's employment in that time has remained constant, but ours has halved – headcount reduction. We have shed labour, through productivity. This has been our driving force. Our competitors in Europe have been unable to do this, due to their social agenda, so have had to drive product development, innovation (different policy levers).

Driving forces:

1) Sterling strong.

2) Competition from low-cost economies: China. Output is growing by about 10% per annum, but 70% of that is due to increased demand in the West. We, in the UK, is only satisfying half the demand,

we are creating. The fact people are moving their factories out to China, is a relatively small part of the balance.

3) Opportunity or threat? Everyone who works in China, in an industrial context, will become a consumer themselves. 1.3 billion people who will become consumers for the products we make in the West. China has become one of the largest markets for aeroplanes. Our growth in exports to China is going at about 35% a year, exports to Europe virtually flat.

4) Cost pressures (oil). Baltic dry freight index (measure of shipping products around the world) – cost of shipping rising (busy). Price of metals at all time high.

5) Weak investment growth in the UK. Less capital available in the UK compared to other competitors. Fiscal disincentive: There is tax relief for the cost of importing goods, but no such benefit for investing in the UK and deciding to make the product here!

6) Globalisation. Will not go away, but will change (see above)

7) Critical mass: can manufacturing continue to decline in absolute terms without links in the chain disappearing.

8) Skills. 80% of vacancies for manufacturers now require at least NVQ Level 3.

9) The government is piling on legalisation. But there was a shift in mindset of the DTI about 5 years ago, which led to the publication of Manufacturing Strategy etc, establishment of manufacturing forum (which represents all of the stakeholders). They are working actively to promote manufacturing. But have we yet seen the results? And the government is ambivalent/hostile to manufacturing. Government funds MAS – which has made a difference. Also, manufacturing skills academy in the pipeline.

Manufacturing is an essential part of the economy. It forms 15% of the employment (possibly up to 20-25%). There is a constant challenge to become more competitive.

Driving high value manufacturing is the agenda for the future. What we need is more action.

Talk 4

Increasing dialogue between universities and companies, but it takes a long time to establish strong relationships.

Role of the Universities.

Public spaces for learning and research. Diffuse knowledge into the economy, which has regional growth impacts, and if successful, market themselves and their claim on government and industrial resources.

But there is a danger in using this as an alternative to putting money into universities. By pushing the universities to make 'quick bucks', you block the interaction. Quote from George Clayton: "Beware of bridges that become bottlenecks".

But in the long term (30 year horizon) it pays off.

1) Universities provide graduates.

2) 1980s Companies approach universities, wanting to be located near them to have joint research projects, joint staffing, and shared equipment. But science parks in themselves, don't build bridges.

3) Web-portals e.g. expertise database. The Universities have listed all the things available to companies: Assets-for-hire, training courses, IPR expertise, 'development officers', and MDA contracts. 'Innovatability profiling' for companies, against a UK-wide database to define strengths and weaknesses. Such a structure is costly to build, but low to maintain. But few companies come knocking on the universities' doors. Lambert described the situation as a conversation between the deaf (industry) and the dumb (universities).

Now we are entering a phase of reaching out. Broken into 2 parts:

1) K.B.E. (Knowledge based enterprises) – RES sectors with a high knowledge bias and interested in research. Focus on interaction with these sectors, worked with them to hold conferences, PR meetings. Macmillan: "Events, dear boy, events." Cost: about £1000 per contact.

2) Getting out to the wider-audience of SMEs. Harder to reach and hard to get a response out of them. Margins too fine to handle a research project, so have to look to process improvements. Cost: about £2000/contact (lots of blanks)

3) A to B. Individual academic goes out into the business world, exploiting his own academic research (5-15% academics, but serves to inspire 30-40% more). Lots of policy issues involved, that universities are now prepared to provide answers for. These academics don't sell research, but sell a service. These turn-key solutions are much easier to find funding for, than to get a research project placed in the

university: consultancy, not research. Often sold to larger companies, though could also be sold to SME sector.

Two fold effect: it affects the rest of the community, gaining their interest and secondly, it gets companies to pay attention to what is happening in the universities where spin-outs are emanating from and interested in building relationships with them.

Talk 5

George Kieffer, Deputy Chairman, gave a talk on EEDA's support of High Value Manufacturing in the East of England. He noted that we are not the only ones moving up the 'value chain', referring to emerging markets. He believed that EEDA could help with improved business support that is more customer-focused. He noted the successes of the MAS East, and had hopes for the Enterprise Hubs across the region for helping SMEs do better R&D and provide general innovation support. He said that EEDA is a strategic navigator and a convenor of partnerships.

PANEL ONE SUMMARY

Where is Cambridge University in terms of companies spinning out and has that become tighter recently?

- It still remains an open-handed policy. There is a report being drafted inside the university, headed by the Chairman of the Law Faculty. They wish to become tighter in terms of the root of the title for IP developing here, so they don't end up in disputes and so, if anyone does want to license anything here, it can be done simply. It remains the university's policy that if individual academics wish to exploit their ideas, then they should be allowed to do so with the minimum of formality.
- It should be noted that in Bangalore, which is the Indian institute for science, they adopted Cambridge's policy on spinouts, for their first spinout.
- The model we follow was the original one at MIT and Stanford, and the more open handed model followed by these three, has reflected its success in the number of spinouts they have generated.
- Need to stick out entrepreneurialism 'in the shop window' to encourage a stronger business relationship.

We have a lot of innovative companies in the East of England, often start-ups, modest in size. How do we make these grow from 10 to 100-man companies?

- Recognise that the team, who kicked it off, may not be the team to grow it. The founders with need assistance: skills. Outreach costs are enormous in the global marketplace, so by partnering, having people to guide is the way forward.
- Events and competitive drive. Entrepreneurs are those who recognise opportunities and use networking to get the right people in to create the conditions for success.
- Many companies in the region pre-sell and deliver, on spec, to the client. But beyond a certain point, you will need to come up with a product you can produce in mass volumes. Need for a sales

force, not sales consultants. Hard to make the move from 'soft' (a highly consulted product, that relies heavily on factors such as design) to 'hard' (a discrete product that sells itself).

- Need for partnerships to enhance global presence.
- One of the most significant blocks to growth in the UK is defence procurement strategy. It takes place in highly secure centres; user spec is specified by MOD scientists who enter into a loveless embrace with a large company, whereas in the US companies are invited to come to them with a user spec. in response to a need. Need to break up research establishments. Huge impact on not encouraging HVM growth. Government is the largest single customer and the MOD research work is the largest element of government research spending. [Yes, but look at the DTCs (Defence Technology Centres)]
- In the US money spent on "defence" is actually being used to boost their industrial base.

Can we do something to persuade the British government that its imitations of the US's Small Business and Research Program are a waste of time and have had no take up whatsoever? By law, any government agency in the US is required to spend 2.5% on small businesses. There are 11 agencies, which, 4 times a year, are required to make their list of requirements available (on the web).

- I agree. Government now saying it can be done by statutory regulation and doesn't need a bill.

Concerning recruitment, why can't we afford to pay people (MBAs in particular) what they demand, or is there some other way we can attract them?

- Not a question of recruitment, but of PR. We must understanding that manufacturing is not dead, but is alive, and exciting.
- People need to take on board the amount of money you can make by running your own business.
- The Judge is very important for Cambridge. Students do their projects in small companies in the region.

R&D doesn't necessarily lead to innovation. How should we measure innovation and growth? Tax credit.

- I see a lot of brilliant ideas, with little prospect of commercialisation. The tax regime should favour investment much more than it does so, and we should make sure it is targeted. Smart awards are given for clever inventions that lack application / marketability.

- In the UK, we seem too fixated on companies interested in growth through acquisition, rather than R&D, compared with the US. The shareholder return for such companies is lower. Acquisition is driven by short term returns and a lack of tangible results from new products. Tax credit should be the icing on the cake in new product development.
- Understanding the structure of the market that a business sells into, determines its success. US companies are not better connected to the universities, but use that connection is a different way.

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Second Session Notes

Talk 1

What is HVM? A process from research to services. Value in moving up the chain. There also has to be strong linkages between the chain. Value is perceived by the customer. It can also be measured as an exchange value.

