

Lessons from the coalface – hard-won insights from many different perspectives

The “Research through Industrial Collaboration” conference brought together four research partnerships with invited speakers from the companies and from the university to reflect upon the lessons they’d learned in working together and how to make it work better. An afternoon presentation provided insights about strategic university industry partnerships with lessons from the US and the UK.

A giant aerospace company, a fast-moving consumer products company, a specialist SME electronics manufacturer and a household name retailer – what could they possibly learn from each other about managing collaborative research with universities? How could one compare a portfolio of projects built over a decade with a company’s projects that have a two-week cycle time, or compare a researcher embedded within the university with an industry sector consortium? What lessons would emerge from this diversity?



Dinner Keynote: Professor Richard Penty

Opening with the conference dinner keynote speech, Professor Richard Penty suggested four important elements of success that were echoed throughout the conference

- People – excited to be working together, excellent in their fields and learning from each other
- Interactions – frequent and personal; it’s all about friends working together, not ‘customers’ and ‘contractors’
- Continuity – where knowledge, built up over time about mutual interests and priorities, is then coupled with deep technical competence and knowledge, again from a team built over time
- Flexibility – for academic freedom and commercial agility, especially to respond to those unexpected outcomes that turn out to be extremely valuable.

He built on these to advocate a mind-set of ‘outcomes’ not ‘deliverables’. This underpins a flexibility that allows both sides the freedom to explore the mutually interesting. The parties have different motivation, and it’s collaboration that enables both to get what they want.

He also explored how collaborations fail, highlighting two causes. When important stakeholders, often decision-makers in the background, aren’t sufficiently committed the collaboration becomes fragile. Then only a small change or setback becomes an excuse to stop the work, and everybody is left with a sense of failure. So be very careful if key people are only lukewarm about the project.

Even the most successful teams break up when people move on to other jobs and other places. It might be an unavoidable change, but it’s seldom unpredictable, so think early about succession planning and make the relationships many-to-many. Build the network and actively manage transitions.

These themes and messages were enriched during the next day of the conference as each company and each academic described the lessons from their experience.

A decade of building and refining a strategic research partnership: Gary Fitzmire of Boeing and Dr Philip Woodall of the Distributed Information and Automation Laboratory, Cambridge University

Gary Fitzmire and Philip Woodall described the experience and lessons of Boeing's decade-long relationship with the Engineering Department, all the way through to Philip's current project and next proposal.



Despite the size of the aerospace business, speed matters - new competitors can emerge in just a few years. But Boeing works in areas where lives matter, where caution is essential and where risk must be managed. So they work with Cambridge on leading edge research to understand and manage risks before bringing new technologies and capabilities inboard. Boeing also needs to be able to expand its grasp of technology capabilities fast – and collaboration with universities gives it access to broad and deep expertise.

It is vital to target the research well – to choose the really 'hard problems' where a successful outcome would have a big impact on the business. And this means having researchers who regularly visit the company and know what would be valuable, and people from the company prepared to invest the time and effort to adopt new ideas and insights.

Both sides participate in the targeting of new directions with a “focus on the white space” in the map and a permanent initiative from Cambridge described as “we think Boeing would be interested in”. Understanding these opportunities takes time, commitment and continuity. As the direction to be pursued crystallises into a project it is essential for the researchers to focus on the potential value of the work to Boeing. Is this worth doing? How will it be used? By whom and how? Only if the Cambridge researchers understand this can they design projects that are most likely to lead to implementable outcomes, not just research outputs.

The Boeing mantra is that it's ok to fail – but fail fast. The obvious answer is a set of small speculative projects that are easy to start and easy to kill – but then how to have the patience to overcome interim obstacles rather than 'fail fast' at something that might have been possible and important? This decision is difficult.

Part of the answer is to focus on questions that really need deep expertise from multidisciplinary teams able to make skilled judgement, and on questions that are potentially very valuable to the company and so would reward persistence. This needs a research community able to marshal the skills needed, across both Cambridge and Boeing. Researchers need to dig hard to check the value of what they're doing and understand what outcomes would be most valuable. And to then focus, not on research outputs, but on business outcomes and then collaborate to create the solution. This might be a software tool rather than an academic paper in order to be useful to the company. But if the problem is 'properly hard' then the papers flow as well.

