Higher Education Academy Fellowship

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1 Preamble

Having a lifelong interest in knowledge and learning, I view the claims and practices of education and higher education practices with active and interested skepticism, which comes out of a profound optimism – that what we have now is not the best we *could* have. Higher education should always be in the best interests of the individual being educated, tempered by the interests of society at large; above all, education should *do no harm*. It seems to me that this "bottom up" approach, whereby improving the thinking abilities of individuals improves the behavior of whole societies is the primary reason for the expensive activity of education. Economic research indicates correlations between education and state prosperity (Berger and Fisher 2013) though benefits of increased productivity may not necessarily be equally distributed. Furthermore, the causal mechanisms at play are not finely elucidated.

For argument's sake, much educational practice could be "peacocks' tails" – *caused* by economic prosperity as well as helping to cause it. The important point is that it is not sheer educational *expenditure* that counts, it is the *efficiency* of that expenditure. Educating an entire populace to be brain surgeons might bring only marginal economic benefit and would not be in the interest of a generation encouraged to have an aspiration that could never be realized. Such a criticism might be levied in respect of most courses: "*…do we need to produce thousands of psychologists/geographers/philosophers (etc.) every year*?" This is the efficiency argument of trying to match supply and demand in respect of graduate career destinations. The contra argument is that the course of study and the eventual career are not close-coupled; many engineers are recruited by the financial services industry, many psychology graduates go on to become teachers. The key efficiency questions are about why students spend much time, effort and money accumulating skills they will not use in their professional life, and what, of their higher educational experience will actually be of utility? The logical question then is "who does higher education serve?"

My own first experience with higher education: at school I had been advised that studying marine biology was unlikely to result in employment, so I went to study inorganic chemistry at university. Within months realized I was there because it

was expected of me; I was not there for my own good reasons. I had had no idea of what was entailed, where I was going; I had chosen something that I had been told was “sensible”. Disinterested, I left, determined to see the real world.

I actually saw a lot of sea, training as a navigating officer in the Merchant Navy. I worked in engineering and oil industries, and a company owner for 15 years. One business I had was involved in technology-mediated perception, and I became involved in the research side, to the extent that I decided to return to university to study perception.

When I decided to take up study as a mature student, I did so with gusto – I knew exactly what I wanted and why I was there. My aim was to utilitarian – to access the best quality information (in the field of human spatial perception) to use in my business. In the event, my enthusiasm for learning grew, I recanted my disdain for the “ivory tower”, became a full time researcher, then lecturer. However, the intervening years had given me a useful perspective. My association with entrepreneurs and businessmen (often highly intelligent but with no automatic respect for higher education and its institutions) helps me to ask questions of HE practice from an “outside view”.

I have been a lecturer and researcher in Higher Education for two decades; part-time and sessional from 1995 to 2001 (University of York, Sheffield Hallam University, Bretton Hall, University of Derby) and full-time from 2002 to date (University of Derby). My PhD, in auditory and spatial perception, is from the University of York.

I headed the Signal Processing and Applications Research Group (SPARG) from 2005 to 2010, and the Technology Foundation Programme (TFP) from 2010 to 2014.

My teaching responsibilities include:
Scholarship and Technical Reporting (levels 3,4,5,6,7)
Scientific method, philosophy of science and critical thinking (levels 3,4,5,6,7)
Sound Technology (levels 4,5)
Research Methods (levels 6,7)
Independent Study/dissertation (levels 6, 7)
Professional Practice (levels 5,6)
Perception for Engineers (level 6)
Auditory Perception and Psychoacoustics (levels 6,7)
3-D sound Technology and perception (levels 6, 7)
PhD supervision

I have served on validation panels for Middlesex University (2006) and Southampton Solent University (2012) and have examined two PhDs, at Trinity College Dublin (2014) and Queen Mary University of London (2014)

2 Case study one: Blending Teaching, Learning and Research

2.1 Introduction

My early encounter with Higher education was quite distinctive. As a researcher, PhD student and sessional lecturer to postgraduates, the predominant focus was on knowledge, discovery and fierce debate. The predominant features of *learning* revolved around how to explore complicated and deep knowledge, generally on the boundaries of what was currently known, and assimilating that into complex cognitive frameworks. It was a matter of *discovery* and *testing*.

Teaching consisted of a high-level knowledge exchange conversation between equals, with no sense of authoritative pedagogy. Motivation, pastoral and student retention matters were virtually absent. The eventual assessments, exams dissertations and theses, were not targets in themselves, but measures of ones grasp of complex subjects, providing official confirmation of achievement.

The 'behind-the-scenes' administrative machinery of HE was virtually invisible.

2.2 The SPARG Years

I joined the University of Derby in 2001, as a researcher with the small Signal Processing and Applications Research Group (SPARG) in the electronics and sound subject group. However, 2002 saw an onset of a fallow period for research at the university; SPARG ceased operations, and I was reassigned to a lecturing post.

As a full-time lecturer to postgraduate students the experience was familiar (though with the addition of course design and administrative issues). Postgraduate students had already committed a great deal to the enterprise of education; they knew what their objectives were, generally had well-developed study skills and had competently designed their life around their studies. Effectively, they were highly motivated and skilled *learners*. My task was to

deliver material, efficiently and effectively, assimilable in form and pace. Teaching consisted of understanding something of their (various) previous experiences and cognitive frameworks. [A1,A2,A3] [V1, V3]

In all the above situations, the learning situation was highly individual; although the assessments were standardized, the methods of reaching them necessarily varied according to the needs and experience of every single individual. Lectures, though delivering particular material, were more in the nature of tutorials, with a great deal of discussion and discovery. Sometimes students would volunteer to rephrase what I had been saying in a way they might find more digestible, and this helped me (and other students) to understand the frames of reference they were bringing to bear

In 2005 I was invited to restart the research group, with a remit to provide a focus for staff research and scholarship, promote projects with industrial partners and importantly, to engage students with scholarly and research activities. All were important; in a strongly teaching-oriented university, where research is not a significant revenue stream, it is all too easy for staff to lose touch with the cutting edge, begin to feel 'rusty' and unable to contribute or compete with research-intensive universities. Without strong external relationships, potential employers' opinions of the worth of the university's offering declines. Without the latter, students lose confidence in the education offered. For many reasons, it was vital that academic activity (and reputation) of the university be prioritized.

I implemented a small study aimed at understanding the 'bottlenecks' which, if addressed, could allow research to happen. [see: appendix 1]. The results showed that, whilst confidence was something of an issue, motivation wasn't. The major issue was available time, and significant issues were fatigue, the academic climate, resources (financial and other) and recognition. [V3, V4]

Given these priorities, it was also necessary to promote the grouping *within* the university. A university is a vast and noisy ecology, and competition for resources means that a research group must make a noise – through research excellence, but also through advertising the fact. At this time, science, technology and engineering were not considered high priorities within the University; they

were seen as 20th century anachronisms – expensive, dirty, and not-very-digital. This view might seem myopic, but should be considered within the historical context. The preceding 7 years had seen a paradigm shift, an explosion of digital, online, virtual technologies. Actual hands-on engineering seemed like something from a previous era, like the metal-bashing industries of the early 20th century, or weaving technologies from the 18th and 19th centuries. To demonstrate the relevance of high technology engineering, and show that the University of Derby had a significant contribution to make, required results and external validation.

We embarked on a programme of promoting the innovative projects that members (often in isolation) had engaged in, developing an online presence. We also proceeded to research industries that had relevant problems – research questions that we were equipped to tackle. Having successfully completed an innovative KTP for a small company, we approached companies in these areas and embarked on small, outcome-specific projects.

I also proceeded to introduce the research group, the subject group and the University to industrial and commercial contacts (with whom I had previously had commerce) in recognizable terms: trading expertise for reputation. I also represented the group at other universities, at research conferences and establishments, giving talks on our work at: the MRC- Institute of Hearing Research, the University of York, the Speech and Hearing research group at the University of Sheffield, Surrey University, BBC, Café Philosophique (Matlock), Lovebytes Digital Arts Festival (Sheffield). [V2, V4]

In parallel, in the interest of "internal promotion", I accepted Faculty level and University level appointments in research and research degrees committees (FRRDC) and formation of Research Ethics (UREC) policy- so that we had a voice in policy formation, and recognition. [V4]

The group provided an environment in which new academics could develop research and scholarship interests; new ideas often came from new members. Fostering self-confidence is as important in staff members as it is in students; having the sense that academia is more than "just a job" is motivational beyond mere wages. The resultant enthusiasm proved contagious beyond the staff cohort – the students felt it too.

2.2.1 Introducing students to research

The subsequent development – bringing the student cohort into the enterprise of research – seemed obvious, though there had been few precedents in this in respect of undergraduates. The prevailing implicit University attitude had been that undergraduates are enrolled on *taught* programmes of study and that research remains the domain of postgraduate study. I embarked on a programme to understand if this was *necessarily* so.

2.2.2 Ask the Students

I had encountered some contrasts (compared to previous experiences) when I began to teach undergraduates on various programmes, initially at level 6 and later at earlier levels. At level 6, students had motivation (having invested time and effort to get thus far) and experience of the HE environment, but their scholarly traditions varied enormously. Some had managed to pass through the various assessment stages with little more than a passing acquaintance with the library or independent reading. Some had never managed to assimilate the appropriate IT skills to manage academic technical reports. Many had barely understood Harvard referencing, or the need for it.

In discussions with these students, several things became clear. Their activities were targeted (sometimes exclusively) at the assessment. They wanted to know precisely what would be in the exam, or what they should write in coursework to get the best mark. They had well-developed assessment strategies which were aimed at maximizing marks for a given effort. Knowledge that might not be tested was dismissed as tangential. Knowledge was not something *intrinsically* interesting, but a means to an end. They were uncomfortable with being challenged to find out things, to actively engage in *learning*. They expected that all their knowledge would come from teaching – they expected to be "spoon fed". They didn't want to know all about a particular problem, they wanted to know what the *right* answer was. They had developed the technique of closely questioning the learning outcomes; they stuck fiercely to them. To them, a degree was wholly bound up with proving they had specific techniques that would be asked for in the employment market. The issues of the effects of assessments on the learning activities of individuals, and related issues are

discussed in Harlen and Deakin Crick, (2002). Basically, my experience is not unusual. [K3]

Further discussion elicited the useful insight that this had been habituated in early education, in school. Many declared that teaching in school was *always* wholly focused on the contents of the exam – that's what education was. This summative-assessment-oriented approach had successfully got them this far, and now would seem a risky time to change tack.

Naturally, not all members of all cohorts were like this. Interestingly, though, in conversation with some excellent students who were thoughtful and interested in associated subjects beyond the confines of the curriculum, they confided that, in their final year, many of the things they were interested in had to be "put on the back burner" – one stated "*…it's really getting hectic now, with so many assessments; there's no time for learning, we have to concentrate on passing*". In other words, they were reverting to the same strategy. Another stated "*I really want to pick this up again, when the exams are over, maybe take a Master's*"; then he added *"…does the Master's have as much assessment?"*

What struck me (apart from the obvious observation that I could hardly ask them to simply desist from their tried-and-proved approach in favour of something which was unknown) was that it was not really their fault that they had been allowed to retain these bad habits. They had been done a disservice by a general "mass production" approach to education. That is, they had never really been treated as individuals with unique strengths and weaknesses. The highly individualistic learning environment in the research and PhD context was almost entirely absent at undergraduate level. They had not been allowed to "grow" as a person, but compelled to conform to benchmarks. [V1, V2, V4][K5, K6]

2.2.3 Research into the Independent Studies Dissertation

To attempt to address this state of affairs, I accepted the post as Head of the Independent Studies Dissertation module, delivered to final year undergraduates, and which differed from all previous modules in that it offered the opportunity to actively pursue personal research interests in contrast to the prescribed content of previous modules. As I was the incumbent Director of the

Signal Processing and Applications Research Group (SPARG), my aim was to more closely integrate the group's research activities with students' learning. This was done by aligning students' and individual staff research interests through a tutorship system. Staff and students enthusiastically engaged in this academic opportunity. [K1, K2, K3][A1, A2, A3]

I also gave cohort-wide lectures and resources on scholarly and research methods including research proposal formulation, research ethics. (I had previously accepted a position on the original ethics policy authoring committee: University Research Ethics Committee – UREC and sat on the Faculty and School ethics committee [K6]) and report writing. In 2009, I contributed to a series of videos produced by the University of Derby Library, on research and scholarship methods for independent studies dissertations (Lennox2012). I also contributed material the HEA toolkit resources (Lennox 2013) [A2, A4, A5][K1, K2, K3]

Students gave progress presentations to their peers and a viva voce system was implemented. Students produced a final poster that was presented in a form of academic conference and at the degree show, along with selected artifacts. Representatives of various industries were invited to view the best projects, and in some cases, students were invited to companies to show their work.

In subsequent years, former students were invited to return to present their project and discuss their problems, methods and experience with the current cohort. This practice of passing on experience proved excellent from all sides; former students were delighted that people were taking an interest in a project in which they had so much investment, current students gained a real insight into the process and were inspired by hearing from someone who had survived and who clearly felt a great sense of accomplishment. I too found real insights in hearing their reflections; it helped me to understand the whole cycle and know when to offer extra help. [K3]

The results were gratifying, in terms of the quality of student work and their reports of the experience. Many found it very challenging, different from all their education experiences to date. Some found the experience discomfiting, requiring extra pastoral guidance. [A4] [V1, V3]

This was their first opportunity to work and express themselves as individuals. Some became enthusiastic to the point of working far longer hours than were required, occasionally having to be reminded not to neglect their other areas of study. The best dissertations and artifacts were easily of Master's level and some students did indeed pursue their interest at postgraduate level; several are in research laboratories around the world. Other students were offered employment specifically on the basis of their highly individual achievements in independent studies. Several external examiners highly commended students' work in this module.