Most companies don't understand where they are within the manufacturing chain. The GCP-IfM partnership has been working with real companies in real situations.

Two areas which companies don't understand:

1) That there is a difference between manufacturing strategy and operational effectiveness.
2) That supply chain is critical for success.

Design Talks

Design is central and critical to HVM. The world is full of commodity-manufactured items. Even people in China, Malaysia, Korea, Taiwan, who currently manufacture low cost items, are coming to realise that there is reason to move up the value chain: money to be made, and 'the low-cost party cannot last forever'.

What is design?

It starts with people, and how they perceive value: often emotional. Thus design is understanding the psychology of what will make someone pay 50-100% more for a product. Aims to deliver: beautiful, desirable, intelligent, appropriate and sustainable products.

Design is not a linear process, but a crucible. Integrated innovation approach all the way through.

An opportunity generator.

Importance of craft: Craft is important as well as high tech community. We should commercialise it in UK. E.g. Gucci.

E.g. Apple: at the highest level Jobs and Ives directors drink together and have design and general strategy ideas together at top level in that context. Design is a unifying force and an opportunity generator.

E.g. Fuel Cell for Hydrogen Motorcycle: Toyota and GM did not believe what it can do. No consumer cares about that fuel cell; turned into silent clean electrical generator. Turn a piece of technology into something desirable. Wrapped a motorcycle around the unit to create a real-world believable

opportunity. Company has pulled in about £50mn of investment. Design can help bring money in and get products to market. Products or design aspects are not necessarily high tech.

Importance of intellectual property:
Safeguarding and protecting.
Speed
Make it too difficult to copy e.g. iPod. Squeeze the supply chain: buy up all needed products for example if big enough.
Are we into long-term investment, or the 'sun-seekers'? ('Sun-seeker'=Making a couple of million and selling out and then buying a boat somewhere sunny.) In the longer term there cannot be a future in that.
The only way for manufacturers will success unless understand what customers want and what they are prepared to pay. Cannot get away with making product which will make profit, without being consumer-centric/-focused, you are wrong.

Integrate design into the manufacturing process.

The future for manufacturing in this country is through adding value. Design helps scientists and technologists connect their product to the market place, to understand and meet user needs. Rapidly growing companies distinguish themselves by recognising design as a core factor of their work.
Design is a market-focused process.
Design involves everyone in the R&D process.
Design brings people together making the R&D process less risky and more commercially successful.

Example Company 2
Ideal business model: To have a core idea and then outsource everything. Take no risk in any of the processes or products but book all the sales and the profit.
Who are we?
R&D in Cambridge, manufacturing in Wales. Portfolio includes manufacturing of the display, design thereof and how it operates. Collaboration with a big business in photographics and printers and a top local university. High levels of automation in the manufacturing plant in Wales.
Why Cambridge and Wales?

Founders happened to live there. Lot of stresses when starting a company, so keep people in their home territory. However, we outsource other parts of the business: model making, electronics.

What does HVM mean?

1) Direct costs form a small part of the business / manufacturing process. You are looking for gross margins of 50-60%. HVM is doing something difficult, that people haven't done before.

2) Significant value-add. Ironically it is the material suppliers who are making the biggest margins at this company (70+%). Looking for a materials number less than 10-15%.

3) High degree of automation, due to high labour costs. Problematic: sets a scale size for a company – you have to be of a certain size to support a team of engineering. There is a lot of 'black art' in processors. Non-transferable knowledge.

4) Deals with new processes or uses a material in a subtly different way. Risk of confounding effects. R&D, engineering, production must work closely together. And when you have solved the boat-load of problems, you often find yourself an expert in your specialised field and can charge more for the product.

I don't believe red tape ties up companies in the UK. Why shouldn't we outsource? We are short of engineers skilled in production. I take a lot of time teaching people innovation in the UK. Critical mass in China means they can source raw materials cheaper than I can.

The future? To solve difficult problems, that others are unable to solve, ones that are in the marketplace and have value added to them.

Example Company 2

There are very few good inkjet technology integrators. It is a difficult industry, since it relies on a lot of parameters and variables: fluid, print head technology, platform engineering, data management software. We integrate these components to create a workable solution, not made in China!

We know high volume is lost from US-Europe. We in US-Europe focus on small volumes, prototyping, made to order goods and digital technology. Inkjet lends itself to all of those things. We have developed the ability to etch, cutting out 3 or 4 of the previous stages. It's faster, doesn't limit the number of jobs, less waste (additive process), lower cost, digital technology reduces errors, yields go up, easier to control and manage and low risk. Will soon be printing onto curved surfaces, reducing production time from 3 weeks to 3 days.

There are great ideas coming out of universities, not just Cambridge. There are hundreds of applications for our technology.

Example Company 3

History: Began 5 years ago. 7 consultants. Funded by Advent Venture Partners. Rapid growth. Sell ink jet printers all over the world. 140 people today, all in Cambridge.

Strongest competitors in the US, Austria, Switzerland, not China.

Key success factors:

Use partners to do the stuff we are bad at. Valuable source of advice. Stop you doing stupid things.

Don't make things. Have things made to design and then assemble them – giving away a lot of the value chain (65% of turnover). Maybe not HVM? Has allowed rapid growth.

Using 'hard technology'.

Summary

We are 'nerdy techies'. Will continue to focus on technology and to use partners.

Key feature: Time to market. A month's delay costs us 2 months salary bill for the whole company. Such times are chaotic and testing. But the product lifetime is less than its development time. The life cycle of these products is set by the competition catching up. So getting products into the rapidly is the key to our success. Our technology is no better, it is our speed. You have to be ruthless about the number of products you do. We can only do two, despite wonderful opportunities.

Example Company 4

Cambridge has been serious about inkjet for 30 years. Now the rest of the world is becoming so too!

Firstly

Agfa launched a new product at a show recently. Moves material through inkjet assembly prints 1.6 linear metres in a few seconds by inkjet.

New product launched and have decided to manufacture the new one in the UK!

This year we made 100k of them in 6 months.

Move production out to China. Ended up deciding was to buy a warehouse locally in the East of England, which will be about four times the size of the Swedish production plant, and so the company has ambitions to become about 5 times it's current size.

We'll have that up and running by end 2006.

Secondly

Other people getting serious about HVM and inkjet printing, such as the UK government.

Cambridge awarded a grant to the Inkjet Centre of Excellence. This association will create patents in inkjet. What are the real problems to be solved and commercial institutions look to commercialise. Pattern for rest of UK industry from this.

Thirdly

Last speaker introduced you to the next industrial revolution! You may not have realised it.

Of the speakers in a recent industry sector conference, half were speaking about manufacturing by inkjet: e.g. making mundane 3D objects or even skin by inkjet printing. We are going to throw away the foundry and moulding machine and replace it all by printers.

Will be able to print it all any material onto any surface, layer by layer, by inkjet printing!

It will make the IT revolution look really rather pathetic.

PANEL SESSION TWO

How far away are we from such printing?

Well, Xennia have just announced a machine that would print all the world's electronic identification tag output today. They are printing a catalyst onto the surface, reel-to-reel. Would make trillions of them.

The technology behind it is getting there. Silicon costs a lot. If one could find the electronic material to be printed directly, then it would be a revolution indeed.

What was spoken about recently was the idea that the printing could get round the costly wire bonding process by printing them too.

They are talking about a 5 cent circuit already; if do this can do it for less than 1 cent, then you will get the intelligent tag in the supermarkets on every product.

What is the smallest dimension that you can print today?

3 picoLitres, 3 trillionths of a litre. A printhead doing this will still print a tonne or ink in a year.

The printhead can print down to about 70 micron line width. Depends on the substrate.
This makes it competitive with conventional PCB manufacture. Planning a machine with 80 of these heads in it that will print a PCB at the same rate as printing a poster.

Government endorsement of interest: Circatex and two other projects were funded by the DTI. Much of that comes from the fact that Lord Sainsbury has attended these CIR HVM conferences over the last few years and has seen what is happening and what is possible in this area and is backing it.

Question for the designers:
Has there ever been an absolute dog of a product that you've taken up and turned into a star?

