Languages of Innovation

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It is a commonplace complaint that every profession speaks its own language, and that encounters between specialists require somebody to translate between these foreign tongues. All of us experience trouble understanding doctors, lawyers, politicians, scientists and even mechanics, unless a translator is on hand to re-phrase the technical jargon in everyday language. The cynical suspect that, where professional fees are involved, this jargon exists to protect the income of the speakers. Many professions are structured such that experts speak mainly to each other, and their clients must pay to participate. Where threat and fear enter the picture, argots like backslang, polari and verlan widen the gulf to protect speakers and their communities from scrutiny by the wider world. In either case, specialist languages provide real benefits for a community of practice, allowing complex concepts to be expressed in a single word, each word bringing with it a rich context of history, tradition and application. Specialist languages allow a professional discipline to do its work quickly, following established patterns of knowledge that are encoded in it its language. However, dependence on a specialist language can also prevent innovation. When it is so easy to express familiar knowledge, novel ideas are not only hard to imagine, but hard to describe as they take form. This can be seen in every part of life, not only the established professions, but also among those whose work is to express original ideas.

Academic researchers are nowadays encouraged to be more interdisciplinary. Those constrained to a single university department are not expected to produce the innovative ideas that seem likely to arise from cross-fertilisation with other disciplines. In fact, little encouragement is needed, because originality is prized among academics. It appears that every modern academic now professes to do interdisciplinary research. Yet this pursuit of breadth is accompanied by increasing specialisation of disciplines themselves, such that the

disciplinary gulfs being crossed seem to become increasingly parochial. A Cambridge research fellowship dedicated to interdisciplinary research was recently awarded to a researcher crossing the apparently very similar disciplines of Chemistry and Chemical Engineering!

These phenomena can easily be explained as consequences of language. The older academic disciplines, those that have their own names and departments, have developed specialist languages over decades or centuries. When trying to cross these intellectual borders, it is far easier to collaborate with a department whose residents speak a related dialect, rather than a whole new language. Even encounters with other dialects can offer fruitful tensions (or evocative poetry), but one suspects that more exciting innovation might come from the collision between completely different languages.

This is the everyday business of Crucible, the Cambridge network for research in interdisciplinary design. Crucible was established to encourage collaboration between technologists, and researchers in the arts, humanities and social sciences (AHSS henceforth). It was largely motivated by the fact that the development of new technologies, an obvious locus of innovation, is constrained by the greater ease of having conversations using related dialects rather than different languages. The evolution of new departments provides an interesting case study. One of us (AB) has an office in a department of Computer Science. When the department was established, there were no computer scientists in the world, so the faculty were recruited wherever possible. They are mainly mathematicians and engineers, with a sprinkling of formal philosophers, cognitive scientists and computational linguists. The fields have different names, but are quickly merging – visitors have no doubt that they are in a department of computer science, and not a department of psychology. Most members of the department are not desperate to increase this variety. Indeed, the mix of disciplinary dialects provides sufficient internal tension that some of us struggle to understand our own teaching syllabus. The other (DG) works in a department of psychology in a social science faculty which has recently moved from being an interdisciplinary consortium to a disaggregated set of disciplinary departments. Disciplinarity has a clear appeal not least because of the certainty and identity it offers in specifying a group of like minded colleagues.

In this organisational context, Crucible offers a disruptive agenda. It is difficult enough for technologists to speak to other technologists, or social scientists to other social scientists, so

why waste effort learning a completely different language? The answer is that our motivation is to contribute not just to the academic worlds of Technology and AHSS, but to participate in design in its most extended sense, and through that to a bridging of the divide between these seemingly distant academic tribes. We are interested in the ways that ideas can shape the world outside the university, whether through collaboration, consultancy or education of students who can be productive members of design teams. UK government policy is also concerned with enabling universities "to contribute to wider society" and in the Cambridge context this is of singular significance as these are the first four words of the University's mission statement. Unfortunately, this policy objective is expressed not in terms of design, but usually as a question of "knowledge transfer". One might imagine the university as a reservoir of knowledge, perhaps contained within books and the heads of individual academics, from which portions of knowledge can be poured out into the heads of recipients outside the university walls. But which of the available languages might this knowledge be expressed in, and how might it be translated into the languages current in business, industry, government and public service each of which have their own lingua franca? Scholarship does not exist in any form independent of language, so the transfer of scholarly knowledge either takes place in the disciplinary language in which it was formulated, or must be translated.