The other vital element is flexibility. So the teams use minimum formal reporting and avoid stultifying milestones. Instead there's frequent verbal communication and continual discussion of possibilities, of directions and of value.

In the early days of the collaboration Boeing's researchers were concerned about the collaboration; was this a source of competition or a threat to jobs? But, positioned as a staff development opportunity the link is now welcomed and the opportunity to write joint papers has been embraced. And about confidentiality –

what can be shared and who can be trusted? Regulatory constraints also loom large. A very pragmatic solution has been for Boeing to use Cambridge’s models, running confidential company data, and then sharing the results with Cambridge to understand the implications and to evolve the models.


Building the relationship has needed a mind-set change for both. For Boeing, it’s been a change from ‘directed research’ (amplify and accelerate Boeing’s interests) to ‘exploration of shared interests’ (work on what the academics find interesting and challenging – and then figure out how to apply this to Boeing’s business). For the academics it’s been a shift from “deliver a report of the research outputs and perhaps a prototype” to “work together to find a solution and then deliver and embed that solution”.

But building such relationships takes time and commitment from both sides. Boeing has signed up to multi-year commitments – despite an annual budget cycle. This has needed championship from Boeing’s R&D team into the organisation (and a few quick wins really help here!). Cambridge has had to find ways to work across its organisational structure in order to staff and deliver the broad portfolio of research projects and the network so valued by Boeing.

Cambridge continues to seek more interaction, finding ways to get more researchers to Boeing to understand context and to take the research to the users and to customise it. But this needs planning in from the outset, budgeting and scheduling from the very beginning.

As the relationship broadened across Boeing and the University both found it valuable to appoint a core point of contact on each side of the relationship – not as gatekeeper but more as facilitator of the evolving relationship.

Summary

- Maintain an open-minded relationship
 - leverage the skills from both sides
- Focus on impact
 - Research output  something the business can use
 - Consider it a significant part of the project
- Garner stakeholder support and feedback early



So both Gary and Philip painted a picture of long-term commitment that underpins the time necessary to build mutual understanding and a shared focus on outcomes that are implementable. The flexibility of reporting also avoids bureaucracy of milestones – again it’s the outcome that matters. And always seeking ways to build trust, build contact time and build personal relationships. This enables earnest discussion to be constructive, for everything from negotiation of contracts and intellectual property to underpinning the intellectual scepticism that leads to serious and robust outcomes.

Questions from the floor promoted the idea of short projects, the quick look-see, contacting a university when needed. But Boeing and Cambridge find the short exploratory project to be most successful within the context of the longer commitment and deeper relationship. The mutual insights and competence enables rapid acceleration and more accurate decision making about the likely research outcome and the potential impact. The trust already established is vital if such projects fail to deliver, as some high-risk explorations inevitably will.

Lessons Learned Along the 10-Year Journey ...

BOB | Partnerships

- Relationships Matter – Jenny Walsham taught Boeing how to start, maximize, and sustain our relationship with Cambridge
- Passion Matters – Many opportunities to say “this is too hard”
- Stability Matters – Our 5-year commitment is renewed every 3 years
- Intellectual Property Matters – “Right Of First Refusal”



- Build long-term relationships focused on outcomes – the commitment allows the creation of good expert networks, the exploration of shared interests builds trust, and the deeper understanding enables proactive technology foresighting by the university partner
- Use the long-term stability to build deep competence and expertise, coupled with an understanding of context and priorities
- Maintain flexibility – set directions, targets and aspirations but avoid bureaucratic reporting and over-rigid milestones
- Focus on outcomes not research results, jointly explore the potential value before you start, and specifically schedule researcher time on company sites to embed the work
- By all means run exploratory projects to identify or quickly abandon potentially promising areas (“fail fast”) but how best to identify the difference between a temporary setback and a show-stopper?