The one that immediately springs to mind was that helicopter.
If cut through the enormous sums of money in marketing, and look at real value, you see there isn't that much real value around for the consumer! We should see this as an opportunity. Because if you give people services and products that do have value, then you can make money out of them.

What would make it even easier for you to grow faster?

It is really hard; we struggle with this every day. One barrier is our own stupidity and idleness. I guess closer working with some of those partners. We have been held up sometimes by the remoteness of some of our partners. 20% of the value of our product comes from the East of England, and 30% in total from the UK. The rest comes from suppliers at great distances, which is a shame.

This applies very much to the new industrial revolution of printing materials; it would be an open ink policy. Traditionally we have closed ink policies: when you pay $800/L for your HP ink, which costs them $1/L to make, it limits the scope of what you can do with an HP printer. Counter to the ink makers and printer makers, we are not seeing ink as a the holy grail to get revenue from, but actually insisting high revenues from inks restricts the opportunity to get more applications from a printer.

There is a lot of Pandora's Box and secrets about formulations and so on. Must get rid of that.

What do the designers think they can bring to bear to this inkjet printed products revolution?

As a design promoter, I would say that this is a very exciting area and could yield an incredibly large amount with good design. The scope of what it will do will be determined not just with the technology but by the interface with the consumer's needs.

I haven't yet seen anything as a user of an HP printer, that really connects with me. Breakthroughs can be made through the design process.

You WILL see that, because when we get past the 'technological hump', everyone is going to be affected by this and the opportunity to design things purely for the design and ergonomics is going to be there in a way that it isn't now, because it is restricted by the manufacturing technology and that is going to change.

I think we are the only guys in volume production of flexible displays, everyone else has to deal with rigid mostly square displays in one plane. If we ever take our product and technology into design, people will immediately get it as to what they can do. It completely changes the design constraints, engineers, infrastructure etc limit the speed you can roll out that technology. As soon as you break all the old rules then designers can come in.

One of the big regrets in my life is that I didn't become a biochemist!!! When you ask that question about whether that excites me, the idea that we could print very large scale structures like printing a building, for example, all of the supplies the pipework the wiring, layer by layer by a printer, or the idea that we can print components out of synthetic bone, I am fascinated by that, all by something near to self-assembly, and if tech can accelerate the process for this then the opportunities are literally limitless.

They are literally already printing a house in the USA.

How much have you used design in printing?

We regrettably haven't really used it.

We've used a bit of design, but it is so much a component that the issue is less important for us.

Probably for us too, we do what is not the right thing, which is to design a very complex, techie, functional product, with lots of steelwork and bearings and engineering stuff, and then we try to wrap something around it that is reasonably good looking, but also accommodates the ergonomics of masking and loading and unloading substrates, and increasingly, to accommodate the current rulings on health and safety, which are starting to make it a bit awkward. We try to make it something our

customers will love, and they do. When they see it, you can see them falling in love with the thing. It is not really woven in from the start.

It is interesting that the level of intervention of design has increased dramatically over the last five years. Then it was ergonomics and 'styling', we still do that but, now we need to understand people, and the reason to have designers involved is less to do with whether you use a certain amount of GRP over the framework, but more about understanding why people fall in love with it and novel applications of the technology that may not cost you that much and might be the last project you can afford to do in a year. I don't undestimate the number of applications your team have thought of, but if you had a good designer on board then you may find more. Risk doesn't have to be as high as you might think.

For us, we spend all of our time interfacing with our customers' marketers. They render up how our product can be used in end user product displays. We have it inhouse.

The whole IJ world is cutting edge and unique, but where the lack of design will bite is where it becomes less unique and you are competing with more people and that's when you need to differentiate yourselves.

The UK is in a remarkably strong position. We really musn't drop this ball. It was a really very special panel of leaders in production technology and design, and we've been very lucky to be present at this session.

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Third Session Notes (MICRO)
Example Company 1
What is HVM?

Definition: "exploits UK strengths in innovation and design" – what we are good at in the UK e.g. inkjet printing. "Part of a longer manufacturing chain" (design-manufacturing-selling). High Value, in terms of component, generated in the UK. No link can be taken in isolation. In terms of this company, you must understand the manufacture of silicon, to be able to design the chips that exploit that silicon. "valuable for the UK": It helps to be able to maintain the IP base.
"Clean and exciting", "capable of creating significant revenue per employee": taxes paid in the UK. Sector examples: drug discovery, luxury goods and fabless semi-conductors e.g. The company (does everything but fabricate the chip itself).
9 founders, raised $85million in total - essential to be able to compete with the biggest companies in the world (Texas Instruments, Broadcom), 45 competitors when they started in Bluetooth, now only a couple. Factor 4 increases in share prices since March 04.
"You can't success by being a single product company".
"To succeed, you have to grow organically" and perhaps, if appropriate, "by acquisition" – have acquired firms.

Why Bluetooth?

Enabled us to spin out taking patents. Cross-licensed and in return parent was given equity in the company, now converted into cash.

Leader in Bluetooth since 1999. How? Were working before 1999, within another company. "Democratize the use of radio." – now far easier to make than 10 years ago. Wider customer base in medical goods, toys.
Sell themselves as a wireless silicon company, not a Bluetooth company.

Business model

ARM licences IP. Intel manufactures chips. This company designs & sells chips, it doesn't manufacture them. Nevertheless, it is very integrated into the manufacturing process. It has a close relationship with

the manufacturing plant in Asia. To build a semi-conductor plant in the UK would cost about $3-5 billion and 5 years. Is this strategically good for the UK?

This is what it took us to make a successful company: Decent product, growing market (1 billion mobile phones produced every year), very focused business model.

To found a good company: Strong founding team. Good role models. Raise sufficient capital. Global presence.

Is HVM enduring? Comparison of UK and China.

Need for state action. Hard to find engineers in the UK, compared with China. Huge difference between the way students are supported in China: the infrastructure around them.
The Judge, Cambridge is indication that we can train people and change the situation.
There is a lot of IP in the UK, which will continue for a long time but if the manufacturing base falls, or is not augmented, with IP rich companies, we will have a problem in the future.
Regulation in the UK is a problem. The Chinese will perhaps be more pragmatic when it comes to regulatory issues. The cost base is roughly the same and increasing for China as time goes on.

Example Company 2
Problem with vaccination: not getting vaccination and not getting the right dosage.
Heavy IP portfolio.
History: Formed in 1998 2003-5 2 person company – 30 people. £1m turnover Contracts in Asia, China, with the US defence department.
Manufacturing moving out to China. Have to be there.. Have raised £5 since 2003. Though angels and private equity (no VCs). Didn't want to be down-valued by VCs.
Have also developed technology into US bio-defence area and multi-component vaccines – strong IP base for worldwide sales of IP.
New pipeline technology incl. filters for stabilisation and new injection devices. Worldwide patents.
7 patent families. Average £400k on patents/annum. In the last 2 years, £600k on IP portfolio.
Very important in India and China.

Strong Company

Team recognition is important.

Takes up to 3 years to get vaccine from manufacture to end user. UNICEF & WHO spend $200-300 million / annum on the cold chain. With stable liquid vaccines, that can be taken out of the cold chain. Saves £300mn. 50% of vaccines are wasted – thrown down the drain. Major markets through UNICEF and US biodefense, who have commissioned $14 billion, for stable vaccines to be stored locally to protect against terrorism. Longevity and removal of the cold chain.

Clinical testing plant in Leicester.

Partners in India, China and US. Product to be manufactured in India and China.

150 million insulin-dependent people in the developing world. Huge market. Licensing of technology the strategy there.

Example Company 3

CSR and ARM, who have similar models to this example company: fabless, based in Cambridge, but all factories are based in China or Taiwan. The company makes antennas that are very small, high-performing for mobile phones and other devices e.g. laptops. The technology was invented by professors; unlike CSR it didn't grow out of another company. Established in 2000, and spent a couple of years doing academic research, which was interesting to the employees, but not the investors. 2003 really started to focus to commercialising the technology. The culture is highly innovative, just like most start up have to be, especially one in such a narrow field. Company had to recruit, hire and move people to the UK, and thus form an international group, which yields a dynamic and creative edge, which has led to a lot of patents, something, which previously did not happen in the antenna world.