Overall, the confluence of research and teaching resulted in a vibrant intellectual climate that benefited the final year students especially, but also 'trickled down' to earlier stages. The research environment improved through focusing on students' learning, resulting in increased publishing at international level, increased contacts with industry (see appendices 2, 3, 4, 5, 6) [V3]

Eventually, the research group had 22 staff members, 20 external associates (companies and individuals) and worked with 120 students per year, embracing diverse areas from power electrics, through electronics, digital signal processing, audio processing, multimedia technologies and music technologies. From SPARG came two new research groups, focusing on electrical and electronics {name} and media technologists (CREATECH). At this time, as I had been inexorably drawn away from actual research into administrative duties, I took the opportunity to hand on research group leadership to two colleagues to return to pursuing my own research interests.

2.3 Conclusions

In the five years of operation, SPARG had engaged in projects totaling about £250K, of which approx. £100K of which was in the form of Teaching informed by research (TIR) and Research Informed Curriculum Funding (RICF) projects, all of which had strong contributions from undergraduate students, and all of which generated healthy curriculum material. Group members published approximately 70 international journal articles, 6 book chapters and two texbooks. We were invited to present our work at in International Conference

presentations, invited talks at The MRC Institute of Hearing Research, Institute of Acoustics, the University of York, Surrey University.

Given that SPARG was one of the University's more successful research groups in terms of the financial and authoring benchmarks, nevertheless, the greatest benefits were "human scale" ones. The general intellectually aspirational context engendered by the Group's activities made research and scholarship normal day-to-day activities, closely intermingled with teaching and learning. Consequently, staff members were enthused, students were enthused and industrial partners were enthused (not just in specific projects, but in what the university expected of, and offered to, undergraduates) [V3] [K1, K2, K3, K5]

The lasting benefits have been in curriculum enrichment and in student involvement with material and activities that stretched and enthused them.

3 Case study 2: Head of Technology Foundation Programmes

> "…Plato demanded a deep sense of moral responsibility on the part of the true teacher, on whom lay responsibility for the sound health and fate of his pupil's soul. It was his duty to protect his disciples against false knowledge and guide them on the path to truth and virtue. He must never be a mere peddler of materials for study and of recipes for winning disputes, nor yet for promoting a career."
> Hummel, C http://www.ibe.unesco.org/publications/ThinkersPdf/platoe.PDF

Involvement with the research group had given final-year students a real sense of accomplishment and optimism, but many had admitted that it was "…a steep learning curve" transferring from the role of recipient (of teaching) to active seeker of knowledge. They sometimes felt under-equipped academically evaluate high-level material, how to balance this claim against that. If both came from equally authoritative sources, yet appeared to contradict each other, on what basis might they choose?

I realized that I needed to reach further back and accepted an opportunity to teach scholarly and scientific method at levels 3 and 4, at the "input end". My aim was to firmly establish a "scholarship strand" within the validated frameworks of various degree programmes. It was necessary to engage more fully with the quality procedures for module design and evaluation.

When my term as Director of the SPARG came to an end, I elected to head the level 3 Technology Foundation Programme, determined to address the core issue of transition from a *compliance* model (Elen and Clark, 2006) to the independent, self-motivated learner model which I (and colleagues) felt was fundamental to the whole enterprise of higher education.

3.1 Introduction to the Technology Foundation Programme (TFP)

The Technology Foundation Programme was a mature small programme designed as a "conversion foundation" for students with good A levels but not in appropriate subjects for entering the Electronics and Sound suite of programmes; often, their shortfalls were in either maths of science A levels. Although the programme delivered some material of level 4 standards, it also brought students up to that level in those missing subjects. The cohort size averaged 24 per year and had a consistent 65% progression rate onto the five destination programmes.

Shortly after taking over, I was asked to deliver extensive changes, broadening the remit and content to provide foundation for up to 15 programmes across the School of Technology. In addition to the Electronics and Sound suite, destination programmes included Architecture, Civil Engineering, Mechanical Engineering, Motorsport Engineering, Product Design and Manufacturing. Although the common theme for these was mathematics, distinct approaches to science and specialist engineering was needed.

In consultation with industry, students and programme leaders, the programme was redesigned and revalidated as 15 programmes with new (semesterized delivery) modules and expanded to a capacity of up to 85 students. [A1, A2, A3, A4] [K1, K2, K6]

The learning styles of across this cohort varies tremendously, depending on experience, expectation, cognitive development, scholarly development, personality type, subject specialisation, individual motivation. Some entrants have up to 280 UCAS points but without sufficient grounding in either maths or science, others have only 160 points and need grounding in scholarship methods. Some students are mature, having been away from further or higher education for more than a decade (and having little IT expertise), others come from schools or colleges with widely diverse academic traditions. With a cohort size of between 50 and 80, the vital challenge is to identify individuals' strengths, weaknesses, cognitive styles and experiences. Many of these students had not previously had good educational experiences There was a significant proportion of students with Dyslexia, Dyscalculia, Asperge's and other conditions that would directly affect their study capabilities, many of whom had previously failed to receive adequate diagnosis. We offered a range of psychometric tests to help the students know themselves better, and diverse assessment methods with many formative feedback mechanisms. [V1, V2,] [K4, K5]

We achieved an 85-90% progression rate, with some students going on to achieve a 1st class Honours Degree, some going on to Postgraduate study. I have, over the years, been immensely proud of the achievement of students who had, at one time, thought they had little or no academic propensity. [V1]

3.2 The evolution of schooling: learning, teaching and assessment.

When I took over as head of the programmes, my first task had been to pay attention to the smooth running, ensuring that the students' experience continued undisturbed throughout restructuring. My next task was to assess and protect what worked well, whilst investigating what could be improved. I had some useful insights from having delivered a module on the programme and from pastoral responsibilities for previous cohorts. It was apparent that the single most important constraint on student performance in the early years was the issue of self-motivation.

3.2.1 Analysis of the problem, synthesis of the solutions, feedback and improve

To avoid conflating desired solutions, unspoken assumptions and objective analysis of the problem, I divide the problem as follows:

- **Learning**: what it is, the underlying mechanisms, what constrains it?
- **Teaching**: What methods evidently support learning, what methods inhibit it? How is teaching theory related to what is known about learning mechanisms?
- **Assessment**: what is it measuring, what is it not measuring, is it efficient, beneficial and motivating, or the converse? What are the interactions between measurement and the *object* of measurement?

3.2.2 Theories of Learning

Oddly, the scientific principles of learning are rarely discussed with students in the context of their learning. Learning can be investigated at Neurobiological and Psychological perspectives.

Neurobiological perspectives at the levels of:

Individual neurons (Hebb, 1961)
Networks of neurons,
Brain structures (McGuire et al, 2000)
Interareal connectivity (Siegel, Kording and Konig, 2000)

Developmental psychology:
Infant learning (Piaget 1958, Vygotsky1978,)
Developmental phases: Language, (Gibson 1963, 1969) intuitive physics (Spelke et al, 1992)(McCloskey 1983), theories of other minds (Baron-Cohen, Leslie and Frith, 1985) developmental disorders (various)

Behavioural psychology
Behaviourism, conditioning (Skinner 1948, Watson 1913)
Behavioural neuroscience (sometimes: Physiological psychology)
Neuropsychology (eg Freedman 1968, Sacks 1986)

All theories of learning have, implicitly or explicitly, philosophical underpinnings. These may or may not overlap philosophies of *teaching*.

3.2.2.1 Neurology of learning

Fundamentally, "knowledge" is instantiated dynamically in patterns of neuronal networked activity, largely in the brain. In Hebbian terms (Hebb 1961), "cells that fire together, wire together". That is, if one cell (on being stimulated by input) repeated stimulates another, the connections between them grow, becoming more efficient, the cells become associated and in this way, a neuronal network self-organises and effectively becomes an efficient processing structure for a particular kind of information.

Hence at this level, *learning* consists of the process of *establishing* neuronal nets 'tuned' to particular kinds of input. Neural plasticity notwithstanding, neural networks in particular areas of the brain tend to specialize in particular aspects of processing. Dennett (Dennett 2014) has it that the reason neurons "elect" to join a network is competition for resources in the form of neuromodulators such as dopamine and acetylcholine. Effectively, without these, the neuronal cell becomes "unemployed" and dies.

At the next level up, local networks communicate with other networks – there is a high degree of interareal connectivity (Siegal, Kording and Konig, 2000) so that a complex informational item (say, the face of a loved one) involves many brain regions, working together in a coordinated fashion, and it is at this level that one might use the term "cognitive mechanisms" for dealing with this or that information.

But the coordination is a complex emergent property of the brain, rather than a "top-down" imposition; Dennet describes the cortical environment as "anarchic" and the neurons as "feral". This underlying principle is so pervasive that in cases of brain insults (due to injury, stroke etc) where a particular region of the brain is no longer able to fulfil its processing role, it can sometimes occur that neurons

in other regions form alternative processing structures (EG, REF); this is referred to as an example of neural plasticity.

Behavioural neuroscience combines the "outside-in" method of inferring cognitive structures from carefully designed observations of behaviour in response to controlled stimuli with the "inside-out" method of observing brain region activation during particular behavioural tasks. Many philosophical questions are now being practically addressed.

An important finding is that learning produces measurable physiological changes in the brain.

In a magnetic resonance imaging study of a sample of London cab drivers (Maguire, et al 2000) the mid-posterior part of the hippocampus, hypothesised to be responsible for processing map-like spatial concepts, was observed to be significantly larger in cab drivers having undergone extensive training on the layout of London's streets, than in the control group. Moreover, there was found a strong positive correlation between further localised brain-structure development and more years of experience. In a following study, Maguire Woollett and Spiers (2000) found that the ability to acquire new visuo-spatial information was actually depleted in the cab drivers. The authors speculated that:-

> "a complex spatial representation, which facilitates expert navigation and is associated with greater posterior hippocampal gray matter volume, might come at a cost to new spatial memories and gray matter volume in the anterior hippocampus"

In other words, not only does learning produce structural changes in the brain – it may come at significant cost.

The reciprocal position, that lack of stimulus can lead to brain region atrophy, is born out in studies of the volumetric loss of brain tissue in the auditory cortex of older adults by Lin, Ferrucci, An et al (2014) who point out that the regions affected

> …also play roles in memory and sensory integration and have been shown to be involved in the early stages of mild cognitive impairment and Alzheimer's disease.
> "Our results suggest that hearing loss could be another 'hit' on the brain in many ways," Lin explains.

The overall impression is that the brain is primarily a "learning organ" and the oft-used metaphor is that, like a muscle, it needs to be exercised for optimal health. [K3]

3.2.2.2 Psychology view of learning

At the level of developmental psychology (often using behavioural methods) there are thought to be optimal "windows of plasticity" where the opportunity for a given individual to acquire certain kinds of knowledge and skill is greatest. The extreme polarity of this is found in the concept of "critical periods". If stimulus input is denied to certain regions of the brain during such a critical period, that region – and that sensory ability – is unlikely to develop thereafter. There is evidence that the presence of a particular neurotransmitter, gamma-aminobutyric acid (GABA) is implicated in this process, and so it has a neurochemical foundation. [Sengpiel, Klauer and Hoffmann 1990]. The inference is that certain kinds of learning must take place at certain stages in ontogenetic development, otherwise it is too late, and subsequent attempts to acquire that type of knowledge will be laborious and, at best, only partially successful.

The complementary principle to that of critical windows is that of appropriateness of certain concepts for certain developmental stages. This is intrinsic to Piaget's approach (Piaget 1964) that *conceptual* development depends upon the development of cognitive mechanisms, and that this has a biological basis. Piaget seems to have subscribed to a mild form of recapitulation theory [Haeckel 1899] which has it that ontogeny parallels phylogeny; the development windows were therefore predetermined at the species level. Although the situations is, in the light of modern experimental methods, seen to be much more nuanced, Piaget's thinking still has some resonance in educational theorising especially in respect of early schooling [e.g: Hearron and Hildebrand 2009].

The idea that there may be innate developmental stages finds support in work investigating the "intuitive physics" of preverbal infants, using preferential looking methods. At 3 months old, infants were found to have conceptual expectations of objects, object permanence and feasible behaviours (Spelke and Van de Walle 1993), though the same authors note previous studies highlighting

striking inconsistencies in common-sense reasoning about objects in High school and College students (e.g. Halloun and Hestenes, 1985, McCloskey, 1983). This has the odd consequence that, in young adulthood where learning is more of the abstract formal kind (Piaget's "formal operational stage) this later reasoning is built on foundations of imperfect intuitions about the physical world.

Alison Gopnik (1966) points out striking similarity between scientist and developing child in the domain of theory formation and revision on receipt of new evidence. Indeed, Gopnik speculates that the developing child's cognitive processes are more similar to the scientist's than to ordinary adult thought.

> The moral of my story is not that children are little scientists but that scientists are big children. Scientists and children both employ the same particularly powerful and flexible set of cognitive devices. These devices enable scientists and children to develop genuinely new knowledge of the world around them Gopnik (1966)

Gopnik proposes that this isn't just a metaphorical likeness, but that the cognitive mechanisms and thought processes involved in formation of causal theory, testing via falsifiability and continual theory revision, are related.

Certainly, both are *pursuing* and *constructing* knowledge, admittedly in a social situation, and so with some help. But in the scientist and the three-year-old child, "finding motivation" barely arises.