A fast-track development of a deep and broad collaboration: Frederic Nicolas, Dyson Ltd, Dr Anurag Agarwal, Acoustics Lab, Cambridge University

Dyson is a company with a focus on speed – speed in product development, in prototype cycles and ultimately, in time to market. They have 850 engineers in one place, the largest rapid prototyping facility in Europe and a philosophy of perpetual experimentation - envisage an idea then immediately try it out. As



Frederic Nicolas explained, Dyson’s approach is always to focus on the customers’ needs and the marketing claims and use that to drive the technology. Dyson was also always committed to doing things their own way and keeping it all in house. They have developed their own facilities so they can test performance against standards and norms as well as against previous prototypes – so they can experiment fast and discreetly.

Into this environment came Dr Anurag Agerwal of Cambridge University who’d been working on acoustic noise sources and building deep insights into the underlying phenomenon, starting with aero engines and then looking at domestic appliances. So the teams worked together based on an intriguing exchange of capabilities. Cambridge thinking and experience augments Dyson’s experimental approach with the insights available from fundamental research in order to drive research directions. So by working together the teams predict likely noise sources and the underlying phenomena and work to address them. Development teams can then use in-house test time to best effect. In turn, Dyson’s engineering and research enables Cambridge to accelerate its testing of prototypes, allowing faster turnaround of experiments which supports more efficient research.



In this context the team can certainly ‘fail fast’ – several times a day if need be!

Like the Boeing experience, the investment of time to get the best from the relationship deserves attention. Dyson find they tend to underestimate the amount of in-house time needed to make the best use of the research results while Cambridge find real value in sending the PhD student to work with Dyson to understand the culture, the urgency, and the context, including the sheer breadth of skills and interests within Dyson. In turn, Dyson uses the interaction with Cambridge to develop its engineers.

Flexibility is another prerequisite in this environment – major funding decisions can be made in a fortnight with, again, a focus on flexibility in reporting, on high levels of interaction and on low levels of formality.

But one consequence of market and technology agility is that Dyson's priorities can change quickly. For that not to have a destructive effect on the research continuity (and the student's PhD) it's essential that Cambridge keep its focus on the fundamentals.

Interestingly then, there's a drive for Cambridge to focus on fundamentals (the 'properly hard problems') for both Boeing's relatively long product cycles and also for Dyson's very short product cycles. But in both cases the value lies in the application of the fundamental research answers to create solutions to the business problem.

Cambridge also provides a 'corporate memory' of experience drawn from prior work in different scales or different applications that can be applied to Dyson's interests needs. Applying this experience improves as both parties learn about each other and as the teams build up continuity and trust, despite the rapid expansion of the depth and breadth of the relationship. As the Cambridge team thinks also about 'the customer' and 'the customer's customer' so the insights can be applied with greater subtlety.

Lessons learnt so far

- Culture change from the all experimental approach
- Research activities to overlap interest on both parties
- External research activity has been product focused
- Tend to underestimate the in-house time to make the most of our external research programmes
- We like student interaction at our headquarters
- External research interaction used to develop our engineers
- Recruitment



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Dyson have also invested in a contact person, building the relationship in depth and breadth and finding the unexpected links and opportunities from conversations across networks of people. Some of these translate into exploratory projects, set up quickly to identify potential and yet more good questions. One effective practice also includes scheduling additional time within project meeting visits to meet new people and explore new topics. Encouraging people to those conversations and recruiting research students is easy because of what Dr Agerwal referred to as the 'Dyson halo effect' – the brand visibility and reputation for innovation.

- Flexibility begets speed
- Investment of time is essential to build the trust to share work and insights – and then the synergy of approaches, theoretical and experimental, can be realised.
- Think also about the wider implications – technology foresight, recruitment and image-building

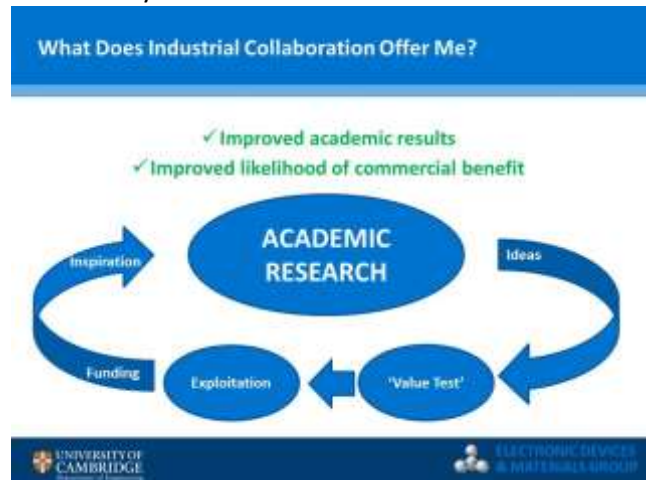
The embedded approach to collaboration: Dr Richard Price, PragmatIC Printing Ltd and Dr Andrew Flewitt, Electronic Devices and Materials Group, Cambridge University