We have a diverse set of investors, both classic venture capitalists and institutions. Between them, they have invested £16 million in the company to date. We believe we have the best antennas in the world, creating value both for our shareholders and to the industry. We are looking to integrate antenna and RF components into the same devices.

Markets:

The market is worth $2 billion for the antennas alone, not to mention the components (cables, connectors, matching circuits) that support them, and is expected to grow to $3 billion by 2010. It is also a changing market. They will be a billion phones shipped and sold by next year, in units of 5-10 million, so new chips, antennas take off well. Modern phones now have Bluetooth, 3G and all the other frequencies use a lot of power, but what people don't realise is that most the power is used by your antenna, so there is a push in the industry to make them more efficient.

Chosen markets for antennas: small size, multiple uses, high-efficiency: Smart phones and feature phones. We are matching our technologies with where the market is going. Also work very well in laptops (also high-performing).

Customer: UK-based. European, Americans and larger growing set of Asian customers. Targeting efforts on top ten customers.

Growing importance of global offices.

Strengths:

1) Antenna research. We scour the world for the best designers: creative, innovative, have PhDs
2) Fabless: can try out new things without the cost of a factory.
3) Knowledge of dielectric material: plastics, ceramics.
4) Thinks how antenna works with the rest of the RS solution. Have looked to CSR. Look to optimise not just the antenna, but also the other components to get better range, less static, better band with.
5) Strong market focus, have looked to CSR. Handset and laptop market.

We need:

1) A stronger customer base
2) To be on approved supplier list of large corporations
3) Revenue
4) Global presence. Need to be close to people, whose product your device goes into.
5) Cost effective manufacturing partners. It's a component. Right type of partners, who can deliver on time and who we can manage.
6) Working with the right type of component manufacturers as we integrate more functions (e.g. switches) into the antenna.

Business Actions:

1) Acquired another company which was based in Sweden, and had a good reputation, not for their technology, but for their sales channel (customer contracts)

2) Global presence: office in Taiwan 5 months ago. Also a design centre. Also have a sales office in the US and Sweden and will be opening more in the next 5 months. Also a design centre in the US in the second quarter of 2006.

Huge growth of sales.

3) Need right skills sets and manufacturing partners. Will have to open up an office in China. Important to work well with RF component partners.

Need to keep antenna as far away from the battery as possible, since it creates static with the antenna. Have been able to integrate filters and amplifiers in the antennas. Aim to move up the value chain: increases the performance of the product. It fits insides of any phone, laptop. Antennas hugely customized to the model of phone, which is not the case with this company's product.

We can either sell the antenna to the RF component company, who will package it and sell it on the customer: handset. Or we package it and ship it to customer ourselves, or we work with the customer to help them integrate it into their technology.

Summary:

Now also make antennas and research into active components. Able to get into the market quickly: flexible, licensing modules shipped directly, done work with competitors, acquisition another company's customers and sales force. Not licensing only, not shipping component in a Fabless way. Constantly need to innovate and create to perform better. Have a new product which will change the wireless industry. Different materials and flexible business module. Key: having the right types of manufacturing partners and suppliers and knowing how to work with them in a quick, cost effective way. Cannot work alone until they get to revenues in the USD100s millions.

Example Company 5

Had to find a specific market for our technology which has multiple market applications: portable power market, which was keen to engage and pay good money. Consumer electronic manufacturers are producing goods with an ever increasing demand for power and current battery power can't cut it anymore. The company has added value by making a fuel cell stack and also following a Fabless model.

There are a lot of challenges relating to fuel cells:

1) Size (they're still quite large)

2) Materials are expensive (platinum catalysts)

3) Highly complex – high manufacturing costs – robotic lines, human assembly.

CMR fuel cells are the future:

1) Stacks are 10 times smaller, so can fit in more devices.
2) They have more space for fuel – longer running time.
3) Also 80% lower price -competitive.
4) Suited to mass production.
5) Strong IP position. Worldwide and high-level.
Outperform and undercut fuel cell technology in the current arena.
Forming strong relationships with materials suppliers and contractors upstream.
One product. Variety of markets. Little need for marketing.

Summary:
Have a breakthrough technology.
Strong commercial focus. Good engagements with customers.
Pragmatic engineering approach.
Key catalysts and system integration partners in place.
Strong financial position and are developing a very expert team.

PANEL 3
Is Fabless manufacturing manufacturing at all?

- Our plants are in Taiwan but we have a team in the plant over there, have a quality office and multi-million dollar test lines in Cambridge. We are utilising the low cost manufacturing, the fact that governments there have invested in making plants, and using those to the advantage of our company here. We don't own the plants, but are very integrated.
- You still have to be aware of the design, quality, health and safety regulations etc. We don't own the bricks and mortar, but we still have to manage it, and the in-product.
- Manufacturing is the big story, production the physical bit.

When you are so 'in bed' with your partner, what do you do when there is a total disruption to your supply lien. Do you have a recovery plan?

- We have to manage risk carefully. Our partner has 8 plants which could manufacture our chip. We have two manufacturers running in parallel at any one time anyway.

- Our customers want to multi-source the products anyway, so we have to set up parallel manufacturing facilities anywhere.

How would you rate your company in terms of agility (speed to market)? And how agile do you think companies are in the East of England?

- 8 or 9 Companies are generally agile. It is when companies expand that they bring in bureaucratic structures and things go wrong.
- Innovation and speed enable us to keep a competitive edge. Bureaucracy grows with time. Government must try to minimise regulation.
- Any company that wants to compete globally is forced to be quick.

Would you have found a different market, if the one you were working for didn't materialise?

- Our product was demand driven.
- Yes, we would. But we would have lost time.
- We spent a lot of time researching to choose the right wireless market.

What sort of companies are coming up with the raw materials you use? Small ones or established companies?

- (All agree) Mostly well established companies, for cost regions, and mostly out of Asia.

What allocation of funds is put aside for protecting patent applications?

- A lot for cross-patent applications. We need to budget for people's time, which means filing patents.
- Patent review is an ongoing process. Have to set reserves aside for challenges to patents.
- IP is a very important part of our company.

How do small businesses protect themselves against somebody who has deeper pockets?

- You need a strong portfolio. Investors will help us protect our IP.

- Ultimately you can't protect everything. Especially difficult in China. Work with other people – above board – it's better than having them rip you off. But we change our designs every 6-12 months.
- Get in bed with the biggest threat.
- Compete in an open standards forum if you are nimble afoot.

How do you make the change from a small group of enthusiasts to medium-sized companies?

- It's difficult. There's no formula. Communicate constantly. Keep priorities in sight. Not everyone makes it.
- Not all the skills to produce a Fabless company exist in Cambridge. You need to bring people in and understand that, as a founder, you can't do everything. You can't get too precious about it. You need to keep the product in sight.
- You need to raise a significant amount of cash to get global.

Is it important for the country to have a silicon plant?

- They encourage clusters to grow up around them. However, you need a lot of cash, to pay people to run the plants, and it's cheaper in Taiwan.

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Final Session Notes

Example Company 1

Polymer Organic Light Emitting Diodes: each sheet 200 nanometres of light emitting material

Applications: 3G streaming video feed to hand-held devices, medical instrumentation, MP3s (switching speed 1000x faster than liquid crystal, high contrast ratio, deep colours). LCD industry: highest costs (50% of total): colour filter and back light, which are not necessary with OLEDs.

1992-9. Passive licensor of technology. Have subsequently licensed 8 companies to make the material. Taken over by American Private Equity in 1999 – provided funding that enabled technological progress.

Important to look at the technology ecosystem. No good having technology that lacks the means of delivery. Picked three fields to concentrate on: the materials, the printing and the development of the printing process: the manufacturing process. Difficult to find the right quality of people with manufacturing experience. Bought a printer from a Californian spinout to have a means of manufacturing our technology. Bought in a Japanese company. Now have a product line and the distribution rights (technology innovation centre, East England). Realised they could access other parts of the supply chain: bought test equipment. Sell ink jet printers and the processing technology. Skill base established in Cambridge, enabled them to enter into joint ventures in Japan – they provide the cash, the company the expertise.