3.2.2.3 Constraints on learning:

From the above, one would classify constraints on learning as follows:

- At the level of individual and networks of neurons, the absence of input causes a cell or region to fall into disrepair; the absence or impairment of neurotransmitters or neuroreceptors has similar consequences. The diminution or absence of nutrition (oxygen and glucose via blood flow) can cause cell death, locally or globally.
- At the level of cognitive mechanisms, the absence of appropriate stimuli can inhibit development of concepts. For instance, overreliance on navigation aids (GPS devices) could inhibit development of hippocampus map-making.
- At the level of the individual person, *demotivational* factors may inhibit learning. These may be *extrinsic* (part of the environment) *intrinsic* (eg fear of failure, depression or specific learning difficulty, say, dyslexia) or

reactive (an extrinsic trigger followed by an intrinsic affective state, such as loss of confidence).

- At the developmental level, absence of timely exposure to concepts *may* inhibit cognitive fluency, though formal longitudinal studies of the effects of systematic intellectual impoverishment are lacking for obvious ethical reasons. Certainly, early trauma is often associated with subsequent behaviour problems (e.g. Perry *et al* 1995)

It is anomalous that the last point about the effects of early learning on subsequent learning are least well proved (possibly because of systematic difficulties in studying the matter) since most arguments for a healthy educational system rest on the principle.

The penultimate point, the issue of motivation and demotivation, is an area of great interest in Higher Education (see: Falout, Elwood and Hood, 2009) and this is a major focus of teaching practice and competence.

It is important to analyze issues of motivation, not simply as a motivation / demotivation dichotomy since one can speak of *competing* motivations, context (where extraneous factors convert something potentially motivational into "just another thing I have to do") and affective response (a tired, stressed or depressed student might find *everything* to be too much). Clearly, a scientific analysis of motivation, competing motivation and demotivation would need to account for these significant confounding variables, whereas academic concern with motivation tends to be focused more narrowly on motivation in the context of course material, construction and delivery. There is a significant need for more robust research.

3.2.2.4 Learning in Social animals

The preceding material has concerned learning in the context what theories of what happens *in* the individual. But the account would not be complete without considering that, in communicative social animals, some learning takes place as a group experience. This goes beyond the simple statement that individuals learn from each other to the idea that individuals *trade* and *combine* information so that the whole is greater than the sum of the parts. This notion that "everybody does better when everybody does better" may underpin the survival advantages

of communicative social animals (when one sees a snake, they all know there's a snake) and could be the chief driver of the evolution of intelligence. Certainly, knowledge in the form of high-level symbolism, the normal currency of higher education, comes out of the complex abstraction made feasible by the evolution of language.

In effect, individual humans are not truly individual; they think with concepts traded, borrowed, copied and stolen from those around them. The individual is at once supported and constrained by this "collective intelligence". In the literature on the social psychology of small groups, the focus tends to be in terms of social pressure (in-group/out-group, conformity, hierarchical pecking order) and group decision-making. There is less on the effects on individual-level learning of group dynamics. Yet this situation is of utmost important in the higher education context. People want to be in a "good" year group in a "good" university because they intuit that they will perform better in a healthy ambient academic climate. Academic lecturers divert much time, ingenuity and effort to managing group dynamics, attempting to ameliorate the potential negative influences that can arise in a group, trying to stimulate an intellectually aspirational atmosphere. Lecturers are not actually trained social manipulators, and this indirectness of access to the individuals' learning experiences can be frustrating., since they intuit that this social context has direct bearing on the issue of motivation/demotivation. Behavioural and neuropsychological research on group learning might yield useful evidence-based methods.

One consequence of this group dynamic is an insidious tropism toward a conventional "stand and deliver" pedagogy, where the lecturer talks and the students listen. The lecturer is outnumbered, but a lecture hall of 100 students is easy to control. The lecturer might be amusing, congenial and not appear to be levying discipline but is constantly transmitting and manipulating the students into being an audience, *possibly* occasionally at the expense of individual engagement. In a worst-case scenario, where a lecturer may have high level conceptual knowledge but no "audience skills", the effect can be positively soporific and students' engagement reach indiscernible levels. From the point of view of individual learning, the benefits of such a situation are dubious; indeed

this may constitute a profoundly demotivational situation where students come away discouraged because they have not understood.

Overall, whilst current learning theory in the higher education context is not yet able to take full advantage of the neuroscientific research on learning at the neuronal level or the levels of cognitive mechanisms (but see publications from The Centre for Educational Neuroscience, University College, London, the Cambridge Centre for Neuroscience in Education, UK and the Neuro Education Initiative at John Hopkins School of Education, US, for example), the issues of learning in the collective context and of motivation and demotivation are fertile areas for educational research.

3.2.2.5 Environment and learning

The other *potentially* influential constraint on learning, for which there is no substantial body of coherent theory, concerns the effects on the individual (in respect of learning) of the environment-as-a-whole. This is anomalous, since there is a long history of expensive, impressive, "iconic" or even "inspirational" buildings in higher education and society at large. Even ancient ceremonial sites appear to have been designed in large part for psychological effect. An institution with a pervasive intellectually aspirational ambience *may* inspire the individual to excel, and by logical extension, one where the general intellectual tenor is low *may* constrain. But this remains an intuition with anecdotal support, but without scientific substantiation.

In fact there are many environmental factors known to constrain learning. Poor sleeping patterns, poor diet, alcohol abuse, distracting social circumstances, rapid exchange of viruses. All are features of the HE context that bear directly on performance, but are not directly addressed. HE institutions focus on facilities, logistics, course design, delivery and assessment. Hence assessment of lecturer's effectiveness based on students' assessment results relies on some rather large and unquantified assumptions, which, from the perspective of scientific method constitutes poor measurement design.

3.2.3 Theories of Teaching; what it *is*, is *for* and how it is done.

Whilst we assume that most species *learn*, we tend to think of *teaching* as a particularly human activity, but the issue is not so clear-cut. Ants (a communicative species) have been observed to engage in instructional activity (Franks and Richardson 2006)

Alex Thornton and Nichola Raihani report that, not only do many species learn – by observing and copying – they also instruct (Thornton and Raihani, 2008). Hence, teaching predates human civilization and probably human *existence*. Explicit teaching theories are much more recent. Effectively, modern notions of higher education are products of *millions* of years of evolution and *thousands* of years of design.

Theories of learning and theories of teaching evolve in tandem, though not always precisely in step. We know that "higher order" learning initially involves effortful, conscious reasoning followed by a process of subduction to more unconscious, automatic, intuitive processes. Neuroscientific investigations reveal that "knowledge" literally migrates from the frontal cortex to different regions of the brain (Ratey, 2002). We also know that, subsequently *modifying* that knowledge (as in Gopnik's "scientist as child") entails bringing that knowledge back into the conscious domain. Hence, higher education involves a great deal of reflective practice.

This especially so of the art and science of teaching. The teacher aims to tailor *particular* knowledge, geared to *particular* learning outcomes, delivered to *particular* individuals in a *particular* cohort [K4, V1, V2] . They must devise the form and delivery of a particular subset of a course (a "module") to accord with the overall design aims of that programme of study. They must devise the assessment methods to precisely measure the degree to which learning is taking place, taking into account the possible motivational or demotivational implications intrinsic to the assessment method. They must do all this in the ubiquitous presence of many potentially confounding variable over which they, and the institution, have no control.

As the situation is constantly in flux, they must constantly engage in reflection, data-gathering (via feedback methods), fine-tuning and even redesign. This takes

place against a backdrop of constant (and sometimes rapid) change of external circumstances: changing employers' priorities, political reorientations, institutional policy and rapid technological innovations. A mature, efficient and popular programme can become redundant because of some external upheaval. This constant innovation is mirrored in the innovative practices in which an academic must engage, designing new programmes to meet new demands, and new methods of delivery to meet the changing expectations and characteristics of new cohorts.

So whilst an academic might be enthusiastic about engaging in new scholarship – about subject matter and about incorporating the recent findings from neuroscience and behavioural psychology into teaching innovations- in fact this activity forms only part of academic practice. Academics must therefore be highly efficient in the processes of assimilating new information and synthesizing new methods.

Excellent sources of teaching theory are always sought, and excellent examples of practice come out of observation – of peers, of documentaries, of online material [EG]. Reflective practice, of the academic about his or her own practice in relation to others' and to theoretical innovations, involves learning in precisely the way any other student does. New information is combined with existing knowledge "scaffolding" (Wood, 1976), information is taken in from the surrounding social context {Vyogotsky}, the material is reflected upon, first in conscious, rational processes and later, "intuitions" are updated. Repeat *ad infinitum.* [A2, A4, A5] [K2, K3,K4,K5,K6]

Much (most?) teaching theory is metaphorical as in the Piaget reference above. Piaget did have empirical data (though not scientifically rigorous by today's standards) to support the applicability of aspects of the metaphor. So the usefulness of metaphor is defined in terms of utility

> A map is not the territory it represents, but if correct, it has a similar structure to the territory, which accounts for its usefulness" Korzybski (1994)(p.58)

I would argue that most teaching *is of* metaphor, and that teaching progression comprises the continual refinement of subtlety of metaphors to resemble more, in terms of complexity and utility, the target domain. However, the obvious caution with metaphors is that they should not be followed dogmatically. A

teacher *could* interpret Piaget's thinking to mean that developmental stages are rigid and so certain complexities should be avoided or postponed. But being aware that one does not understand something need not be confusing or demotivating. The idea of teaching down to a specific level should be critically assessed. [K5,K6 V3,V4]

Hence, the academic is constantly looking for new metaphors that will explain things better. These come from peer observation, HEA resources, other teacher's resources, introspection and education journals.

3.2.4 Feedback

All complex systems with desired specific outcomes require sophisticated feedback systems for error correction. This is true of living organisms, information technologies and societal structures. The most flexible, adaptable and competent systems are those with the most competent feedback mechanisms. To achieve adaptability, feedback must deliver information in a *timely* fashion. The important corollary to feedback is feed *forward* – how one uses gathered data to alter course. A further vital ingredient is *constraint*; one should not be entirely stimulus-driven, or recursive feedback loops will occur, producing unintended consequences (*ad infinitum*)

In education, *assessments* form the primary class of feedback mechanisms (including a subsidiary class: the assessment of assessment)

Testing whether a metaphor is working is via feedback and analysis. Formal, end-of-module feedback is useful, but inevitably after the fact. It is also conflated with memory effects, so that the most recent experiences tend to dominate. What people feel, and what they *remember* feeling, are not the same (Kahneman 2007) End-of-module feedback is also not finely detailed, it does not explain how particular items in the "metaphoric scaffolding" came together. Similar criticisms apply to the end-of-programme National Student Surveys (NSS) – they employ a "big data" approach across an entire country's graduate year group, but are not finely detailed and are likely to be contaminated by memory effects. More timely feedback mechanisms, such as questions and discussions during the lecture (or tutorial) have different problems. One the one hand, they are finer-grained – about a particular aspect of a particular topic, on the other, they do not yield

statistically valid data. There are many other considerations; the social situation may inhibit particular students who are naturally reticent or shy when speaking in front of many people, or who do not wish to admit failing to understand. The more forward or vociferous students may or may not represent the quiet ones. They may even divert the discussion towards their own interests at the expense of others'.

The simplest and most instantaneous form of feedback has similar advantages and disadvantages. By continuously monitoring facial expressions, one can have a running "mood gauge" and can catch fleeting looks of query or whether someone momentarily disagrees. One can see when some revelation hits or when an item snags attention. One can also see if someone is settling into a passive stupor and of course, if a significant proportion does so, it is time to change tack. These skills of reading an audience, making sure no-one is being left out, gauging the pace and general mood, are crucial in tuning the fine timings of delivery, and are really only assimilated in front of audiences. They are important in helping the lecturer understand when to accelerate, and when to pause, revisit and explain a different way. This technique can be useful in knowing when to plan to reiterate or revisit material in a subsequent lecture, so that the lecture series interlocks into a knowledge framework. One final informal method can be very useful: when students can come to ask, discuss or tell you of an idea relevant to what has just been presented it is a good indicator that they had been intellectually engaged. When students make a point of saying "thank you", one should listen (and likewise, when they don't).

Tutorials offer excellent feedback opportunities – whether formalized ("after the lecture, write down one question, and bring it to the tutorial") or informal, where students discuss the material, and questions (and explanations) come out of that discussion. Carefully monitoring of the flow of conversation, the tutor (who should avoid obviously taking the lead in the conversation) can interject here and there to help students arrive at their own conclusions. This sense of "ownership" provides a sense of accomplishment and confidence. It is at this point that students can engage their imagination and creativity, discusses ideas as they occur. This leads to a learning activity more similar to that of

enthusiastic, engaged children in contrast to the receptive model more usual in lecture situations.

In the less formal atmosphere of the tutorial, I casually probe students' retention of material from previous modules and stages of study, by discussing it in the light of the current study topics. I sometimes find a surprising phenomenon of "knowledge insularity", where information from an earlier learning-and-assessment experience is not carried beyond the bounds of that module. Students on being asked about a particular subject will deny having done that before, then, on being reminded will reflect: "oh yes, we did something about that in the second year – that was ages ago; I passed that". This should be a reminder that knowledge not practiced may fall into disrepair. It also reminds us that students sometimes conceptualise assessments as hurdles-to-be-cleared and which, once cleared, need not be revisited. This is a strong indictment of the modular approach to course construction; modules should not be insular entities. I don't berate the students, as this would inhibit the flow of similar disclosures. I incorporate into a future lecture some material that ties what is currently in focus to previous knowledge and allow the students to explore the relationship in discussions. In fact, colleagues and I discuss each other's modules in respect of certain key concepts, because the modules are also actually rather insular to us. Sometimes we suggest particular input – a convenient metaphor here and there- to lay foundations for future discussion. This concept of "vertical study strands" is quite valuable. We have implemented a "scholarly and research" strand in several programmes, from level 3 to level 6. We had a precedent in embedding Personal Development Planning (PDP) into all levels of study.