In a global market of big companies with deep pockets, how does a small company explore new technologies, understand their scope and de-risk the exploration of new technologies that might profoundly reshape their business? And as an academic, how do you choose directions of research that will be of most value to society?

The answer is to build large pools of capability, resource and facilities enabled by long-term funding from the research councils, do so with flexible management and timescales, and then couple this with small projects and grants that allow industry to work inside the University alongside the University's researchers. But always there are questions of direction, of priority and of continuity.



Andrew Flewitt uses a 'value test' that helps him to prioritise research that is of most value most quickly and then, working alongside industry, unearths the interesting questions that are candidates for the evolution of his research direction and capability.



Richard Price described how, simultaneously, PragmatIC Printing found a research capability in Andrew's group, combined this with flexible funding and were able to recruit a researcher from the networks around Cambridge. This researcher, knowing the team, was able to quickly come up to speed and to work on the key questions for the business, exploring the potential for new technologies and creating early prototypes alongside Cambridge researchers. Embedded within the Centre for Advanced Photonics and Electronics he also had access to facilities within the Nanoscience Centre. The Cambridge Integrated Knowledge Centre provided a focus for access to networks with the University and across the wider sector, especially across to the Electronics, Sensors, and Photonics Knowledge Transfer Network (KTN).



Flexibility looms large as a key factor of success. Flexibility in contract conditions enabled the extension of a post-doc's contract in order to insert a focused bit of work into the agenda. As the research matured, flexibility in funding continued with a shift from underpinning by the Engineering and Physical Sciences Research Council (EPSRC) to Technology Strategy Board (TSB) funding to build and maintain the capability to explore applications and so to build the supply chain of small companies. The partners' complementary skills enabled them to work across the two funding regimes with PragmatIC leading with the TSB and Cambridge leading with the EPSRC.

The flexibility continued as the research evolved further and PragmatIC Printing moved their research out of Cambridge University to become embedded in the High Value Manufacturing Catapult for the next stage to explore scale-up. Here the key to success is to explicitly recognise the change in character of the needs, the research and the relationship and to explicitly manage the transition. So a creative way of viewing the embedded research model is as a form of 'open innovation' featuring "the spin-in before the spin-out".

- Use long-term funding to build capabilities and resources, use shorter-term funding to drive specific projects, and use 'value' to choose a virtuous cycle of general research directions that embody interesting questions and industrial relevance
- Recognise that collaborations evolve and manage this explicitly – choose the right team, the right funding and then, when it's time, move on.

Research collaboration via cross-sectoral consortia: Justin Laney, John Lewis Partnership, and Professor David Cebon, Transportation Research Group, Cambridge University

The Sustainable Road Freight consortium, created in the last 12 months, builds upon the 20-year history of the Cambridge Vehicle Dynamics Consortium (www.cvdc.org) and both embody the power of leverage, combining research budgets to create and maintain a critical mass of researchers honing skills and building facilities that enable both fundamental and applied research. Having this repository of expertise means that members of the consortium can find answers to important strategic questions, for example as posed by Justin Laney of the John Lewis Partnership “are we looking at the right things and are there other aspects of the problem we should be considering?” The consortium structure also allows networking among people sharing common problems and people from up and down a supply chain providing many perspectives on ‘properly hard problems’, such as how to substantially reduce carbon emissions from road freight.



The John Lewis Partnership with its strong focus on sustainability and responsibility have put the Cambridge project at the core of their work in reducing aerodynamic drag on truck trailers and are making full use of the engagement options, from fundamental research through to applied student projects.



David Cebon described how the consortium is able to build a portfolio of projects collaboratively – from micro to macro, from strategic to tactical, so giving industrial partners what they want via a mix of consortium research projects and individual research projects. The aim is to focus effort on a core research programme that tackles key issues and technologies, rather than company-specific consulting projects.