One product: diverse revenues: licenses for displays and lighting, ink jet printers, transferring the process, consultancy work, sell small volumes of the inks, test equipment, and in the long term: royalties. Very rapid process of scale-up.

Manufacturing displays has disappeared from Europe and North America. The Chinese have not quite caught up with Japan, who are trying to deny them the technology. Worry about security of IP in China and governmental pressure being put on the Chinese. We cannot change the fact that manufacturing is now in Asia. In the UK and the rest of Europe, we have to focus on innovation and value added parts of the process. You have to be global. It's not done on small budgets. You have to pick your partners very well.

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Summary:
In the last 6 years company built "a multi-revenue source business from a single invention". This needed a global approach to partnering and selection of the critical technology elements which we had to solve to make the whole package acceptable to the manufacturing industry.
Also needed gutsy, well-resourced investors. In this company's case, it is close to $200 million over its lifetime (95% since 1999). You need to move the technology closer to the manufacturing scale.

Talk 2 – Local Infrastructure Issues

The environment is going to be the biggest problem by far over the coming decades. Two key areas: the production of energy and transport, which are intertwined. Energy must be saved before, in, and during the manufacturing process. Such an argument is unlikely to find any favour yet outside of Europe. But we can find a vanguard manufacturing world. Let us consider the geographical area of the GCP. Many commute into this area and face problems of congestion. Returning to the UK, from any country, other than the third world, makes you realise how third world our transport network is. It's time for a new strategy to emerge. All effective empires have been founded on a good transport infrastructure. Need for restoration of our railways. They need to be costed properly. HVM has a part to play in this. We don't have to buy foreign, if we are prepared to invest properly at home. Railways are a property play, not just a transport system. This is proven by the new train service to Norwich. Cambridge's housing and transport problems are being addressed by inadequate development e.g. a guided bus service along a disused section of railway line, when what we need is a fast connection Cambridge-Peterborough, which should form part of a larger network to link ports on the East coast and thus alleviate freight transport form the roads. The alternative to new settlements, such as the one proposed at Longstanton is to improve the lot of the commuting population, or to throw off the green belt planning restrictions.

Summary: Talented people are the region's greatest asset. The knowledge that is created, developed and attracted to this region underlies its capability to stay at the forefront of R&D. The questions of transport and energy have to be well thought through if HVM in this region is to cope with other global players. We have just a small window of opportunity. Imperial college is already reawakening its interest in nuclear power and Cambridge should be joining forces with it, since it will buy us time to develop solar and wind power.

Regional bottlenecks:

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Inadequate roads and an almost non-existent railway
Overstretched power supplies
Under funded RDA (EEDA) – lack of funding
Uncoordinated planning

Good things:
University in better shape than many would believe.
It is at the heart of regional economy.
Its spin outs are surprisingly few. But perhaps commercialisation is better done elsewhere e.g. in consultancies, especially if they are close enough to the university to be able to recruit some of its graduates, before they go into the service sector in London.
The university should not be so angst-ridden about creating a tech-transfer office. It is fundamentally an institute of research and learning.

We should not become complacent about the UK economy. Financial series are a useful export, but the city is significantly foreign owned.

We need to regain the industrial sector through HVM. The many, small companies in this region should be encouraged. There are a good number of Business Angels in the Cambridge area. VC money is hard to come by. Locally there is no *new* money around. We are still living in the shadow of the 2000 bubble. I also don't subscribe to the vogue enthusiasm for turning everyone into an entrepreneur. Those who can, do so. Entrepreneurialism cannot be taught, anymore than common sense. So, let's avoid becoming a suburb of London and harness the resources and ingenuity our HVM sector to solve the problems of transport and energy, so that the environment which we enjoy will be enhanced against the background of economic growth, for which we are justly renowned.

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Lord Sainsbury, Undersecretary of State for Science and Technology, Address

Global manufacturing is undergoing revolution. In 1980, less than 10% exports came from the developing world, today that figure is 30%. China, with 5% of our wages, alone is producing 70% of the world's photocopiers, 50% of the cameras, 40% of the microwaves and 25% of textiles. We have to beat them on high value and high skill and must develop our technology-intensive- and skill-based industry. So in 2002, the Government established its strategy, fundamentally base on innovation, to help companies meet the twin challenges of globalisation and technological advance. In 2004 we reviewed the strategy, set up the manufacturing forum to ensure its effective implementation.
Three areas have come out of that:

1) Skills
2) The image of manufacturing.
3) Public procurement.

What do we mean by HVM? There is a myth that manufacturing is old-fashioned and that the future lies with services. But this damages our ability to get investment into the sector and to recruit talented graduates into the sector. Research has shown that manufacturing is moving away from a focus on production and raw materials into an understanding that value can be created from all parts of the chain. Manufacturing is inextricably linked with services. We aim to demonstrate that high-tech manufacturing is an important part of the economy that can offer an exciting future for young people. The government does not believe that it is its role to intervene in the competitive process, but to create a dynamic market economy and to create good conditions for companies to grow. In three key areas – design and technology, skills and fiscal policy – we have made changes which will benefit HVM companies.

Science & Technology

There are 120 000 more young people doing science and technology today than in 1997. As a percentage of the total number of students, the total has risen from 38% to 40%, which is extremely high by national standards. The biggest increases have comes in Biology and Computer Science. Fall in engineering students. Problem in the UK on the technician level.

1) More generally, scientific understanding and technology – rapidly changing. Many new opportunities. UK has great science and technology capabilities, and it was this base that we first funded when we

came into power. Budget (1997/8): £1.3 billion. This will have more than doubled in real terms to £3.4 billion by 2007/8. More than £0.5 billion per annum on university facilities. There is also a focus on the world-class universities.

2) Also, we have focused on increasing knowledge transfer (Higher Education Innovation Fund). The market value of University spin-outs floated on the stock market in 2004 = £604 million, £100 million more than the governments investment in knowledge-transfer to date. More people receiving enterprise training. And these cultural changes in universities are reflected in the high-tech clusters that are forming around top universities.

3) To encourage more user-driven /applied research. Technology strategy plan identifies sectors where the UK has the capacity to create a competitive edge. This funding we have used to support areas such as ICT, biotechnology, nanotechnology, aerospace. We've allocated £320 million over 3 years and set up an industry-led technology strategy board to regulate it.

Micro and nanotechnology: I launched a £90 million initiative (2003) to develop new products. Offered support and helped create a network for facilities, covering academic and industrial capabilities. R&D projects in healthcare, crime prevention. Investment into national measurement laboratories. Joint industry and government research projects. Access to networks and sources of new knowledge were identified by the DTIs innovation review as two of the most important determinants of business innovation performance.

4) Developed a community of overarching knowledge transfer networks, e.g. Bioprocess UK, at a cost of £43 million over the next 3 years.

Innovative manufacturing and research centres set up in 2001 to create relevant research outputs.

In summary: Results are no longer seen as discrete process or product improvements, but can be part of long-term strategic partnerships, which produce strategic improvements and strengthening of a company's technology base. November 8th: announcement of the first professorship of technology transfer in the physical sciences at Imperial College.

In conclusion: The government sees high-tech manufacturing as a crucial part of our strategy for the future and innovation as the means by which we can change globalisation from a threat into an opportunity. We should not underestimate the size of the challenge, but neither should we forget our skills and technological capability.

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FINAL PANEL with Lord Sainsbury

1) Having read recently in depth the latest strategies and plans, including the 5 year plan I find little to disagree with in them. Would a Conservative government be so concurrent? Would there be some visibility of stability, which is what we need as businessmen?

- I don't know. But I am also not in the best position to ask them either! I don't see any sign that they have focused on science, technology or innovation at all.

2) One speaker in this session was talking about developing energy supplies other than fossil fuels. But, it seems economically difficult to justify other sources. What can be done about that?

- I believe the role of government is to set a framework and then let the market fulfil the needs of the country. However, there are 3 conflicting objectives: 1) lower cost 2) energy security 3) environmental impact. Additionally there is uncertainty regarding the technology and economics of each type of energy. One conclusion: key to a good energy policy: keep options open and have a variety of sources: diversity and flexibility of sources as the economy changes. Plurality of answers.

3) But doesn't that entail investing in these alternative sources of energy, or making them an attractive investment?