One valuable feedback mechanism is available in the form of summatively assessed weblogs that progress over a semester, but which can have multiple formative feedback to students in the form of comments. The style of student writing in these blogs is less formal than in a report, but is more informative for that. The blog can communicate students' progression through the material, highlight specific misconceptions, and, because of its piecemeal nature, does not provide a psychological obstacle- the "writing it all up at the end" fallacy. Importantly, these blogs accidentally capture something else: how each student

feels about the course, the delivery and their own progress through the material. Students sometimes communicate in ways that they would not in public discussions or formalized feedback forms. The blogs therefore provide a very useful extra window onto the students' learning experiences. Having trialed the blogs in two modules, I intend to cautiously develop the approach. As with all forms of observation, it is important to minimize the disturbance of what is being observed. [V3]

Overall, feedback – from student to teacher and from teacher to student – is the main form of discourse; it is the ongoing conversation that runs right through the student's academic career. But it takes place in a "noisy" environment which is full of fast-flowing subject knowledge and a considerable amount of traffic in respect of administering the students' journey through modules and programmes.

3.2.5 Assessments: accuracy, fairness and motivation

The underlying assumption is that the product of an assessment regime should be of some utility outside the educational context; the process should not be circular, merely assessing the ability to endure assessment. The aforementioned underlying utility might be associated with employability, suitability for postgraduate study or simply official acknowledgment of the possession of specialist knowledge. Assessment should be a measure of competence.

In the spirit of scientific method, an important principle is that the measurement of a state of affairs should not significantly interfere with what is being measured. Another principle is that measurement should be solely of the target state of affairs, and not of extraneous factors; so-called "uncontrolled experimental variables"

In effect, assessment should measure what it is supposed to measure, nothing else, and with neutral effect on what is being assessed.

The measurement of the effectiveness and efficiency of assessment should be equally rigorous. What are the cost/benefits and potential for distortion in any given method? Such considerations are vital precursors to innovations in assessment methods.

One might expect that academia, the home of critical scientific thinking, should present the most rigorously designed assessment methodology. Actually, though, the evidence base for many traditional forms of academic assessment is less substantial.

An adversarial, skeptical position might have it that results in a written exam might only be tangentially related to an individual's ability "in the wild". A medical student's ability to recall the latinate names of brain structures might bear little relation to their potential abilities as a brain surgeon, though it might tell us a great deal about their recall abilities of abstract knowledge in pressurized circumstances.

Another pressing criticism is the question of "fairness"; does the exam situation present a level field in situations where "ranking' (as against pass/fail) is being measured? In other words, does the exam situation inhibit performance for some students more than for others? Some students might, for example, be slightly ill, or suffer from exam phobia (which, in milder forms, is likely to be undiagnosed).

Coursework assessments are subject to similar criticisms. A written assignment *about* a subject might not necessarily expose expert knowledge *of* the subject. Students might have excellent knowledge of a subject, but poor organizational skills in respect of formal presentation of that knowledge. One student may have excellent practical knowledge that incorporates high-level knowledge, yet be poor in writing about it. Another may have excellent skills in formulating reports, yet have incomplete practical skills. Another may have well-developed verbal skills, yet be poor in practical or even written presentations

Finally, in all cases, students will have different affective responses to stressful assessment situations, so that some will be relatively unconcerned, whilst others become demotivated: "paralysed by stress". Saying that "the ability to work under stress is a necessary ingredient in professional life" is simply an excuse that dodges the point; the stresses in working life may be qualitatively different. Anecdotal evidence and (Harlen and Deakin Crick, 2002, 2003) indicate that the demotivational effects of assessment methods can reach backwards, affecting learning; some students' learning is depressed by the prospect of the assessment. "I'm going to fail, so why bother engaging?"

Inasmuch as assessment *ever* interferes with the target learning, it is pernicious. Likewise, if it fails to accurately measure the intended target of measurement, along with the accidental measurement of uncontrolled variables.

It therefore behooves the educational establishment to rigorously analyse the effectiveness of assessment methods, and to present the results of that analysis completely transparently.

Strictly, then, examination conditions are supposed to present "fair", objective and controllable conditions, but they may do nothing of the sort. The formality of the exam often in a large echoic gymnasium, preceded by admonishments about regulations and cheating, conducted in silence but where the slightest cough, squeak of the invigilators shoes, dropping of a plastic ruler might in fact be incredibly distracting for some (but not all) students, presents a hostile environment – and one which is not equally oppressive for all students. So the "level playing field" condition is not met.

In a rough and ready straw poll across several cohorts, totaling about 600 students, I gained the following insights:

I asked:

Q: How does stress affects your academic performance? – better or worse? :

A: 55% = worse, 5% better

Q: "Do you find exams stressful"

A: 75% yes, 1% no

Q: Do you find the actual exam room oppressive, neutral or reassuring?

A: 80% oppressive, 5% neutral, 0% reassuring

Q: If, (somehow) you were able to listen to your own choice of music on a personal player through headphones, would you be able to concentrate on the exam more, the same, or less (through distraction)

A: 70% more, 10% same, 5% distracted

If you could have headphones, but listen to someone else's choice, concentrate on the exam more, same or less?

A:60% "not sure", 40%= less.

The discussion also brought out comments such as "…*the exam room isn't quiet – it echoes, and the slightest squeak of a shoe, or a cough, or a dropped pen seems amplified – it's unbelievably hard to concentrate"*

It appears that examination conditions are not well designed to maximize performance and minimize distraction at all. Although a resounding and robust majority *thought* they might do better if allowed to do what they normally do – block out outside sounds with their own music, it's worth noting that this is still just an aggregated *opinion*. Some students, on reflection, did volunteer that their choice of music might be crucial. Although this kind of study cannot provide scientific evidence, there's certainly enough here to suggest that the design of examination circumstances should be investigated. [K3,K5,K6]

Mixed assessment methods might be hoped to "average out" the differential disadvantages, though a statistician might disagree on the basis of restricted sample sizes. Choosing an assessment method that most closely simulates conditions for which that method is asserted to measure competence (so, for instance, a student surgeon might demonstrate actual competence in conducting that activity) is vital for the objective validity of assessment.

It is not clear that objectively validated assessment methods are ubiquitous, or even that an evidence-based "yardstick" exists. It does seem, that for some individuals, assessment may do "more harm than good", and so a primary directive, that education should do no harm, is not being met. Those individuals are not numbers, they are people whose lives may, in fact, be deleteriously affected by engagement with higher education. It is often said that "education can change people's lives", but surely nobody enters into the arrangement thinking they *could* be worse off?

Overall, I construct a module with multiple assessment styles chosen from: written examination (where appropriate), practical demonstration (ditto), weblog and written academic report. The last, I manage the pace so that they commence writing the report, already formally laid out into sections, from day one. The idea is that the report actually forms an ongoing document of engagement with the subject material, which can be discussed in tutorials and provides a focus for questions. This offsets the stress of deadlines, "writing it all up at the end" and makes better quality academic reports.

3.3 Synthesis of solutions

3.3.1 How students learn, and why they sometimes *don't* learn

The contrast between my experiences in learning and teaching in postgraduate studies and those with the level 3 Foundation programme was marked. In the former, colleagues and students would enthusiastically discuss academic matters in their leisure time, often arguing late into the night, sometimes going back to the lab to try out an idea that had come out of the discussion. In the latter, I would sometimes encounter a student staring miserably at a computer screen convinced he could not begin to understand. Learning was a torment and the inevitability of failure blotted out all motivation. Every task was undertaken with a kind of leaden fatalism. There was no sense that learning could ever be fun.

What was going on? Why should learning *ever* be anything but fun? Could taking the fun out of it take the utility out of it?

I embarked on a series of "straw polls" – of businessmen (potential employers; see appendix ? "The Wednesday Club"), or parents (of students or potential students), of current students (level 3 and 4 cohorts) and of academics (colleagues at my own, and several other universities). Although this was hardly a scientifically rigorous investigation, to avoid contaminating the results I asked, without preamble, a simple question: "what do you think university is for?". To the businessmen, I added "what do you think it *should* be for?", to the parents I added "why do you want your son/daughter to go to university?, to the students I added "why are you here, what do you want?"

Of the four groups, the businessmen were most voluble, skeptical and emphatic. Their answers included the themes:

- …that university is for people to sit around and talking about the job, instead of getting on with the job (this is the "those that can, do, those that can't, teach" argument),
- …that universities were a shelter for left wingers,
- …universities suffered from lack of common sense,
- …universities were hideously bureaucratic to do business with (several had ceased to trade with universities because of adverse cash flow issues)

The business men were quite in agreement that universities were not very sympathetic or understanding of businesses, and that business people should be consulted about what they expect graduate education to provide – chief among which were *professional attitude* and *humility.* They thought that universities should pay more attention to upcoming skills requirements, and did expect that the level of intellectual attainment should be maximized at university.

The parents were most focused on a singular answer, " …to give people a good start in life" (interestingly, many added that the fees were ridiculous, but they had no choice)

The students were most vague and reticent, "…get a better job" and "…gain experience" were the main themes

The academics came up with several answers, some of which were abstract "in vogue" answers such as "employability", others featured the phrase 'to teach students to..".

Although the questions were different for each group, the underlying question "what do you think university is for?" was answered in instructively different ways, revealing of the differences in expectations of higher education. [V3,V4]

3.3.1.1 Encouraging students to question and to speak out

When it comes to questioning why things are the way they are, my students appear a great deal more accepting (or at least fatalistic) than I. This, I would argue, stems from that same compliance model. If one were to design a university from the ground up, aimed at taking in mature, self-realised and quite critical "customers", my guess is that would be somewhat different from what we have now.

The centre of such an enquiry should be the students' experience of learning – is it adequate, could it be improved, does it ever do harm, is it cost effective?.

If one does listen to them, one of the first observations that come up is the fact that they don't particularly *feel* listened to. Effectively, teaching (for them) appears to be a one-way street; they tend to feel "done to…" reliant on blind faith in the expertise of the institution

There is something subversive about honing students' questioning skills. It is not the anodyne cosy comfort of received wisdom and it forces different approaches to student feedback. In discussions, many students have explained to me that existing feedback mechanisms are "after the fact" – too late to benefit the person feeding back Many students feel that not only do they not feel heard 'in real time' they are essentially being asked to help the University improve their offering for future students, acting as unpaid consultants.

Students who are encouraged to feel they can question what they are learning, why they are learning it and how *at the time* of learning it, may at times be vociferous (which shouldn't be allowed to *impede* learning) but there is a sense that they are learning as partners in teamwork, not as recipient subjects.

In the principle of "a stitch in time…" I adapted some of the final year material in order to provide introduction to the concept of scholarship and research to first year students. In the first two weeks of study, students were introduced to report formatting, Harvard referencing, academic journals and scientific method. I again invited former and final-year students to give short talks on their experiences; this was illuminating for all concerned. This helped to set a context where students could feel much more comfortable discussing their educational experiences hitherto, their expectations of higher education and the educational "bottlenecks" they encountered. I embedded this into tutorial activity so that students could come to feel it quite normal and necessary to question and challenge established practices, their own motivations for education, the methods for achieving their goals (which in many case had not been clearly articulated). [V1, V2,V4]

Most importantly, a straw poll across all the cohorts I teach had uncovered the fact that most (more than 70%) answered that they had indeed, at some time or other been told "…you must learn to be more organized" yet almost none (less than 10%) remembered ever being told how to be more organized – they had followed task instructions, but had never learned how to devise their *own* task instructions. Consequently, when I asked them to consider deadlines, (possibly because of the word "dead.." in there) they thought of them as something to put out of their mind until absolutely necessary. When I asked them how long, prior to hand in deadline, they should allow for final editing of an assessed 2000 word

report, estimates ranged from ½ an hour (5%), through 4 hours (20%) to 1 week (50%) ("…don't know" was about 25%). When I asked how much of that week would be available for editing, bearing in mind the scheduled lectures (12 hours), and probably, two other assignments due at the same time, many realized that it would be a stressful week and perhaps, a little longer would be better.

When asked whether they had ever been taught how to plan backwards, from deadline through editing, writing abstract, conclusions and rewriting the introduction, back to analysis of findings, preceded by assembling the findings, preceded by actual research, preceded by research and planning the research methods, almost all (more than 90%) said they had never received guidance. Subsequent discussions with students at other universities has reinforced my suspicions that the vital skills required to actually be organized enough to carry out complex study are often left to chance.

I developed two 2-hour lectures on coursework project planning, in which I explained that this ability was fundamental to their employability prospects. I outlined a method that, if followed, will mean that the task is almost "self-organizing". This has become a staple of the scholarship strand in the TFP, and also has proved vital for all other cohorts; indeed, several academics at other universities have asked to use variations on that material. [A1,A2,A4,A5, K2, K3, K4, K5,K6]

At the core of all pathways sat "Scholarship for Technologists" which I designed from the 'ground up' to accommodate 85 different students with 85 different skill sets. The module provided IT, scholarship, research and communication skills through hands on learning. Students engaged in teamwork, individual work, debates, research presentations. They had to design, present and debate the merits and feasibility of new forms of Higher Education institution, present academic reports with proper Harvard referencing of decent academic sources. They learned tools and techniques to help them analyse complex academic material they all assumed would be beyond them. The module was also used as a pastoral care opportunity so that students could feel comfortable discussing problems. Above all, the predominant characteristic was questioning – how to formulate and refine questions, break a problem down into manageable chunks.