The CVDC is a good example of a consortium in which R&D staff from various positions in the heavy vehicle supply chain can talk with their customers and suppliers, within a research context. The SRF consortium brings together some of these same manufacturing companies with a group of freight operators: the end-users of the vehicles. Although the operators may sometimes be competitors, they share a common goal in trying to reduce the impact of their fleets on the planet and on the perceptions of the public. They are happy to work together towards this end.

An explicit and encouraged commitment for companies in the consortium is the time to get involved. Only by getting involved will they participate in the decision-making, only then will they understand how to get benefit from the consortium and only then will they be equipped to defend the research budget inside their own companies as a worthwhile investment. And the researchers have to work hard to ensure that the companies are getting value from the research.

Both sides have found the staff interactions very valuable – for JLP staff to visit the university to understand the opportunities from the research and for the student to see the harsh environment and the very pragmatic restrictions on design freedom. Frequent contact – once or twice a week at the engineer level to keep the project moving and the focus on the pragmatic has allowed rapid progress. The ‘quick wins’, especially coupled with the Cambridge brand has helped, both in seeking funding internally for continuing research and for publicising John Lewis’ attention to the environment.



The marketing opportunities are explicitly considered by a marketing committee that meets several times a year to discuss how consortium members can get PR value from the relationship with the university (and also how to access the typically bigger budgets from the Marketing function!)

A key factor in the success of the consortium model is the creation of long-term stable and predictable funding. This gives the academics time to build stable research groups and good facilities, to gain a good understanding of the industry issues and to deliver real commercial value to members via a virtuous circle.

- Ensure that the academic research is focussed on the most important issues facing the industry partners.
- Use consortia as a way of building networks – down a supply chain, across a sector or both, then use the networks to explore long-term and shared issues and opportunities
- Recognise how consortia can provide leverage for R&D funding and also provide the funding continuity to build repositories of capability and facilities
- Create portfolios of long-term and short-term projects and invest the effort to ensure that the consortium members are actively involved in project selection and execution so they are committed to the programme
- Explore jointly how consortium members can maximise the marketing and PR opportunities that arise
- Use the opportunities to expose researchers and company people to different perspectives and ways of thinking

Emerging themes: Philip Guildford, Director of Research, Engineering Department, Cambridge University

Philip Guildford identified and fleshed out seven common imperatives from the morning's sessions:

- Drive swiftly towards peer relationships
Get the intermediaries out of the way as soon as possible and allow company and university researchers and engineers to discuss the opportunities. Only in this way can you build the energy, enthusiasm and commitment to fuel the continuing relationship
- Only do stuff that excites individuals
Ask the question “is this the right project with the right person?” This picks up the thread opened in the dinner keynote speech that emphasises the enthusiasm of stakeholders. It is the individuals’ enthusiasm that will make the work robust against the inevitable setbacks within research.
- Do something simple now, rather than plan something perfect for later
Beware paralysis by analysis and the endless planning and discussions that sap energy and enthusiasm. Begin now with an immediate and bounded problem; allow the working relationship to develop with real issues and then later decide whether and how to expand the agenda. Beware stagnation and the “dead hand of corporate and university bureaucracy” – find a local interest and local champion and begin. With a project under way it becomes possible to broaden interests naturally, but abstract planning sessions soon become a burden. A funded project is an ‘entry ticket’ to opportunity where the unexpected can happen (as well as the project).



- **Nail niggles quickly**
Resolve any emerging issues before they grow into major frustrations. This implies both parties being very open and constructive which is important to building and maintaining trust and high performance. If it's "not quite working" then stop and explore what's going on – do not blunder on in the forlorn hope that it will somehow fix itself. Address the issues. They can probably be fixed and lead to a better project.
- **Maintain a close dialogue**
This is the most important driver for trust, flexibility and adaptability. Unexpected value arises at the boundaries of the projects, from the unexpected conversations. And so ...
- **Keep searching for new connections, new interests, new opportunities**
Every time there is a visit in either direction take the opportunity to have conversations outside the project and with new people. Seek serendipity
- **Choose a single co-ordinator on each side as the relationship becomes big enough to need it**
Eventually management will be needed as the portfolio of projects and linkages increases. The target is flexibility and adaptability, recognising a need for some general direction and focus without it becoming a straightjacket. Furthermore, as collaborations grow and mature or simply change shape then be prepared to recognise it and re-organise and redirect as necessary. This can often be done more easily by liaison between co-ordinators who can see the whole picture.