The conceptions of knowledge transfer that often drive public policy are modelled on the supposed economics of the technology industries (and especially the Internet boom of Silicon Valley). According to this model, innovations made in a University are refined into "intellectual property" that can be legally protected, sold, exploited, and transferred between universities and businesses. In those industries, innovation does not require an inordinate degree of translation between disciplinary vocabularies. The employees of the university typically have degrees in the same subjects as the employees of the companies to which the intellectual property is being sold. To the extent that if any translation is required when the knowledge is transferred out of the university, it is in order to describe the knowledge in terms of business models, corporate strategy, financial and legal terms.

From this description, it is apparent that there is little similarity between this model of successful knowledge transfer in the technology industry, and the translation challenges that are at the heart of the Crucible mission, of encouraging collaboration between technologists, and researchers in the arts, humanities and social sciences. Knowledge transfer from an academic in one of those disciplines is unlikely to have easy outcomes in the field of

technology, let alone in the transfer of that knowledge to innovators and creators in the commercial world. Yet this model is often clung to despite much evidence that what is important in developing the knowledge that can be successfully transferred is a prior two way flow of problems, observations and ideas between a university and its external partners. This two way flow around concrete challenges has much in common with the design process in that it focuses around the creation of entities which are essentially the cross-boundary objects to which all parties, no matter what their mother tongue, can orient and understand. It is for this reason that design seems a singularly appropriate mode of engagement between technology and AHSS and subsequently with the outside world than any conception of knowledge transfer.

Our question, therefore, is how innovative design can be informed or performed by people who do not share a common disciplinary knowledge. Should this be achieved by translation, by the construction of a pidgin that we hope will become a Creole, by education, or by the search for language-free encounters? In practice, Crucible acts in all of these ways, and usually by adopting more than one option at a time. The remainder of this chapter describes strategic approaches informed by each of them.

The Translation Model

Some of our earliest experiments in strategies for interdisciplinary collaboration were funded, not by technology investors, but by the Arts Council of England. The Collaborative Arts Unit is a research unit of the Arts Council led by Bronac Ferran, an international innovator in arts policy. After working with Bronac to run a European policy conference on Collaboration and Ownership in the Digital Economy (CODE), we created a series of collaborative experiments to explore the questions of intellectual property and creativity that had arisen as from the conference. Working with performing arts venue The Junction, and the Cambridge contemporary art gallery Kettle's Yard, we invited artists to engage with academic researchers through New Technology Arts Fellowships.

The starting point of NTAF was an invitation for artists to engage with new technologies under development in Cambridge University, in the hope that we might disrupt the usual routine of technology investment. Promising developments in basic science are quickly sold to, and thereafter shaped by, investors from large corporations or defence organizations, to an

extent that many technology researchers seldom have the opportunity to consider applications outside the paths well-paved by investment funding. We hoped that collaboration with technologically sophisticated artists might encourage technology researchers to see different routes for development, perhaps even leading to different formulations of their research questions and objectives.

This was an ambitious goal, and we wished to approach it with an attitude that would encourage playful exploration and creative adventure, rather than premature commitment to the first solution that seemed likely to "work" (whether as an artistic outcome or potential technology). We therefore funded and described the three fellowships as "Phase 1" projects, which might or might not be followed by further phases. The primary intended outcome of phase 1 would be a social goal, rather than an artistic or technological goal. Our ambition was that the artists appointed to the fellowship would establish a personal relationship with a scientific collaborator, sufficiently secure that the two would wish to work together to draft a funding proposal for further collaborative work as phase 2. A successful outcome of phase 1 would be the submission of that proposal to some funding agency (our own resources were not sufficient to fund realization of the kind of work we imagined might eventually result).

To further encourage openness to adventure, we regularly reminded all those involved that NTAF was a series of experiments, not a contract to achieve guaranteed outcomes. We stated that an experiment for which the outcome is known in advance would not be an experiment, and there would be nothing to be learned. We therefore warned sponsors and collaborators that we expected at least one of the three fellowships to "fail", in the sense that the collaborators might not reach the proposal submission phase. However, we always said that the circumstances leading to this outcome would be just as interesting for research purposes as those that resulted in progression to phase 2. All collaborators appreciated the opportunity and freedom afforded by this attitude. Nevertheless, the three fellowships did all result in proposals for further work, at the end point of some number of meetings over periods of three to six months. Furthermore, all artists successfully obtained funding to proceed with a realization of their collaborative concept, for example artist Alexa Wright's experiments with a computer-animated face that responds to the viewer's own facial expression was supported with a further grant from a national art touring fund.