Finally, the students were allowed to complain about any aspect of their studies – the only proviso was that "moaning" was not allowed – criticisms had to be logically formulated. Laughing (with, not at) was positively encouraged. [A1,A2,A3,A4, K1,K2,K3K5,V1,V2,V4]

In inviting students to think for themselves, I was inviting them to engage in transition from *being taught* to actively pursuing knowledge. This is not a transition that can be rushed (and not all students move at the same pace). One issue is that of motivation. Hitherto, many students had used instruction as a *substitute* for self-motivation. They had been at school because they were told to and had done assignments for the same reason.

A *compliance* model of education is essentially aimed at producing compliant students and ultimately, compliant employees. However, prospective graduate employers do not prioritise this, preferring graduates who have developed in professionalism, time management and the ability to question ways of doing things with the concomitant creative skill of devising new and better ways. Most importantly, prospective employees are expected to be motivationally self-contained, not reliant on continual instruction. (Warwick University Careers 2014: what employers want) [V4]

Fundamentally, I have fostered the view that each student should get to know his or her brain – what it's good at, where it needs help in organizing material. The idea is that a brain is the most useful tool one could have. But it needs some skill to get the best out of it – that is, after all, what teaching is aimed at. Whilst these students will not become neurologists, they should understand that they don't simply have to deal the hand they are played, that they can intervene (for good or ill!) and affect the brain's function. They need insights into their emotional variability, performance variability, the effects of tiredness and stress. These are not new insights, but often students have simply been told that they must pull themselves together, grow up, be more organized – without actually being told how to go about it! This is a little like telling a depressed person to "cheer up"!

Instead of the previous mathematics module, that was delivered by the mathematics department and had a strong pure mathematics content, we hired a new tutor to devise and deliver a targeted mathematics-for-engineers module.

The immediate improvements were gratifying.[A1, A2, A4, K1, K2, K3, K4, K5, K6, V1]

Similarly, I implemented a programme to adapt the technical and engineering modules to deliver programme-destination-specific strands, delivered by the teaching team of the destination programmes, so that they received teaching using the terminology and examples with which they would need to become familiar in future study. This helped to give them a real sense that they were embarked on a 4 year degree programme, rather than simply enduring a preparatory year that contained material they might never meet again. This helped to deal with a motivational issue that had come up in previous annual monitoring reports that students sometimes had felt a lack of sense of identification with their target programme. [A1, A2, A4, K1, K2, K3, K4, K5, K6, V1]

Overall, I learned a great deal from these students. Many had never been taught how to organize task, how to plan backwards from task completion to the present. Most had never undertaken any analysis of their strengths and weaknesses. Many had never known they were Dyslexic; they simply thought reading was a mind-numbing chore to be avoided, by subterfuge and procrastination. Some had decided that they were "…never very good at maths…" and had been surprised to find that they actually were, when it came to applying it to real world problems. Most importantly, many had been carrying a deadweight of low self-opinion, convinced that, in educational terms, they were failures. In a sense, they did indeed have historical failures, but what they learned in the foundation programme was that failure is not a sentence for life.

3.4 Conclusions

I often meet my ex TFP students in their final year of study, in my level 6 modules. They report that they have used the techniques and tools they had learned in TFP right through their studies. They are comfortable with proper academic writing, research and time planning. They even help other students with these, and I am often asked to post sample documents on to these final year modules' course resources, for the benefit of those who had not been through the foundation course.

These successes are gratifying; without compromising academic standards, we managed to help several hundred students (who otherwise would have been unable to access higher education) to change their lives. [V1, V2, V4]

4 Discussion

Higher education is an expensive enterprise. At its heart is a simple goal: to beneficially affect individuals by altering their brains, beliefs and behaviours, through learning. All learning is instantiated in the form of structural changes in the brain. Since the brain is the most complex structure in the known universe, teaching theory is necessarily incomplete. Nevertheless, a great deal *is* known – in developmental psychology, behavioural psychology, perceptual psychology, philosophy, neuropsychology and neurophilosophy. Some of this is osmosing into educational and learning theory; less is evident in current practice. We do know that every brain is different, but do not know how to accommodate this fact. It does seem likely that education is not best suited to a 'one size fits all' approach, and that this has implications for how we construct HE experience. How we teach and assess seem logical starting points.

We do not yet know enough about scientific approaches to motivation, imagination and creativity, yet these are surely core areas that any attempt to improve people's experience with learning and self-improvement should be grappling with. Paradoxically, infants have fewer difficulties with these attributes than adults. If we take it as reasonable that we are not aiming to produce obedient, uninterested and unimaginative drones, then we must also accept that Higher Education has a developmental marathon to cover.

> Prediction is very difficult, especially about the future. (attributed to Bohr),

The societal context is changing too, bearing on future higher education practice. Higher education institutions no longer have a monopolistic position in respect of higher-level knowledge (most is available on the internet), favourable geographical position (people can travel easily to study), degree-awarding powers (increasingly, further education colleges, private education suppliers and even company-specific schemes are able to award degrees) and even facilities (higher education institutions are delivering off-site, using authorized providers' facilities). The growth of Massive Open Online Courses (MOOCs) where people study remotely and in piecemeal fashion could mean that the traditional university campus may become redundant. Similar trends might be observed in another major raison d'etre of the university: research. Increasingly, researchers

can collaborate remotely and though laboratory facilities are still required, they don't actually have to be provided by a university. Increasingly, the "University" may become just a name, attached to an administrative structure and a set of assessment standards – and of course, even the latter could be externally administered.

Given the above, coupled with the fact that most people will have two or more quite distinct careers over the course of their lives (thus requiring periodic updating of education) and we have a situation whereby higher education will no longer be a sort of intermediate stage between school and work, and *going* to university will be an anachronism. Instead of the monolithic higher education sector, we might see education become ubiquitous-yet-invisible, embedded in daily life. Unthinkable as all this may seem, yesterday's monasteries, baronial castles and institutions of royalty must have had equivalent air of permanence. More recently, the music industry warned that it could not protect the supply of music without protection from the depredations of internet file-sharing. Today, music is still here, but most of the industry is not. Higher Education faces challenges at least as ubiquitous as those the music industry faced.

> There is no progress in evolution. The fact of evolutionary change through time doesn't represent progress as we know it. Progress isn't inevitable. Much of evolution is downward in terms of morphological complexity, rather than upward. We're not marching toward some greater thing. (Gould 1995)

Whatever the outcomes, the generations we teach today will inherit; it behooves us to equip them as well as we can for an unknowable future. Practically, this means that they need adaptability, flexibility, skill in anticipating change, and the capacity to keep on learning. Given what we now know about the aging brain and the beneficial effects on it of continued learning, what we hope we are giving them is a *longer*, *better quality* life.

5 Afterword

I have now been asked to head the research development programme in the Department of Media and Performing Arts, a role similar to the one I held in School of Technology until 2010. My aim is to extend the approach I adopted there (described in Case study 1, see also Appendix 7), closely integrating staff

research and scholarship, student research and scholarship and teaching. I also aim to integrate some of the scholarly activities of students in their first and second years of study, so that independent study dissertations do no come as a huge shock when they arrive in the final year. My hope is that, for those students who can take advantage of it, learning as active pursuit of knowledge should supplement or even gradually replace the passive paradigm with which many have arrived at the University. [A1, A2, A3, A4, A5, K1, K2, K3, K4, K5, K6, V1, V2, V3, V4]

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APPENDICES:

SPARG REPORTS,

STUDENT COMMENTS,

CONVERSATIONS

REF TO STUDENT PAPERS

7 Appendix 1: Survey of attitudes to research

Personal opinions of constraints on research activities

Research activity in this context is defined as: "the search for new knowledge, through systematic investigation to establish facts" (Onelook dictionary search)

This pilot questionnaire was taken to SPARG members within the Electronics and Sound subject group (other SPARG members from across the School of Tech were not canvassed due to time constraints). The questions were asked verbally, explanations given when asked for; time taken averaged 8mins.It was stressed that opinions sought were to be relevant to local conditions, rather than faculty, university or national-level considerations. Of the potential 14 *staff members,* 12 *sets of answers were obtained*

1) Do you engage in research? **Yes** 75% **No** 25%

2) Would you like to do more research? **Yes** 100% **No**

Maybe

3) If "yes", do you have a potential research project idea? **Yes** 66.6% **No** 25% **maybe** 8.3%

4) If "yes", do you have *several* in mind? **Yes** 50% **No** 41.6% **maybe** 8.3%

Summary: all 12 respondents said that they would like to do more research, and 8 of them had a specific project in mind (6 of them had *several* in mind)

5) What *prevents* or *inhibits* your increasing your research activity? (choose from list or add suggestion)

Factor	strong	medium	weak
Available Time	100%		
Available Money	33.33%	58.33%	8.33%
Available facilities	33.33%	50%	16.66%
Personal fatigue	33.33%	58.33%	8.335
Personal motivation	0%	25%	75%
Academic climate	16.66%	66.66%	16.66%
Recognition (*or lack of*)	25%	41.66%	33.33%
Fragmentation of time	82.33%	16.66	0%
Other suggestion(s)			

Other suggested constraints:

- *Diverse "initiatives" and others' administration interfere with my ability to organise my time effectively.*
- *General university admin issues disrupt my time (e.g. OMST, TAC, Moderation, Quality procedures, moving offices, subject review, revalidation, etc)*
- *Teaching associated responsibilities (admin etc) fill my time, leaving neither time nor energy for scholarly/research activities*
- *Management issues: imposed deadlines descending mysteriously and often without warning. General paucity of teaching and tech support; suggest teaching assistants, used properly*
- *Others' time-management issues disrupt my time and efforts*
- *Having the confidence to embark on research is an issue; I don't feel we are recognised as being capable of doing valuable work*
- *Lack of dedicated 'play' space for work-in-progress. I manage somewhat in my current office, but that's all gone in the new building.*
- *Others' priorities (often inconsequential) interfere with own control of own time*

SUMMARY: Time was cited as a powerful constraint by 100% respondents, and the *fragmentation* of time was cited by 82%. Suggestions indicate that this fragmentation is imposed by non-local factors. The state of the local 'academic climate' and lack of recognition were seen as significant factors

6) **Expand on constraints highlighted in Q5? -** Yes **/ No -***This question proved to be irrelevant, as all respondents wished to expand on question of time constraints*

7) Constraints on time: do you have sufficient time for the following activities?

ACTIVITY	Enough	Barely enough	Inadequate	No time
Teaching	75%	16.66%	8.33%	0%
Preparing presentation materials for teaching	33.33%	41.66%	33.33%	0%
Marking (*this was characterised as being able to return marked work within the prescribed 3-week period, by any means necessary)*	8.33%	33.33%	58.33%	0%
Administration (‘*local’= relevant to your modules and programmes*,)	8.33%	41.66%	33.33%	16.66%
Meetings *(are there meetings that, if you had more time, you feel you should attend?)*	16.66%	50%	33.33%	0%
Preparing new material for teaching (*keeping modules up-to-date, new modules)*	8.33%	0%	58.33%	33.33%
Scholarly activity and Professional development	0%	25%	58.33%	16.66%
Thinking and reflection	8.33%	0%	41.66%	50%
Understanding colleagues’ needs and activities	8.33%	0%	50%	41.66%

Marketing and recruitment activities	16.66%	0%	66.66%	16.66%

SUMMARY: >90% respondents thought that time for preparing new teaching material was inadequate (or worse), >70% said time for scholarly activity was inadequate or worse. >90% said inadequate time for thinking and reflection, >90% said inadequate time for understanding what colleagues were doing. >82% had inadequate time for marketing and recruitment activities.

8) Constraints on time (continued). Do you ever have to supplement your salaried hours, by staying late at the office or by working at home?

Very often	Often	Sometimes	Rarely	Never
41.66%	58.33%	0%	0%	0%

9) If "often" or "very often" do you manage to claim 'time in lieu'

Very often	Often	Sometimes	Rarely	Never
0%	0%	16.66%	41.66%	41.66%

SUMMARY:

100% respondents said they *often* or *very often* supplement their salaried hours in order to meet their commitments, and 83% said they *rarely* or *never* manage to claim time-in-lieu

10) if you indicated "money" as a constraint in Q5, what would you suggest more money should be use to buy? (*NB – one respondent did not so indicate; %s here do not total 100)*

	Vital	High priority	Medium priority	Low priority
Your time, in which to conduct research activity	33.33%	41.66%	16.66%	0%
Space and equipment for your potential research project	58.33%	16.66%	16.66%	0
Administrative help for specific research projects	16.66%	25%	33.33%	16.66%
Specific Research Project staff	16.66%	16.66%	25%	33.33%
Full-time researcher(s)	8.33%	25%	33.33%	25%
Research activity infrastructure (outside of *particular* projects)	8.33%	41.66%	25%	16.66%
Postgraduate researchers' *recruitment* and *facilities*	33.33%	33.33%	16.66%	8.33%
Technical support for research	25%	50%	16.66%	0

SUMMARY: 75% would prioritise spending available money on purchasing their own time, space and equipment and technical support for research. 66.66% would prioritise postgrad researchers.

11) If you cited "motivation" as an inhibiting factor in respect of research activity, can you point to prevailing conditions that inhibit motivation?

This question was found to be barely relevant

- *One respondent said that fragmentation of available time-for-thinking, due to interruptions, made it hard to concentrate on long and complex trains of thought*

12) Overall, do you find the general atmosphere (the conditions surrounding *you*) conducive to thinking about, planning and conducting Research?