The above imperatives are all in pursuit of a longer term and overarching objective for each party; for the academic - "how do I become the attractor for new ideas", and for the company - "how do I become the company that the academics will seek out?"

"How do I become the attractor for new ideas?"

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Building and Sustaining Long Term Strategic University-Industry Partnerships: Experiences and Insights from the UK and US: Dr Eoin O'Sullivan and Tomas Coates Ulrichsen, Centre for Science, Technology and Innovation Policy, Cambridge University

Eoin O'Sullivan introduced the Centre and its workshop of March 2014 which brought together practitioners from companies, universities and policy from both the US and the UK to explore good practices in long-term strategic partnerships. Tomas Coates Ulrichsen went on to describe the key points that emerged from the workshop.

Industry is becoming more selective with fewer stronger partnerships and asking their academic partners to add more value in both depth and breadth of the research agenda, technology scouting, leveraged expertise and resources, and networking, with greater pressures to ensure stronger and clearer pathways of the outputs back into the firm.



The move to strategic partnerships transcends the single project because it offers greater impact, especially by influencing many corporate agendas simultaneously; knowledge development and acquisition, capability building, talent management and recruitment, reputation management, and supporting their embedding into the innovation systems of different states and nations. The best companies are explicitly bringing these different corporate aspects to bear on the strategic partnership.

A partnership also allows much greater efficiency in negotiation, management, and relationship maintenance to run a portfolio of projects under an umbrella arrangement compared to a sequence of separate single project. The same is true for both the academic partner and the continuity helps keep the teams together.

Trust, continuity and flexibility are also important to allow maturation of thinking that enables partners to identify and frame the 'truly hard problems'

Trust is particularly important if the science is contentious, uncertain or politically charged – because then the corporate partners report the value of help to cut through the froth to the scientific reality and a better understanding the dimensions of uncertainty and risk.

The early stages of a partnership are characterised by an overriding concern – “have we chosen the right partner for this?” – so success depends on the choice of focus, the breadth and depth of expertise and an ability to connect deep into both organisations.

A nuanced approach to IP is essential. Universities are becoming more skilled at understanding the significance to their commercial partners of different kinds of IP at different stages in research and so are tailoring IP in new ways. For example, Georgia Tech has an explicit “contract continuum” with different IP arrangements as the work and the relationship matures.

In an unusual warning, Tomas highlighted the risk of too much money too fast – the growth in team size, complexity and breadth can create early management problems that have the potential to contaminate the relationship for some time. The key is to manage expectations regarding what is possible for different milestones and budget accordingly.

Build a rich network of formal and informal links to enable many ways of fixing problems and to maximise the robustness of the partnership. The same network maximises the success of embedding understanding in the research groups and embedding useful results and solutions in the company

Tomas confirmed the morning's message that trust is critical and needs to be built and managed. The existence of 'blacklists', both in industry and academia, confirms how much damage is done if trust is broken.

Both companies and universities are managing a portfolio of relationships and so, increasingly need to manage each relationship as it evolves and changes, both individually and in the context of the portfolio.

Government can assist collaborative research relationships in ways that support both the strategic and the tactical. When governments provide long-term support, universities are able to build the fundamental insights, capabilities and resources which are so valued by industry. University - industry partnerships can then jointly build the mutual understanding to design good projects to deliver both research outcomes and industry solutions. The key is joint university-industry relationships that identify the 'hard problems', find and articulate "the value test" and then work together to deliver.

- Strategic partnerships offer more impact than a sequence of independent projects and offer greater efficiency of negotiation and management
- Government policy has a key role to play in building academic and professional capabilities that will be valuable to industry – but should not direct universities away from their focus on the fundamentals of engineering and science because that is what industry finds most useful and hardest to replicate



And of course the conference was also an ideal opportunity for networking and exchanging experience and insights