The process involved in reaching this point was almost exclusively one of conversation. The three fellows were selected on the basis that they were interested in new ideas, enjoyed conversations about their intentions and work processes, and looked forward to the challenge of understanding the work of other traditions. Nevertheless, none found the early stages of the fellowship straightforward, as they were introduced to a series of academics in the field that they wished to explore. These meetings were often awkward, as artist and scientist groped for some ground of mutual respect and interest that would motivate the necessary patience for the process of translating each other's understanding of a mutual goal. One or more Crucible staff always attended these meetings, acting as translator and multi-skilled facilitator (for example, simply ensuring the drinks continued to arrive in a pub where an artist was being given a rapid tutorial in applied mathematics).

The process of interdisciplinary translation here was not a literal one, in the sense that a statement in one language would be repeated as a statement in the other. Both were speaking English, of course, but were not necessarily aware of which English phrases common in their discipline might be misunderstood, threatening, meaningless or offensive to the other. A typical "translation" strategy was to interrupt the conversation at these points, warning both participants about the nature of the likely misunderstanding. The skills necessary for this kind of translation are essentially those of cultural empathy, having sufficient familiarity with each discipline to recognize which phrases are special, and which underlying attitudes are unlikely to be welcome. In many cases, it was also necessary to anticipate some of these problems, briefing potential collaborators before they met for the first time.

Creating a Pidgin and enabling a Creole

We found it useful to present the NTAF project to stakeholders and participants as a social experiment. The artistic and scientific outcomes were interesting in themselves, but our own interest was in the development of social strategies for interdisciplinary collaboration. As a result, working with social anthropologist James Leach, we became increasingly interested in the relationship between these artistic encounters and broader academic conceptions of interdisciplinarity. A project investigating "Social Property and New Social Forms" included four Interdisciplinary Design Workshops, at which James, working with the first author, convened groups of 15-20 experts from extremely varied disciplines to spend a day addressing some concrete problem. The problems themselves tended to expose the

inadequacy of single disciplinary perspectives, including fair international law for licensing of pharmaceuticals, the development of a single ontology for genome research, and the ethical responsibilities of “creatives” in the advertising industry.

Each workshop in this series lasted 24 hours, starting with a seminar investigating academic perspectives on interdisciplinarity, followed by a reception and dinner. We had realized in the course of NTAF that food, drink and casual social gatherings were an essential prerequisite of the easy working relationship that would allow people to move beyond the comfort of their own discipline. The following day employed a range of strategies intended to help participants develop a common working language with which to address the workshop objective. In the course of the project, we found some strategies that were notably unsuccessful. One was the attempt to provide expert introductions to technical aspects of the problem. The time devoted to the expert introduction appeared to privilege one disciplinary language over the others, without any genuine opportunity for discussion on equal grounds. Eventually, we realized that even our own statement of the problem to be addressed on the day predetermined the acceptable language of the discussion, in the vocabulary that we used to describe the problem itself.

We therefore developed a workshop facilitation strategy in which the participants would construct their own interdisciplinary language, in the course of addressing a common problem. The statement of that problem, however, was deferred until the final phase of the workshop. Instead, participants were invited to reflect on their own reasons for being present. They were encouraged to speak as persons, not simply as representatives of an organization or academic community, and to accept the ethical and intellectual responsibilities of doing so. As facilitators, we wrote down and displayed the language used in these statements. The emerging aggregate of these personal motivations, discussed over the course of several hours, became the basis for a Creole of the different disciplinary languages. Rather than struggling for the validity of their own disciplinary perspective, or assuming a disengaged stance with regard to the applicability of others, the focus on mutual recognition of personhood required the recognition of each person’s preferred vocabulary.

The final phase of the workshop involved the agreement of a question that should be discussed. In some ways, this might seem inadequate as an outcome of a rather expensive and time-consuming process. However it does correspond to common understanding of research

challenges. Most researchers find that answering a question is nowhere near as difficult as asking the right question in the first place. In this context, a workshop designed to formulate good questions is a worthwhile accomplishment. However these workshops (using a format that we call the “Blackwell-Leach Process”) produce a further beneficial outcome. The shared language that has been created in the process of agreeing the question persists as an intellectual tool available for use by those who have participated in its creation. A new language brings with it new perspectives on existing problems, in fields where re-describing a problem may reveal its solution.