Yes	Perhaps/almost	no
	33.33%	66.66%

Other comments:

- *"It would be nice to spend less time on mundane issues, more time on thinking – even abstract thinking, and this would indirectly benefit teaching as well as research."*
- *"Without research (in this widest definition) we are not really academics. Yet research is almost always accidental – urgent deadlines always bump research to the back of the queue. There's no time to think why we are doing what we are doing."*
- *"We feel generally unsupported and unrecognised by the overall university structure – we are 'an island' "*
- *"There's no encouragement, no prioritisation of research issues."*
- *"Budgets! –mysterious, often disappear, usually without warning. We often have to spend unused portions of budget with very little notice or planning, but when we actually plan carefully for resource provision, there's no budget at that time. Trying to plan resource provision is time consuming and usually wasted time."*

- *"Human space" – time and space free of others, free from distractions – no opportunity to think about teaching, never mind scholarly activity or research!*
- *"I would like to conduct research and be recognised as a 'proper' academic – one who contributes to the body of knowledge in my field, rather than simply delivering pre-packaged and 'stale' material"*

OVERALL SUMMARY

All respondents want to carry out research, and a majority have fairly specific ideas about what research projects they would undertake, were it feasible. There was a strong general feeling that academia *should* be characterised by research and scholarly activity, but currently isn't.

There seems to be a strong correlation between feelings of professional worth and research activity. Morale seems to benefit from research, but is adversely affected by lack of autonomy. Many respondents felt that others' administrative concerns adversely affected their own academic performance, and this was reflected in the majority opinion that the local climate is not conducive to academic pursuits, but is dominated by administrative issues.

8 Appendix 2 Sparg Activities 2006

SPARG Activities

The group is currently working to re-establish a research infrastructure within the School of Technology. There is, within this, a pressing need to refresh relationships with external partners and potential partners, in other universities and in technology-related industries. Some useful groundwork has been laid, with visits from collaborative partners.

The group is currently examining options to develop research activity. In the first instance, and updated analysis of strengths, weaknesses, opportunities and threats is being conducted – to be completed Aug2006.

The main points that appear to be emerging are:

1. The primary obstacles to re-engagement with research are *internal* rather than external. The University now affirms the importance of a healthy research agendum, but as yet has not facilitated an appropriate climate. There is an extant attitude that research is inherently a loss-making activity.
2. The chief requirements are stability, good staff-student ratios to enable staff time to conduct scholarly activity and paid research, and identification of worthwhile and feasible projects.
3. Following the above, appropriate funding streams must be identified and applications formulated. There is a shortage of expertise in funding applications due to previous staff losses.
4. The need to re-establish an academic community. Currently, the subject group has lost capability to provide postgraduate *teaching* (both MSc courses have been suspended) and there are no current postgraduate researchers in the subject area. There is also an identified shortage of qualified supervisors for postgraduates

The group is addressing these emerging trends as follows:

1. We are auditing remaining expertise within the subject area, with a view to focussing on feasible research areas. We are also

researching funding sources to find 'best fit' between our current capabilities and funding sources' requirements; the aim is to minimise wasted time and effort in the application process.

2. Dr Bruce Wiggins is examining the validation requirements for MSc by research degree classification, with the aim of implementation of such a programme in the year 2007
3. Dr. Peter Lennox is currently in discussion with several potential Doctoral students with the aim of pursuing a specific integrated research programme, probably in conjunction with an identified post-doctoral researcher and appropriate funding bodies (EPSRC and AHRC). A funding application is to be formulated in Autumn 2006
4. We are developing collaborations with other academic institutions.
5. We are working to develop "visibility projects" – that is, research projects whose outcomes can attract reputation for high quality and relevant work within our field. This can pay dividends in aiding informed decisions by potential funders. SPARG will produce a short list of viable projects for which specific funding can be sought, and these projects should 'dovetail', so that advances in each can complement those in others.
6. We need to elucidate the University's commitment- in specific terms; many funders look for universities' willingness to support particular projects with appropriate resources (including money). Wasted applications can be minimised by aborting those that are beyond the scope of the University's commitment.

7. We're currently seeking to develop the composition/engineering environment for spatial sound-and-music, so that non-engineers can intuitively use it. There is no equivalent commercially available tool. Such a tool would feed directly into teaching provision at various levels, not least in complementing the new degree proposed by Chris Wilson, the "Sound Art" programme. More generally, it would furnish certain sound artists with the capacity to address unconventional and innovative listening circumstances.
8. We are working to renew industry links with a view to research projects and Knowledge Transfer projects

9 SPARG Activities – visit to Funktion One Ltd., Surrey. (April 2006)

We have recently visited Funktion One Ltd in Surrey. The company is a small, but internationally reputed company who have some co-incident interests in the types of technology used here at the university – specifically, *spatial sound* tools. They are interested in the notion of technology transfer partnerships, which we discussed at length. They are also prepared to offer some help to us in aspects of our research interests in the form of loaned equipment that would normally be beyond our modest means. In this way, we could explore large-scale and multi-scale psychoacoustics; a fertile area for groundbreaking research.

We have arranged to accompany them later this month on a 'field trip' to explore and assist in their use of large-scale spatial sound. In this way we can develop better understanding of the pre-requisites for designing spatial sound manipulation tools. Dr. Wiggins and Dr. Lennox are to visit a large scale installed surround Public Address system used for a music festival ("The Glade" near Newbury in the UK). The system will use a 6-way ambisonic horizontal-only display, which will surround the public and will be used to convey spatial dance music, controlled by well-reputed DJs. The system will deploy novel prototype PC-based algorithms for controlling spatial effects (using higher-order ambisonics) via dedicated spatial control interfaces. SPARG will be studying the user-interface issues, perceptual issues (including aesthetic effects) with a view to further enhancements. Currently there are no available products dedicated to this type of usage. The company have indicated willingness to extend experimentation to larger speaker numbers, permitting even higher-order ambisonics (and therefore much greater spatial resolution, especially for large audiences). Hence, these experiments will be unprecedented, thus offering potential publishing opportunities.

The company hope that one possible outcome would be a saleable dedicated product, which would be unique in their market. We hope that the association might provide work experience, KTP and possible commercial opportunities. Additionally, our relationship with the company will reinforce the reputation we are building. We have an ongoing relationship with Soundfield Research Ltd.,

another small-but-internationally renowned company in a related area. We are developing similar relationships elsewhere, with an emphasis on smaller companies that we can efficiently achieve results with.

These relationships are also increasingly important with respect to our ongoing project to stage some wholly novel 'art meets science' large-scale audio pieces.

The foci of this collaboration are:

1. Spatial sound control for diverse applications. For instance, the problems of studio mixing (of material aimed at large-scale events), live engineering (for similar events) and live 'DJ mixing' (ditto) are quite distinct problems in terms of engineering, ease of use, and perceptual effect.
2. In all the above cases, the psychoacoustics of large-scale sound fields are largely undefined and under-explored. This is an opportunity for SPARG to make a significant contribution, with concomitant publicity opportunities.
3. Possible funded collaborative research
4. Possible KTP opportunity
5. Inexpensive access to technology resources beyond are normal means
6. Enhanced reputation in the audio engineering community.
7. Good quality publishable material for academic and trade publications.

9.1 2007Update;

The initial demonstrations were very successful – some manipulations were found to be very perceptually impressive, others less so. Overall, the reception by audience was so enthusiastic that the company (Funktion One) are very keen to explore the field further. They would like us to help develop live spatial sound manipulation tools that they can test in the field, thus refining our ideas about usability and perceptual effect. The short-term benefit for them is that they are at the cutting edge of innovation in this area and can have tools that competitors do not have access to. They also have a strong belief in the notion of applied research.

A further visit is to be discussed, and further field trials.

Recently, and as a direct result of our work with Funktion One, that company has been asked to supply large-scale surround sound systems for almost all the individual venues at the Glade festival; they will also be trialling technically similar systems at the Glastonbury festival.

9.2 Other activities

On April 10th, Dr Wiggins and Dr. Lennox attended the inaugural committee meeting of the EPSRC-funded spACE-net collaborative network, in which the University of Derby, via SPARG, is a founding partner. The network currently comprises academic institutions such as the universities of York, Surrey and Derby, along with research-interested companies such as Sony, Sensaura (Creative Audio group) and SoundField Research Ltd.

1. Space-NET (http://space-net.org.uk/): is a small, EPSRC backed network of partners with key expertise in the domain of spatial sound – for musical and other purposes. It helps to provide some background justification for related project-specific funding bids. The founding members are:

- Sensaura
- Sony Broadcast and Professional Europe
- Soundfield Ltd
- University of Derby Signal Processing Applications Research Group (SPARG)
- University of Surrey Institute of Sound Recording (IoSR)
- University of York Audio Lab & Department of Music

2. SPARG's *niche* in this network is in the area of control of larger scale spatial sound display- i.e. many speakers, for depicting large environments to many listeners. The other network partners do not have this capability, with the *partial* exception of the University of York, who have some similar technology but for different applications.

3. SPARG does not currently have the capacity (time, physical resources and money) to carry out "basic research" as defined by research councils (such as the EPSRC). We *do* have an accumulation of material and expertise that can be capitalised on in the form of *applications*. For instance, Bruce Wiggins' Windows Mediaplayer tool that allows playing and streaming of audio material in the ubiquitous '5.1' surround format.

> We're the only member of the network that has successfully demonstrated 3-d sound (with height) via 40 speakers to an audience of 150 people. We know *theoretically* how this could be done on a much larger scale, using <256 speakers. We have particular expertise in environment auditory perception, and the concomitant scientific and engineering principles.

9.3 Teaching informed by research.

A new trend in thinking about HE delivery is of great potential interest to SPARG – the upcoming "teaching informed by research" funding strand. Since group members have always relied heavily on scholarly 'spin out' to maintain viability of teaching material in the face of rapid technological developments, research activity has always been more closely integrated with teaching activity than in many, better-research-funded institutions.

Increasingly, encouraging students to learn by proper application of research methods has been seen as important for inculcating versatility in students who must face rapid technological development during the course of their working life.

SPARG members support final year students in their Independent Studies (double) module, which accounts for up to 20% of marks the final degree classification. Research projects are proposed that are, in some cases, near the 'cutting edge' of knowledge in relevant fields, and advice about research methods in these situations is supplied by members who may be researching in very similar areas.

A recent innovation is that particularly well-written project reports can be published by the group on the student publications section of the SPARG website. Hence, successive years' students have access to relevant and up-to-date information and can build on this instead of "reinventing the wheel". In a very limited number of cases, student work may be of near-publishable standard and it is planned that SPARG members should assist, possibly as co-authors, to bring the work to publication. The benefits in terms of enhanced CVs for talented

undergraduate students (especially those who may go on to postgraduate studies) may be considerable.

SPARG is therefore well-placed to pursue the teaching informed by research trend, and it is expected that this will prove pivotal for the group's success and ultimately, the good health of the subject group.

9.3.1 Particular advantages: Art + science + philosophy + perception

Although a small research group, SPARG has an advantage in members' diversity, producing a congruence of technology, philosophy, perception and art.

All technology is the concrete realisation of some philosophy, whether explicit or not.

Bringing the artistic perspective to bear on technology can lead to useful (and sometimes unexpected) developments; many artists refuse to use technologies as prescribed by the design engineers, and manage to 'persuade' new uses out of a piece of equipment. This exerts an *evolutionary* pressure on technological development, rapidly producing novel solutions.

In respect of the convergence with the *perception* strand, most technologies are designed to interface at some point with human perception; some technologies are *wholly* aimed at effecting and managing perception. Inherited metaphors (such as a graphic onscreen depiction of "sliders" in audio software) make a piece of technology initially easier to grasp, but can constrain subsequent usage by limiting the perception of what is happening 'underneath' the metaphor.

Artists naturally have a direct interest in evoking perception. Theories of perception and testing of perceptual effects can be iteratively incorporated into research, stimulating rapid development of new technologies, which artists can explore.

The final useful ingredient in SPARG lies in the traditionally strong links with various industries; group members have been involved with companies in diverse sectors, where research issues must be efficiently focussed on specific solutions.

To conclude, SPARG can contribute to the ongoing enhancement of the reputation of the University of Derby by helping to produce students that are distinctive in their blend of skills, flexibility and wide-ranging competence. This distinctiveness is vital for the long-term health of the organisation as a whole and the competitiveness of the School of Technology.

10 2007 updates – research activities

10.1 Publishing;

Whilst publishing activity by group members was largely curtailed in 2002/03,

2006-07 has seen an increase in activity; this is largely publishing of 'backlog' material that was produced in previous research. Although the increase is large in percentage terms, output is actually modest, as shown:

- One textbook on Embedded Systems
- Four International Conference presentations
- Two international journal articles (plus one in review)
- Three international workshop presentations

The above is the output of five of the group, none of whom is currently engaged in externally-funded research; publishing remains a 'spare time' activity.

10.2 Research Funding

There has been an increase in small-scale research funding proposal formulation, though no successful bids have been completed (April 2007).

Some internal funding has been secured for specific projects:

- £10K from Open Studio for equipment purchases
- Two promising researcher grants of £1K each
- Three TIR units at £2.3K each for audio signal processing projects relevant to subject group programmes
- 1x £4.3K award for research inspired curriculum development

10.3 Postgraduate provision and recruitment

There are currently no postgraduates, researchers or taught, within the subject group. The two taught MSc programmes developed in 2001 were suspended in 2003. Material for these Programmes substantially contributed to the scholarly content of current undergraduate programmes.

Development of new MSc provision is underway. The infrastructure for postgraduate research is currently non-existent, a situation that should be addressed as a matter of urgency. Of our yearly output of approximately 140

graduates, 5-10% express interest in further study/research opportunities. Currently, these candidates go to other universities and are generally very successful.

10.4 Morale

Following the 2002/03 radical restructuring, several researchers of national/international repute departed for research-friendly environments. Morale in the subject group (and therefore of SPARG group members) reached a very low ebb. It was assumed that the School of Technology would be phased out.

2006/07 has seen an upturn in morale, locally – a note of cautious optimism is emerging. This has been expressed in the desire to re-engage with individuals' scholarly fields. Whilst available time is still at a premium, it has once again become conceivable that one *might* find the time and energy to aspire to being a 'proper academic'.