- We have major schemes funded through the renewals obligation to alternative sources of energy to encourage investment.
- There has been so much bad publicity about nuclear. But it seems clear that power stations of significant capacity are certainly an option. We need more research.
- Not research, but a time frame. Wind is the only one commercial at this point. Are we happy to get to 2020, having replaced 20% of nuclear with <20% wind energy, and not dealing with the problems of emission. The energy review will deal with the issues surrounding nuclear energy.

4) CDT gave us an overview of how to turn an idea into a global business. From CDT's experience, what could we do to promote that model and make it easier to adopt.

- The greatest barrier to CDT expansion has been funding, and then skills. Loss of the semiconductor industry, getting people with these skills has been a problem. We have had to bring them in from abroad. There is still a hangover from 2000 in the VC world. They need to regain their guts and start to reinvest in early stage startups.
- How do we attract better qualified people into manufacturing? Accounting firms employ about 5000 university graduates this year, a third of which will be scientists and engineers. We should be seeking to retain these people, by better promotion of the manufacturing industry.
- Need to convince young people that manufacturing is a fun, exciting and challenging place to be, where you can make a lot of money, if you get it right. Young people are interested in entrepreneurial activities – we do this relatively well in the UK.
- Change in the universities -students want to start their own companies. But there is little money in the VC area and VCs have a tight timeframe and often work at odds with the companies which they get involved with.

Chairman Closing Remarks

"You'd have to be extremely unresponsive to a place not to be excited and fascinated by the things we have heard in this room today" (Mike Gregory)

People are making loads of money and having a lot of fun in the process.

We've seen today a range from small companies working on the science for applications to medium-sized companies making things like bluetooth chips and displays going very well and growing quickly in the region and in global market too.

It is a pity more people on the street cannot see this and one thing is that we must try to get these messages of what has been said today out to the person on the proverbial Clapham Omnibus, and indeed that is what the Manufacturing Forum is also working on.

I think it only remains for me to congratulate Justin Hayward and Mike McCreary and the other CIR people Helen and Rosie, for organising this 4th HVM event.

Justin Hayward then thanked the conference, announced that CIR hopes to run further HVM events in the East, South East, London, South West in 2006, and invited networking.

END OF CIR HVM EAST & CAMBRIDGE CONFERENCE SUMMARY 2005

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i10 (www.i10.org.uk)

A new collaboration between the region's universities and colleges, i10 offers businesses access to the huge combined resources of knowledge and expertise of Anglia Polytechnic University, University of Cambridge, Cranfield University, the University of East Anglia, Essex University, University of Hertfordshire, Luton University, Norwich School of Art & Design, the Open University and Writtle College. i10 works towards fostering a culture of innovation, encouraging technology transfer and knowledge-sharing, and providing specific support for manufacturing sector, as one of the region's clear strengths.

Design Council (www.design-council.org.uk) (Jointly with IfM)

The Design Council improves prosperity and well-being in the UK by demonstrating and promoting the vital role of design, particularly by helping businesses be more competitive and by improving the effectiveness of public services. Its national design programme, being developed with the RDAs, is designed to help UK manufacturers to transform their bottom line and secure competitive advantage by using design to guide decision making and produce strongly differentiated products.

Institute for Manufacturing (www.ifm.eng.cam.ac.uk) (Jointly with DC)

The Institute for Manufacturing (IfM) is a part of the University of Cambridge, Department of Engineering. Its activities encompass industrial services, research, education and courses that aim to provide a clear understanding of the challenges that face manufacturing.

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CIR Ltd offers market and investment research, financial, technology and strategic consulting through dynamically formed, small teams of business, technology, and financial analysts and sector-expert consultants. CIR's 30 partners are expert in printing, displays, electronics & semiconductors, biotechnology, new materials, energy and software sectors.

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Introduction to High Value Manufacturing and Definition

CIR is delighted to organise this 4th HVM-UK conference. The series is now expanding across the country. The leading institutions are now with us in using the expression "HVM" as defined below, to encapsulate what is the most likely long-term future of the business of making products by UK companies.

We welcome all speakers, sponsors and delegates to participate as fully as possible in this important discussion today. We have changed the programme so that any emphasis on particular sectors is taken away with the intention that all talks are important to all delegates, as case studies often of successful or perhaps earlier stage companies trying to work out their best way forward for growth. The days begin with definitions and general talks laying the foundation for the case study talks, which are arranged according to 'business model' or position in the 'supply chain' rather than 'sector'. We finish with a multi-stakeholder high-level session, whose aim is to capture the knowledge shared earlier in the day, and to formulate strengths and actions. Those on the panel are government and government manufacturing advisors, leading HVM companies, financial and academic players.

CIR definition of High Value Manufacturing (HVM)

CIR uses the trademark phrase 'High Value Manufacturing' or 'HVM' rather than the phrase 'high value-added manufacturing'. This was a deliberate choice by CIR in 2002, which has now taken root. CIR believes the recipe for HVM is not simply about linear 'value-add'; it is a function of time-to-market, IP and reinvestments, among other factors.

CIR developed a working definition of HVM: "HVM is manufacturing where there is relatively high value created in the supply chain segment involved.

In a corporate setting, HVM is usually characterised by higher-than-average expenditure on R&D as a proportion of sales, and/or is highly innovative with respect to product development & design, and/or is associated with above-average levels of intellectual property (IP).

HVM often applies to newer markets, where design or manufacturing processes may be fast-moving, new, unfamiliar, or not well tried and tested; and where prototyping, demonstration and or lower volume production are valuable. Selected business sectors where this is often realised are: electronics and semiconductors; printing and displays; medical devices and biotechnology; aerospace; automotive and motorsport; new energy; new materials and nanotechnology; and communications technology."

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CIR HVM-REPORT 2006: ADVANCE SUMMARY

2.1 Introduction

We use the expression "HVM" as defined below, to encapsulate what is the most likely long-term future of the business of making products by companies headquartered in the UK. Our general aim is to shed light on this section of manufacturing, and to support it. We wish to create a community that is aware of itself in taking forward confidently this type of manufacturing. We are writing this authoritative report, of which this text is a summary for the perusal of HVM-UK Conference Series participants.

2.2 Defining High Value Manufacturing

2.2.1. *Definition of HVM*

CIR uses the trademark phrase 'High Value Manufacturing' or 'HVM' rather than the phrase 'high value-added manufacturing'. This was a deliberate non-standard choice of phrase by CIR in 2002, which has now taken root. CIR believes the recipe for HVM is not simply about linear 'value-add': it is a more wholesome function of time-to-market, IP and reinvestments, among other factors. CIR developed a working definition of HVM: "HVM is manufacturing where there is relatively high value created in the supply chain segment involved. In a corporate setting, HVM is usually characterised by higher-than-average expenditure on R&D as a proportion of sales, and/or is highly innovative with respect to product development, and/or is associated with above-average levels of intellectual property (IP). HVM often applies to newer markets, where design or manufacturing processes may be fast-moving, new, unfamiliar, or not well tried and tested; and where prototyping, demonstration and lower volume production are all still valuable. Selected business sectors where this is often realised are: electronics and semiconductors; printing and displays; medical devices and biotechnology; aerospace; automotive and motorsport; new energy; new materials and nanotechnology; and communications technology."

2.2.2 Selection of appropriate Key Performance Indicators

The following are taken from the government's manufacturing strategy for reference:

Segment/'Pillar'	**Key Performance Indicators**
Promoting Science and Innovation	Innovation, investment, skills and productivity
High Skilled, High Performance Workplaces	Skills

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Encouraging Intelligent Public Procurement	Overall Outcome: A more coherent, transparent and predictable public procurement process resulting in innovative bids from UK manufacturers and better value for money for the public sector.
Encouraging High Value Added Investment	Investment and profitability.
Promoting Best Practice	Output, productivity and skills.
Improving the Understanding of Manufacturing	Overall Outcome: Well publicised and received programmes of research that effects real changes in stakeholder attitudes towards manufacturing over the next ten years.

In 2002 the UK government published its manufacturing strategy in recognition of the fact that UK manufacturing output had been falling over the previous 2 years. The strategy was compiled by a multistakeholder working party initiated at a manufacturing 'summit' chaired by the Secretary of State and held in 2001.