Essentially, the process involved the creation of a primary common language which was based on the experiential worlds of the participants. They were then enabled in both formal and informal settings to creolize collaboratively that pidgin, and through it to have a mode of expression of their capacities which could be understood and valued by both themselves and the others involved. As this process continued it became a basis for mutual respect and trust which completed a self-reinforcing basis for the interdisciplinary endeavour.

Encounters without language

As an alternative to translating between disciplinary languages, or creating a Creole outside the boundaries of different disciplines, the third of the alternatives proposed earlier is that we might try to work without language. The Crucible strategy sees design as providing a meeting points between disciplines. A product can be understood for its own nature, perhaps to be described by each discipline in its own language, but necessarily tangible and available to each party irrespective of a linguistic description. Design processes often create concrete artefacts well before the final product takes form. Sketches, models and prototypes can all be understood to some extent without explaining them. They are used frequently in craft and professional practice, but less frequently as a component of intellectual pursuit apart from in architecture and certain parts of engineering. Indeed, there is a degree of prejudice against the use of diagrams in presenting concepts in many disciplines, even where those concepts might be of comparable complexity to a diagrammatic presentation.

Of course most academics are relatively unskilled at model-making and sketching. We felt that this might be an advantage when encouraging mutual encounters with the outside world. Rather than constructing such encounters in the form of presentations, seminars and reports,

all of which give the impression that the goal of an academic is simply to impose his or her great learning on others, a focus on physical products might enforce a more appropriate humility on an academic wishing to share the language of industry and the professions.

A number of Crucible projects have provided opportunities to explore this hypothesis under controlled conditions. One of the most successful, a project entitled Choreography and Cognition, was a collaboration between about a dozen choreographers and dancers, and a slightly smaller number of researchers from different fields of neuroscience. Meeting initially in the rehearsal studio of Random Dance Company, it was clear from the outset that different worlds of knowledge and skill were colliding. By (literally) sitting at the feet of experts in language-less field, the project became grounded in a recognition that our academic languages were at best peripheral to the work that we wished to study and influence. However, rather than simply reversing the familiar conventions of artist-in-residence at a laboratory, the fact that there were a group of researchers allowed us to be more than scientists-in-residence at the dance company. That first morning's rehearsal was immediately followed by a research meeting, attended by the choreographers and several of the dancers, at which they were able to observe the complementary working modes of research scientists.

This productive starting point to the project bore fruit over the following six months, as the collaborators worked in parallel to create outcomes that realized their own ambitions for the project, while also involving regular encounter and influence between the groups. Wayne MacGregor and Random Dance created a critically praised new work, Ataxia, that was centrally concerned with a neurological condition. The researchers produced a wide variety of academic publications with new perspectives of embodiment, language and representation. At no point did the two sides of the collaboration really share a common language, but we established a productive way of working side-by-side, often quite intimately, to productive ends.

An alternative stream of Crucible work has been based more literally on the sketching and model-making traditions of intellectual design disciplines such as architecture. In work that has been motivated and funded according to the technological concerns of Ubiquitous Computing, we have been building "tangible user interfaces" (TUIs), where physical objects become part of the computer user interface, replacing or supplementing the traditional mouse and keyboard. Innovations in TUI design have potential outcomes for the design of systems

in which computers are aware of the physical environment around them, and of small digital devices (such as mobile phones and personal music players) that are carried in pockets, integrated into clothing or even become pieces of jewellery.

In several research projects, and also in short courses and facilitated workshops, we have encouraged computer scientists and their collaborators to explore very simple model-making techniques as an approach to inventing innovative TUIs. We provide them with the most basic physical materials (modelling clay, coloured card, straws, foam and so on), in order that their childhood experience will supply sufficient memory of how to use them. We then ask participants to explore the materials physically, letting transient physical forms inspire them to new digital interpretations of three-dimensional shape. This 3-D sketching is then used as the starting point for an analytic process in which we regard the relations between physical objects as solid diagrams, exploring the usability consequences of those shapes, materials and relations as a notational system.

After more than a dozen experiences of facilitating these 3-D sketching workshops, it is clear that the departure from academic language can be successful, although not guaranteed. In one case, the childish implications of using school art supplies was resisted by a group of scientists who perhaps felt that it was beneath their dignity. Some of them had been reluctant to participate in the event at all, and this abandoning of conventional academic language was the last straw, apparently convincing them that they were going to waste a day. More positively, the technique has been used for design collaboration between computer science researchers and members of the Alzheimer's Society, helping both people with Alzheimer's and their carers express their desires for technology that might assist them in everyday life. In this case, the lack of shared language was more extreme than in most Crucible collaborations, yet still allowed productive engagement between academics and a new constituency outside the university.