10.5 Projects

There are currently 5 projects underway, involving 7 staff members. Internal funding has been deployed as start-funding, and it is envisaged that at least 3 of the projects can be brought to a stage where they can attract significant external funding. Of these, 2 projects are planned as interdisciplinary projects that can involve diverse members of the Faculty, and 1 project might be suitable for cross-faculty involvement. Up to 4 projects could mature to involve collaborations with diverse institutions, possibly with European partners.

The group has recently completed a recording and mastering project for the Derby Cathedral choir, to produce a forthcoming Christmas CD.

10.6 Update conclusions:

The health of SPARG remains bound up with the overall health of the Electronics and Sound subject group and the School of Technology. Several members of the school, from outside the subject group, have expressed the desire to work within the SPARG framework. Morale is much improved, some of the infrastructure has

been repaired, and the group has contributed to the University's reputation in international journals and national news sources.

Nevertheless, the group remains fragile and under-resourced. Some successful projects (successfully *reported*) and improvements in the postgraduate situation are required.

11 Appendix 3 Teaching Informed by Research report 2007

University of Derby

Teaching Quality Enhancement Fund 2006-7

Teaching Informed by Research Stream

Final Report Template for Developmental Funding Package

Names: Dr Peter Lennox, Alex Gibbins, Dr. Bruce Wiggins

Faculty/School/Department: ADT, School of Technology

Theme?

☒ Curriculum development and delivery (15 packages)

☒ Learning resources development from research outputs (10 packages)

☐ Student skills development (2 packages)

12 Proposal:

The technical, perceptual and aesthetic exploration of cellular "multi-scale" artificial auditory environments.

A novel hardware and software system will be mounted, wherein existing concepts of *surround sound* are extended to include true 3-dimensional auditory environments, combining large-scale and fine-grain spatiality. This system will be capable of displaying, in perceptually satisfying manner, massive events (e.g. thunderstorm, train/plane arrival/departure) and small events (e.g. whispered conversation, small change, crumpling a piece of paper). The listener can explore such a field in detail by moving through the environment, unlike all existing sound field systems. This work comes out of previous basic research by Peter Lennox and Bruce Wiggins. In this project, students will experiment and explore the synthetic applications, learn to 'fine tune' system elements and display

examples of their work. No such opportunities are currently available to students, in Derby *or* elsewhere.

12.1 University LTA Strategy target(s)

- *"5.1.8.1 Each Faculty to offer the opportunity of work related learning to all full time students"*

The proposal will be implemented as a closely-specified project with explicit deadlines, budget and outcomes. Students will occupy team-roles with local management. They will (under guidance) instigate research questions and methodology, managing physical resources and their own time. In this, they will be operating under the sorts of constraints that operate in the world of work.

- *"5.2.2.1 Provide systematic opportunities to further develop staff skills in developing modules partly or wholly characterised by e-learning & work-based practice"*

Through the use of logbook-style documentation, a report will be produced (summer 2007) documenting the opportunities and problems of this type of exercise. This report will be presented at subject group level and discussed their as part of an iterative approach to improving delivery of this type of learning opportunity.

- *"5.2.3.2 Senior Teaching Fellows to promote scholarly activity in Schools and provide support to staff engaging in action research."*

12.2 Simple plan:

October 2006. Capital resources agreed with faculty and specialist equipment manufacturers. **December 2006** project planning, resource purchase-and-assembly. **January 2007** Initial systems trials. **February 2007** Custom environment recordings collected. **March 2007** System setup, critical assessments, iterative adjustments, public demonstration; student analyses. **End Summer semester, 2007** degree show demonstration, possible further public demonstration.

12.3 Outputs and outcomes

The first deliverable is the establishment of a unique spatial sound projection system, and the initiation of evaluation techniques for use in further development. This should be achieved by the summer, 2007. The project should

then carry over into 2007-08, in the form of further technical developments by the contemporary student cohort, and collaborations with students from other areas (e.g. architecture, fine art, psychology) who are interested in exploring the capabilities of the artificial environment. The system is intended as a vehicle for concerts and innovative uses of sound

12.3.1 -*Actual* outcomes- 2007

- A 3-cell demonstration system was assembled, using 24 speakers in horizontal config.
- Custom recordings, using 3 Soundfield microphones (one borrowed) were made of the choral performance of the Derby Cathedral Choir
- The system was trialled at the annual degree show, choir members were invited to visit and walk around in the 'virtual cathedral'. Initial subjective reports indicate the the system is very capable of depicting a large-scale artificial environment that can be explored, and that some 'tuning' an be applied to significantly improve perceptual and aesthetic results.
- The system was reported in two international conferences

12.4 Evaluation

The project went smoothly, within specific constraints:

1. The turnaround time for equipment ordering, especially if any equipment comes through LIS, can be in excess of 4 months. On occasions, orders went astray completely
2. The administrative time spent chasing equipment and facilities amounted to <40% of the man-hours devoted to the project.
3. Extra curricular activities (outside teaching) were very hard to programme due to movement of entire faculty to new building
4. Some money could not be spent before the deadline for year-end.
5. A single package did not suffice to cover start up *and* a full involvement of students in project. Subsequent year should involve more students, more deeply
6. For 2007-8, perceptual testing is being incorporated into two 3rd year undergraduate modules, using approx 80 students in total

12.5 Dissemination

Public demonstrations; invitations to other departments, journalists. Funding to be sought for the commissioning of art works for this environment. These may be musical or designed to explore perceptual aspects; they are all likely to be highly experimental. A progress paper will be prepared for the LTA conference. A

system report will be offered to the Audio Engineering Society; students who have made unusually significant contributions will be mentioned in this report.

12.5.1 2007 dissemination:

- Degree show demonstration – public and students
- Poster presentation at LTAARG conference, Buxton, 2007-08-30
- Progress reported to the International Conference on Auditory Displays, Montreal, Canada, 2007; also to the Audio Engineering Society International Conference, Finland, 2007
- As a result of the above public disseminations, several artists have expressed direct interest in compositional involvement, and at the time of writing, this is being discussed. Funding is to be sought to commission works.

12.6 Further details

12.6.1 Number of packages

1

12.6.2 Extension 07/08 bid likely*?*

3 (YES)

12.6.3 Links with other applications*?*

Not at this stage

12.6.4 Are pro rata / sessional staff involved*?*

No; Probable in future bids

12.6.5 Are any ethical issues likely to be raised by the methodology you adopt?

No

Signed Name(s) Date 28 aug 2007

Sign offs?

Name:	Name:
Role: Subject / Line Manager	Role: Senior Teaching Fellow (STF)
Date:	Date:

13 Appendix 4: Report on SPARG activities – bringing business and students together

Report on Spatial Sound and Music workshop

Tuesday 16th September 2008
Signal Processing Applications Research Group, University of Derby
http://sparg.derby.ac.uk/

Discussion workshop with demonstrations
Final event in the EPSRC-funded SpACE-Net series
http://space-net.org.uk/

Report by Nicholas Mariette
Postdoc Researcher, Sound and Space Group
LIMSI-CNRS, Orsay, France
Nicholas.mariette@limsi.fr

http://www.limsi.fr/Scientifique/ps/thmsonesp/SonEspace http://soundsorange.net

Contents

Introduction

The Spatial Sound and Music workshop was organised by Dr Peter Lennox of the Signal Processing Applications Research Group at University of Derby. Peter emphasised the workshop was for discussion and demonstration of spatial musical instruments and large-scale audio environments, rather than only academic presentations. This report summarises each presentation on the day (based on notes taken at the time), with some brief concluding remarks based on discussion with Peter after the workshop.

Peter Lennox : P.Lennox@derby.ac.uk

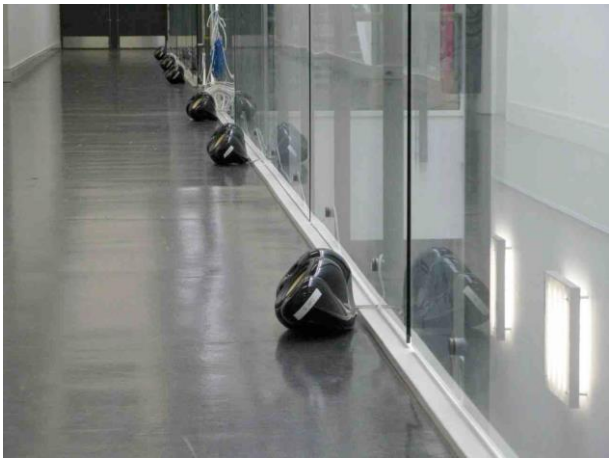
http://sparg.derby.ac.uk/SPARG/Staff_PLX.asp

Venue

The workshop took place in two rooms at University of Derby, one a lecture theatre, the other a large performance room set up with a roughly hemispherical (upper dome) ambisonic loudspeaker array. The array was comprised of three horizontal rings of speakers at different heights, with 4 hand built tube subwoofers in the room corners. The first (largest) ring of 8 speakers was a little higher than ear level, the second ring of 5 speakers roughly half way to the ceiling (possibly 3 metres), and finally the smallest ring of 3 speakers at approximately three-quarters of ceiling height. Ambisonic processing for the workshop demonstrations took place on a high end quad-core PC with a Soundscape Mixpander audio interface that supplies 64 output channels (daisychainable up to 256).


Performance room

Also present at the workshop was an installation by a group of Peter's students based on the premise of « non surround , multichannel audio». The installation in a long corridor took the form of a linear, 8-channel speaker array playing sounds of a ten-pin bowling ball rolling down a bowling alley lane. This was quite effective in its economic use of the array to provide appropriate egocentric reverberation and amplitude distance effects from any listening position. The panning was also quite succinct, given that each channel simply replayed the signal from a discrete microphone placed at a corresponding location in the recorded bowling lane.


Bowling alley sound installation

Peter Lennox, opening address

10am, lecture theatre.

Peter introduced the workshop as a discussion on spatial sound and music. His aim for spatial music is to provide a listening experience of being immersed in the music, with elements moving in all directions, not just a frontal image, yet after over 20 years working in the field, he realises that this idea is not as simple as it seems it should be.

The workshop involved participants from many backgrounds : musicians, engineers, signal processing and sound perception researchers, sound recordists, stage and event sound professionals amongst others. The programme traversed fields from engineering to aesthetics and involved presentations, discussion and demonstrations.

Peter stated that while his aim is for spatial music, he considers that not all music should be spatial, in fact much shouldn't be. When spatiality is used in music, it should involve not just direction, but « location » - in which sounds are placed within an acoustic space at a particular position. For example, a sound should not just come from a given direction from the listener (say north-east), but should be located at a given distance, with a precice position in relation to a particular acoustic space. Peter noted the standard usage of reverberation simulates distance in a way that actually smears the sound source in range from a minimum distance out towards the virtual room boundaries, when in fact, the sound should be localised at only one distance, with space behind it as well as in front. He described how Derby students have done project recordings of choirs with multiple soundfield microphones to get distance that you can walk through. This ties into Peter's wish for a *navigable* spatial music, that could be experienced by moving through it, listening to different parts distributed in space.

Another problem with spatial sound is that of scale – for example, the apparent physical size of sound sources may change when an ambisonic recording is reproduced on a large scale array. This was observed recently when playing a John Leonard recording of geese « When Geese Go Bad » [1] on the Ambisonic array set up by Funktion One [2] at the Glade electronic music festival [3]. Played on this rig, the geese seemed like giants. Peter noted that plausible imagery is not independent of reproduction, but requires recordings made with target speaker array radius in mind. To conclude, Peter summarised the planned presentations and schedule for the day.

[1] http://www.ambisonia.com/Members/soundmanjohn/ambisonicfile.2006-04-20.5053732244

[2] http://www.gladefestival.com/

[3] http://www.funktion-one.com/

Peter Lennox

Michael Brown, composing with space (including demonstration)

Performance room

Michael Brown is a composer and music production lecturer at University of Derby, with an background in the arts. He discussed his inspirations, concepts and observations of the process of developing a composition for the workshop, which he then played on the 16-speaker rig.

Michael started with the observation that conventional composition involves composing in time, not generally space – for example, it is not common to hear of someone « composing in stereo ». Also there isn't a common language or « syntax » with which to express concepts of spatial music. So when he started composing using Ambisonic spatial sound, he found that space changed his thoughts about composition. He started thinking about spatial structure with sounds and musical entities as « physical objects » or events taking place in different positions. Then he considered the interactions between events, and how the relationships between objects were affected by the space in between them. For example, he described his curiosity for being able to *throw* a sound around, for example, « bouncing a ball around the room ».

He noted that in fact the space needn't be realistic, but could be a pseudo space. He would also like to challenge the notion of the front orientation, and accept the movement of sounds as the listener moves within the physical performance space.

For the workshop he designed a composition the previous evening and auditioned it in the space for the first time only an hour or so before the workshop, since the array was specially installed for the event. On auditioning the piece he found some ideas didn't work as he'd planned, for example, this was his first composition with height, which worked differently from his expectations. Also the horizontal rendering turned out to be slightly raised in height.

He started composing on paper, with three pianos placed symmetrically around the room and the idea to have a dialogue between the instruments made coherent by the space. In audition, this separate placement wasn't particularly obvious until the listener starts moving around the room.

Michael had many other ideas for the piece, from ambient elements and events starting, migrating, triggering others around the space, dramatic orchestral elements, delicate and large parts. He found some things weren't possible yet, for example fine position placement and vertical drops in the centre of the space, due to spherical coordinate panning tools. He'd also like better interfaces than the mouse to play with the ambisonic tools and manipulate sound positions

– for example to use physical controllers such as motion capture devices.