The introduction summarised the positions as:

Manufacturing is important. It accounts for a sixth of the economy, it employs around 4 million people and many more in associated industries and services. Manufacturing accounts for 60% of our exports and 80% of research and development, so is a key driver of innovation and technology uptake.

But manufacturing productivity in many other industrialised countries is higher than it is in the UK: around 30% more in France and Germany, and 55% more in the US. If UK manufacturers could match performance in these countries, the UK would be £70 billion better off. Returns on investments would be higher, jobs even better paid, and companies more competitive.

The strategy document went on to introduce the so-called 'Seven Pillars for Manufacturing Success'. These seven pillars are: Macro-economic stability, investment, science and innovation, best practice, raising skills and education levels, modern infrastructure, the right market framework. All but 'macro-economic stability' appear in the table above.

Image of Manufacturing

Stakeholders continued to feel there was a widespread poor public perception of manufacturing leading to problems in recruitment, reluctance on the part of financial institutions to invest in it and with schools having little awareness of the real opportunities in manufacturing. The document suggested that that we should investigate the issues. There should be promotion of a positive attitude within schools and a broader senior ministerial presence at key manufacturing events. Finally, a public relations campaign should celebrate success to counterbalance negative media reports. Further, the sectors we are writing about should be those, which will lead the way forward longer term. Good news does not easily sit well with the media, except as part of a 'build-up and knock down' strategy; this is merely to note this difficulty, but not to offer solutions now, beyond seeing that greater, skilled PR management is needed to handle this fact.

2.3 Global Perspective

Our 2006 report will cover this in much more detail.

We arbitrarily divide the manufacturing landscape in the world into two distinct categories, the existing 'developed world' economies and the 'emerging' economies. They are those who are seeking to regain what they had, and those who are seeking to retain the growth rate they have achieved. America clearly fits the first category together with Western Europe, whilst Asia, Eastern Europe and South America define the second category.

America

America has arguably just awakened to what it lost and, in 2004, President Bush commissioned 'Manufacturing in America, a comprehensive strategy review to address the challenges to U.S. manufacturers'. The stated goal was 'to help the American manufacturers compete and win in the 21st century' and the question posed to participants was 'How can government help manufacturers compete?' For diplomats reading it, this title may ring some alarm bells. But the resulting document stresses the role of manufacturing with the phrase '…a healthy manufacturing sector is key to better jobs, fostering innovation, rising productivity and higher standards of living in the United States.'

This led President Bush to announce a six point 'jobs and growth' agenda. These points are:

To make healthcare costs more affordable; To reduce the lawsuit burden on the U.S. economy; To ensure an affordable, reliable energy supply; To streamline regulations and reporting requirements; To open markets for American products; To enable families and businesses to plan for the future with confidence.

Advisors have spoken with Bush. He has taken on board that the energy supply cannot indefinitely be satisfied by fossil fuel extraction. He has talked about the switch to the hydrogen, and possibly other, economies.

Of particular interest to companies involved in HVM is the stated approach to 'investing in innovation' that recognises the need to bolster further the development of new technologies that tend to increase productivity. The measures include a review of the federal R&D funding for generic technologies, engineering and the physical

sciences to encourage better co-ordination and focus on innovation and productivity enhancing technologies. The key action is a review that has the following remit:

'The review should consider the need for additional investment in core R&D programs for generic technologies, engineering and the physical sciences, especially in interdisciplinary scientific endeavours. The model followed should be the same one used over the past 50 years to develop the major technologies influencing the U.S. economy today (semiconductors, computers, network communications, biotechnology and now nanotechnology). This model is based on government funding of basic science and early phase generic technology research, followed by massive investment in applied R&D by the private sector'.

European Union

The key policy statement reads:

'In the face of globalisation and intense international competition, the European Commission has launched a new industrial policy to create a better framework for conditions for manufacturing industries in the coming years. The manufacturing industry matters to the EU, it employs over 34 million people, it accounts for three- quarters of EU exports and over 80% of EU private sector R&D expenditure. The new EU industrial policy will complement work at Member State level to support a strong and dynamic industrial base. It includes seven new cross-sectoral initiatives:

An intellectual property rights and counterfeiting initiative (2006); A High Level Group on competitiveness, energy and the environment (2005); External aspects of competitiveness and market access (2006); New legislative simplification programme (2005); Improving sectoral skills (2006); Managing structural change in manufacturing (2005); An integrated European approach to industrial research and innovation (2005).

In addition, the commission brings forward seven new initiatives targeted at specific sectors:

Setting up a new pharmaceuticals forum (2006); Mid term review of life sciences and biotechnology strategy (2006/7); New High-Level Groups on the chemical industry and the defence industry (2007); European Space programme; Task force on the competitiveness of information and communications technology (2005/6); Mechanical engineering policy dialogue (2005/6); A series of competitiveness studies, including for the ICT, food, and fashion and design industries.

This industrial policy whilst laudable in intent and purpose is in danger of being too much dialogue too late and can definitely be seen as lagging behind the US initiative. However, the member states have been proceeding with national initiatives in pursuit of national interests that can be to the detriment of other member states.

Asia

To speak of 'Asia' is, of course, to make sweeping assertions about a large number of diverse nation states, cultures and economies. However, with respect to industrial strategies, one can consider them as essentially similar in that they have large populations coming from an essentially subsisting agrarian and hence low purchasing power background. This leads them to offer access to a large labour force and in turn a potentially

large domestic market. Many of the principal nations, with the exception of Japan, have increasing GDP growth at a time when the world growth in GDP has been slowing down. There is an obvious division within them between established and emerging manufacturing centres. Asia boasts some well-known established manufacturing centres, built over the past couple of decades in Japan, India, Taiwan, Singapore and South Korea, and emerging low labour cost centres such as China, Indonesia, Malaysia and Thailand.

Today the developed countries have the majority of world trade with the EU and US accounting for some 51% of international trade, but it is not going to stay this way!

Economically, China has experienced average annual growth of almost 9% over the last 25 years and if carried forward means it will become the world's largest exporter by 2010. India registered 8.2% growth in 2004 giving it the second fastest growth rate in the world after China. Each of these two nations has been investing heavily in education with, for instance, graduations in India currently running in excess of 2 million per year with 5% in technology related subjects. These and many other 'Asian' nations are transforming from heavy state intervention in industrial strategy through ownership towards a strategy of positive state assistance to attract inwards investment and the establishment of private enterprise. China's growth has been so strong that it now strongly effects the global market for oil; academics in China are already thinking about new forms of energy, aware not only of the demand-supply relationship for oil pushing prices up, but also of the political stability implications of it.

Taking India as an example, the objectives of the Government Industrial Policy are:

- to maintain a sustained growth in productivity.
- to enhance gainful employment.
- to achieve optimal utilisation of human resources.
- to attain international competitiveness and
- to transform India into a major partner and player in the global arena.

Policy focus is on:

- Deregulating Indian industry;
- Allowing the industry freedom and flexibility in responding to market forces;
- Providing a policy regime that facilitates and fosters growth of Indian industry.

Amongst the many measures being taken to implement these policies in the HVM arena is the establishment of Electronic Hardware Technology Parks (EHTP) and Software Technology Parks (STP) aimed at building a strong electronics industry and with a view to enhancing exports. Under both schemes, inputs are allowed to be procured free of duties.

Along similar lines, the Chinese government has funded massive technology parks and provided state funding for the establishment of large R & D centres with tax and investment benefits. Construction companies are cash-rich and becoming more so.

The American paper referred above may apply universally: "Competing in a global marketplace puts a premium on government getting the fundamentals right to create an environment in which manufacturing can flourish. It means examining whether the government's actions and the structure of the market improve or hinder the ability of firms, in manufacturing and throughout the economy, to compete in an increasingly global marketplace."

Most governments around the world have awoken to this situation with many taking dominant roles in promoting that 'economic environment' and using the remains of their declining control economy powers to promote their capabilities. In these enlightened nation states, manufacturing has the image of salvation to remedy years of regression and poverty.