Education

Developing novel programmes in either design or research some combination of the two with experienced researchers and practitioners from outside the University offers both opportunities and difficulties. A number of the difficulties could be avoided if the educational experiences which formed the beliefs attitudes and sentiments of the established disciplinary

researcher were different. Suggesting this is easy, but achieving it is not. Interdisciplinary educational programmes are superficially attractive, but often condemn students to superficiality in their work. This can derive from poor combinations offered in the syllabus or chosen by the students if their choices are unconstrained; having disciplinary teachers for each part of it who do not talk to each other; lack of clarity about the embedded disciplinary educational goals; and assessment systems which orient to a multidisciplinary rather than interdisciplinary agenda where creative use of more than one discipline by a student is not rewarded. Here again the Crucible focus on design is of value, but in a context where students achieve real conceptual depth as part of their studies.

The creation of Crucible was facilitated by engagement with the Cambridge MIT Institute (CMI) which was established by the UK Government to experiment with innovation and educational practices in connection with industry and based on the strength of the two Universities. A number of the new curricular developments it fostered were interdisciplinary even if the disciplinary reach was not as far as the Crucible mission proposes. In those new interdisciplinary curricular, as indeed is the case for single disciplines, the relevant literatures are so large that students cannot be taught a subject by teaching all of the available material. Some of it has to be neglected, but the key question is how much and should breadth or depth be privileged. The conclusion reached on the basis of various studies and findings from the existing literature was that depth should not be compromised for breadth. Depth in some part of a student's work is fundamental for establishing a basis for understanding those parts of a discipline which have not been taught and indeed understanding future research developments. It is also fundamental to developing the student's sense of their own capacity to be flexible and innovative with respect to both the development of new applications and new ideas as well as their communicative and team working skills. The latter which are often looked down on as mere transferable skills depend upon a flexible grasp of what is known so that it can be offered to ones colleagues and partners in an intelligible form no matter what their own knowledge of the subject at hand. Communicative skills depend upon understanding ones own ideas, and being able to learn from others when they do not share ones own background.

In our work with doctoral students, we have been able to begin by assuming an established conceptual depth, and then have worked with students on innovative projects which bring together a variety of perspectives from outside technology if that is their background, or do

the opposite if not. In each instance, however, we do not ask the students to become highly skilled practitioners of all aspects of other disciplines, or even pretend to a smattering from them all. Instead the focus is on appropriate depth and collaboration with others who are more widely trained for each part of the research and design work they undertake.

At the undergraduate level, this is a harder goal to achieve, but we are currently laying plans for a new studio design component of the undergraduate computer science degree which will be taken by students in their first year. In that, students will have extensive opportunities to work on design projects and will be expected to take certain other ideas from the various domains of AHSS and explore them in depth to understand their implications for their design practice. In this, the emphasis will be on the use of ideas in design rather than the mere critical evaluation.

Although a few universities in the world have experimented with programmes of this type at Master's level (for example, the world-leading Computer-Related Design course at the Royal College of Art), the most significant innovation in our experiment is to introduce this material as the first thing that a student encounters, in the first year of a computer science degree. This will be offered as an option to replace first year physics, in a syllabus that otherwise includes no options, minor, or other opportunity to study in faculties other than computer science. Studio-style experiences, of building new technology under the guidance of practitioners, will alternate with theoretical seminars drawing on applied social science, business strategy and critical theory. We expect that it will attract a new kind of student to the discipline, a student that becomes a "native speaker" of the language of innovation, and equipped to translate and mediate when new technologies are constructed between business, the academy, and the rest of society.

Looking Forward: A Crucible Mission Statement

In the context of a metal foundry, the (literal) crucible is a vessel used to carry molten alloys from a furnace to the moulds in which products will be formed. For us, this is a fertile metaphor for a new kind of academic life. The Crucible mission is to provide a melting-pot in which academic disciplines are stirred together and recombined, to create innovative engagements between industry, society and the academy. To the extent that academic disciplines are constructions of their own language and discourse, our role is to melt these

down, combine them, and carry them to new places. The result may be either new forms or new languages to describe them. But more than either of these, we hope to contribute new ways of working, in which reflective research practitioners are aware of the languages they use, are able to adapt and modify them, and can educate new generations of researchers whose language offers new insights, ways of thinking and ways of describing the world. Where these students go on to become technologists, we expect them to be innovators in design, escaping the preconceptions of many new technology research initiatives with regard to the nature and social role of technology.