2.4 UK Perspective

The image of manufacturing in the UK is not perceived to be good. The lack of prestige for manufacturing makes it hard to attract the brightest individuals coupled with the inability to recruit and the lack of status afforded to science, technology and engineering make it difficult to enrol new UK students. Of grave concern must be the fact that, according to Professor Peter Dobson, '… a shortage of PhD students is developing with the number of UK nationals starting PhDs declining'. Given that the essential fact of High Value Manufacturing is the meeting of new science and industry, it goes without saying that if the source of scientists reduces then the size of HVM may well fall accordingly. Against this backdrop it is essential that all parties interested in the long term role of UK manufacturing, schools, academia, industry and government must utilise every opportunity to extol the virtues and the importance of science and HVM. Within this group, government alone has the authority to direct schools and academia whilst industry has the responsibility to influence. Without a concerted effort through this partnership we will fail to attract the calibre of entrants to industry that is required to survive as we enter the 21st Century.

2.5 East England: Statistics and Outlook

There are nearly 20,000 high value manufacturing companies in the UK, with more than ten percent of those based in the East. It is clear that the sector has generated much interest and support in the region since 2002, and we hope that this will continue.

We refer to our report of 2002 "HVM in East England" as a reference for statistics, and we hope to update these results and produce the beginnings of a trend analysis in the near future.

2.6 Recommendation, actions

Background

- In making recommendations for a subject as complex as HVM in a diverse region, it is always possible that the initiatives may already be underway but not immediately known to CIR.
- The existing Manufacturing industry has 'done lean to the point of emaciation' and the future strategies for Manufacturing both conventional and HVM must move on from internal navel gazing efficiency improvements and recognise that HVM has an economic scale that only National strategies can address. In saying this it does not relieve HVM's of striving for world class capability, that is the given to stay in the race!

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- If the UK is to have a long-term sustainable High Value Manufacturing industry it is vital that actions are taken now! The science and technology is at a turning point that if grasped now will put the UK in pole position. That turning point or watershed is the adoption of nano technology in all its various guises. Nano is an all-embracing and enabling technology that has applications in all HVM products. If the UK adopted a genuine cross party, cross agency, cross industry strategy to ensure that the next generation of all designs incorporated the benefits of nanotechnology it will lead the world..
- Whilst there is investment money available for short to medium term projects the *real* issue is the funding of long term (7 –15 years) projects. Private funding in the UK just will not wait that long for returns.

HVM structure: networked, international collaboration, cleaner, ethical*:*

- Start up companies and Universities should consciously create 'Joint Venture clusters of similar start ups and research projects to share knowledge and the 'above the line' costs of say marketing, compliance, sales channel etc to avoid dissipation of efforts and money. These could be initiated by the RDA's or similar
- The government needs to think through the current panoply of bodies addressing Science and Manufacturing, These include the DTI, RDA's, University Councils, Research Councils, Professional Institutions, Trade Associations etc etc. They have vast duplication of boards and staff collecting data and all spending vast sums of money in terms of administration and actual grants to industry. The system needs to be streamlined, focused and strategically re-directed with the money saved re-invested in Science and HVM. The nation needs to adopt the role 'venture capitalist' for emergent technology companies.
- There must be a national strategy for enabling technologies such as nano that brings together all the body of knowledge and seeks to disseminate across industry sectors. In the mean time, the SE RDA needs to get on with the Regional Nano and Microtechnology Network plan and become the pilot for UK best practice.
- The 'Encouraging Intelligent Public Procurement' initiative needs to step up a gear with the strategic impact of the decision being taken into account on an equal footing to the economic circumstances. This is particularly so in medicine and defence spending that have historically been a great catalysts of technical innovation.
- There is a need for skilled 'intermediaries' to work with HVM's to ensure that both inward and outward licensing together with patent registration becomes easily understood, is beneficial to the UK strategy and is more easily affordable. This could become one of the front office 'cluster' services referred to above.
- The SE Regional Economic Development plan should become the catalyst for stimulating the growth of HVM.
- A national awareness campaign for the stimulation of science and maths as entry to HVM and in turn the attractive opportunities for the future of employment in HVM needs to be mounted.
- We need to reach out to the young people of today and show them the attractiveness of working in modern HVM as opposed to their 'smoke stack' view of it.
- Need to see tax benefits for those people willing to invest in long-term investment projects.
- Need to stimulate Apprenticeship training schemes through some form of Tax levy redeemable by those companies who invest in training.
- 'Cluster' training schools to be set up to link with the Apprenticeship and academic technical training schemes. Must increase the technician engineering pool.
- Bring back technical colleges to train the technicians in association with the above.
- Enabling technologies need to produce 'road maps' of where they are going and what other industries need to become involved. A technical elite knowing all is inadequate: we need buy in from all aspects of HVM.
- Need to improve the roads. Look at Germany, long distance road lorries are taken to their destination on flat bed trains and only travel on roads for the last part of their journey.
- Need to breed more inter-disciplined people, scientists who understand marketing, engineers who can speak foreign languages etc

The need for IPR and process 'recipe' retention

The current UK manufacturing strategies are based on the following political premises:

- Energy costs featuring oil at $60+ per barrel
- The Suez and Panama canals remain open
- America (and others) maintain an open market free trade stance
- China continuing to grow at around 10%pa, becoming increasingly dependent on imported oil

If any or all of the following 'fat-tail' or 'low probability' events were to happen, for example:

- Oil went to $150 per barrel
- Either or both of the canals were blocked for a prolonged period of time
- Barriers to free trade were erected by any of the major nations
- The present minor conflicts that exist around the world in very sensitive areas were to escalate to full scale wars with major blocs supporting opposing sides

Then, the mass importation of goods of any description from extended global supply lines would be either stopped or subject to re-evaluation in the light of soaring logistic costs. A very sobering thought!

It is routine for all companies to have a plan for localised events, fire, flood bombs etc. Eventualities on the scale above require national level planning. We must maintain the 'recipe' for all production processes, even if only at pilot scale, and arguably (although in the event of free trade barriers perhaps not so) ownership of the IPR to continue manufacturing. We must not allow HVM to go the way of the garment industry where, during the recent hiatus regarding import quotas, the Chairman of the Garment Manufacturers Trade Federation said that the UK no longer had the skills and knowledge, let alone the capacity, to fill the vacuum in the supply chain.

Whilst the above is the blackest of situations, at the national procurement level it is essential that investment in technology and new products is made in recognition of the possibility that the UK may have to produce the items on shore under certain circumstances. The person who recovers from a catastrophe the fastest is the one who planned for it!

In any eventually, we do need to retain generic, older and new intellectual property for both products and processes.

2.7 Concluding remarks

- The DTI and the RDA have already made good progress but it needs to be better resourced and more forceful, with good ideas put to positive actions.
- We in the UK have the ideas and in most cases the people to start them off.
- Now is an opportunity for government, the DTI and the RDA's to give strong leadership in determining the place for Britain in the 21st century.
- It may not require a lot of 'new money', just the re-distribution of the existing funding that disappears into a 'bureaurocratic soup'.

- To do so will mean that a number of powerful people may have to check their personal and political beings and put the national requirement to the fore.

2.8 CIR Global High Value Manufacturing Report 2006 (to be completed and released)

CIR's team is developing the work done in this UK context so that it provides a view of this topic nationally in depth and indeed globally, as seen from the US, Europe, Asia-Pacific, in high and low cost regions, and across a broader range of subjects. This will be an authoritative report, based on knowledge obtained from nearly four years of consideration, conferences and consulting work on HVM. CIR seeks sponsors, supporters and purchasers of this report.

Acknowledgements

This summary is part of a report being written by CIR: the Global HVM Report 2006 alluded to above. CIR seeks supporters of the project.

CIR would like to thank EEDA for its Platinum Sponsorship support since 2002, and all its sponsors and manufacturing partners in HVM, who have also been supportive. CIR would like to thank in particular one of its expert Associates Mike McCreary for collaboration in this report and interpreting research and interviews performed inhouse by a junior analyst at CIR.

Announcements

CIR would like to announce further HVM events in 2006 in regions adjacent to the East and South East.
CIR will set up a membership society for all those who have attended an HVM-UK event since 2002.
We hope to see you and colleagues back at HVM Series conferences to continue the discussion.