Michael Brown

After initial creation on paper, the score was developed in Logic Pro on Mac OS X, although this interface doesn't show any space, only vertical instrument tracks and a horizontal time scale. Logic audio output was sent to Reaper and each track was encoded using Bruce Wiggins' WigWare Ambisonic Encoder plugins (with spherical coordinate panning – enabling manipulation of azimuth, elevation and distance). In Reaper, the ambisonic tracks were finally decoded using the Wigware decoder, live to the ambisonic array.

After an initial audition for the workshop, Michael decided to try playing it again at 12dB lower in level in an attempt to make the positional spatialisation clearer by reducing the extent to which the speaker array engaged the room's acoustics.

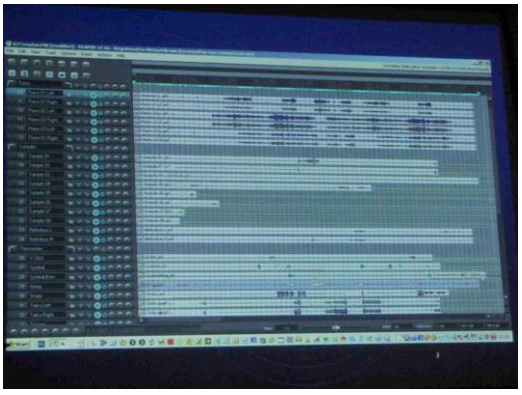
Discussion of the composition by Michael and audience began with his disappointment in the height representation – due in part to ambisonics limitations, a non-ideal array, room acoustics and possibly the cognitive difficulties with placing real instruments with known timbres in unrealistic places (e.g. dropping a piano recording from above the audience). The effect of height cues from high-frequencies resembling pinna resonances was also discussed as a means of enhancing height spatialisation. However, it was noted that a composer may wish to subvert this (partly metaphorical) association between height and pitch. Also it's possible for high-frequency sounds to be perceived at a low elevation, for example birds or insects at ground level are usually localised correctly.

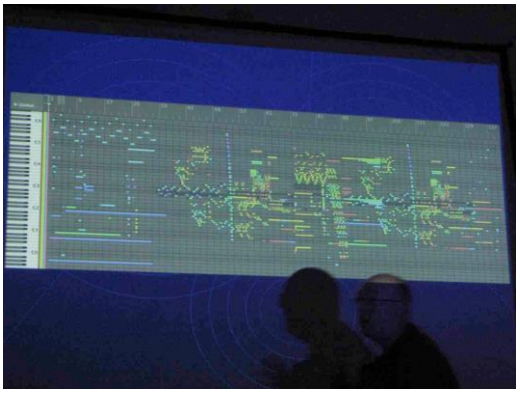
Michael Brown : http://www.derby.ac.uk/staff-search/mr-michael-brown

Derby multichannel facility : http://uod-true-multi-channel-mixing.wikispaces.com

Reaper : http://www.reaper.fm/ - Logic Pro : http://www.apple.com/logicstudio/

Reaper (left), Logic Pro (right and below)



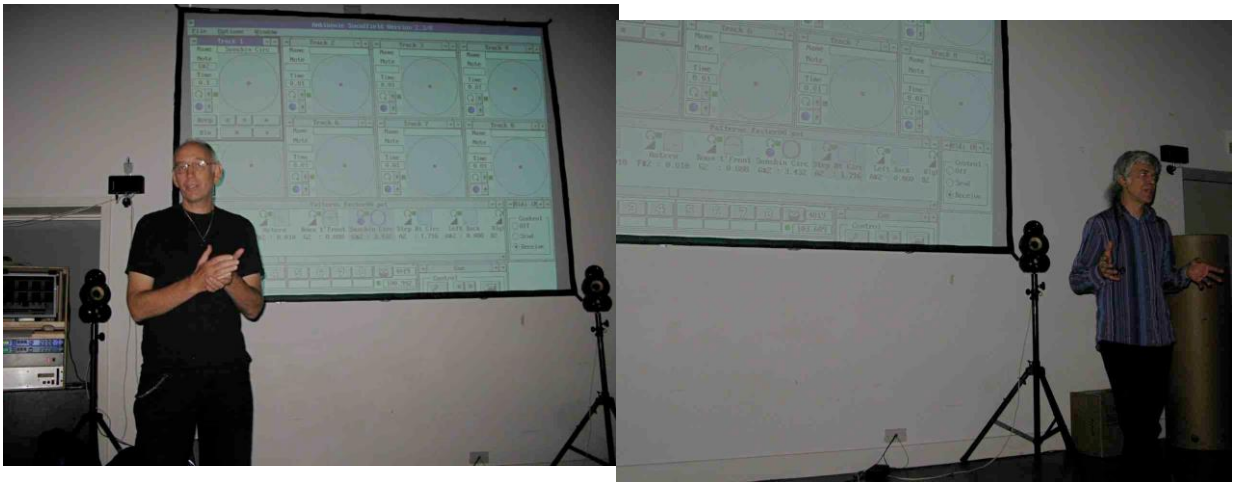


John Newsham and Tony Andrews of Funktion One, ambisonic panner hardware

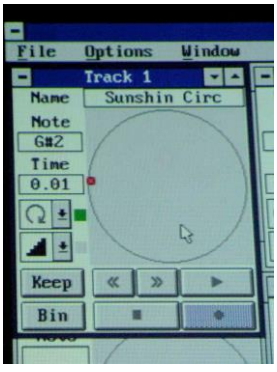
John presented an older hardware and DOS software ambisonic panner with automation, partly inspired by using an old manual Pink Floyd quad panner at the 1992 Glastonbury Festival. This hardware has 8 mono audio input channels that can each be encoded to 1st order ambisonic for separate decoding. The DOS software component controls the hardware and enables pan trajectories to be recorded, automated and sequencied via MIDI, with various trajectory options. The equipment was used by Chemical Brothers for at least one surround show in the 1990s and is still used at the Glade Festival.

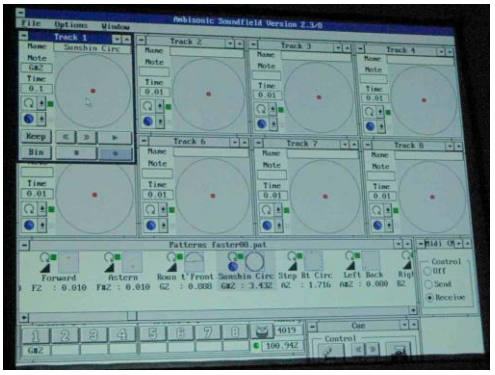
Tony noted that Ambisonic playback on a large speaker array is partly compromised by the panning using all speakers, so they install the speakers aimed at the ground in the centre of the space to absorb the signal to the far side.

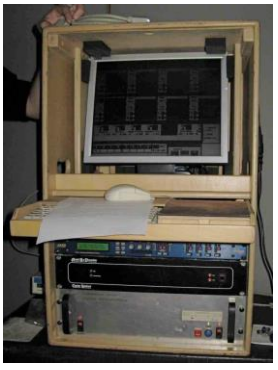
Discussion covered spatialisation of stereo music from DJs by simple feature extraction using filters, and the approach to sound as objects, creating a sonic choreography, in which static parts could be seen as the « landscape ». Peter mentioned the possibility of endless linear trajectories (made using the same principal as Shepard or Risset Tones), and cited the example of Terre Thaemlitz performing one piece that featured a continually-building fade-in, or « endless comingness ». Also discussed was the possibility of placing sound absorbing occlusions as objects, which is possible in computer game 3d audio software, and possibly in IRCAM's Spat. Bruce also mentioned this feature is available in a particular BBC stage set simulator.



John Newsham, Tony Andrews, Funktion One. http://www.funktion-one.com/







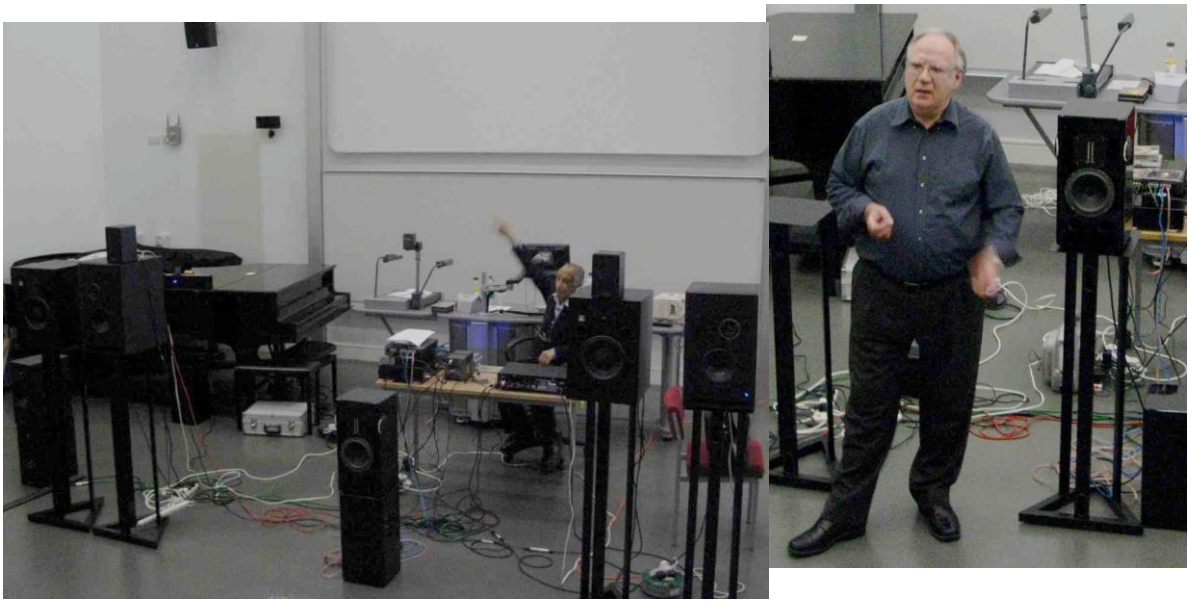
Bill Dyer, 2-channel demonstration!: phantom images, phase and audio imagery

Lecture hall

Bill Dyer of Digital Audio Systems (formerly Dyer Audio Systems) presented a demonstration of « two-channel spatial sound» made possible by his fine attention to detail in the transient time response design of his hifi and monitor loudspeakers. He began with a pair of other speakers representative of studio monitors sold in large numbers and played excerpts from a performance of Carmina Burana, then switched over to his monitors. The demonstration showed how the depth and breadth of the image of stereo recordings is highly dependent on the loudspeaker.

Before the lunch break, Bill played a series of recordings including an organ recital, raw drum-kit test recording, a thunderstorm field recording, and a big band.

[Ed.] – Peter notes that : Bill Dyer's point was that few speaker systems are actually designed so as to optimise their phantom imagery. Naturally, for studio pan-potted stereo, this is less of a problem. But Bill pointed-out that, especially where material has been recorded using a coincident microphone technique (Blumlein, Soundfield, etc) stereo is theoretically capable of conveying substantial depth of field (similar to what Mason and Rumsey refer to as 'ensemble depth'), but practically rarely does. As a result of the workshop, Bill Dyer and Tony Andrews (F1) have agreed to attempt to collaborate - an unusual pairing of the hifi end of the market with the huge stadium end of the market!



Bill Dyer (left), Terry Fletcher (right)

Terry Fletcher,!«!single point stereo!»

Terry presented a demonstration of his « single-point stereo » loudspeaker, inspired by some notes in Blumlein's 1931 patent on stereo techniques, in which Blumlein reportedly noted that there is another better way than dual crossed microphones to reproduce spatial sound from two channels. Then, after making a stereo Mid-Side choir recording in 2005, Terry began researching ways to listen to M-S recordings, which evolved into his « single-point stereo » loudspeakers.

Terry has a company that makes consumer products using the principle – for example, a childrens' neck-worn (lanyard-mounted) portable-music speaker and a TV set-top speaker box. His personal research presently uses a single loudspeaker box with front-mounted woofer and ribbon-tweeter, with two side-mounted almost-full-range speakers at tweeter height. These side-mounted speakers produce frequencies down to around 200Hz, so there is a 2dB raised level in the woofer response to compensate and produce a flatter resulting spectrum from all drivers.

The resulting sound produced a wide and deep image, although it can't produce strong asymmetrical lateral images. Terry has found that time alignment of the side speakers with the frontal tweeter is critical to a strong image.

Bruce Wiggins, introducing Ambisonics and free engineering tools

Performance room

Bruce presented and discussed his « WigWare » series of free Ambisonic VST plug-ins that he developed to enable easier ambisonic sound production on digital audio workstation software.

Clearly there has been a long history of different approaches to ambisonic audio production, but

Bruce found that even recently there was no easy way to do it. Software is usually stereo to begin with and even many surround-capable applications don't help for ambisonic production. He has found the Reaper [1] software to be a suitable platform, since although based on stereo tracks, it has only arbitrary limits for channel numbers grouped into buses (64 channels at present?).

Bruce then presented an overview of ambisonics, describing the frequency-dependence of velocity and energy vector components in spatial ambisonic recordings and decoding techniques. He notes that the ambisonic microphone technique is essentially a 4-channel, 3-dimensional extension of the (2-d) Blumlein stereo technique that Blumlein himself called « binaural reproduction ».

Essentially, ambisonic coding and decoding calculates what to feed the speakers to reconstruct any first-order spatial patterns, no sharper than a dipole (figure-8) in any direction. By adding different proportions of the omnidirectional (spherical) signal to a single dipole, other broader shapes can be generated such as a cardioid pattern. Decoders then vary the ratio of the omni-directional W signal to reconstruct energy and velocity vectors to different levels of accuracy, with the best possible energy vector magnitude of 0.7 (square root of 2).

Bruce Wiggins, WigWare plugins.

Compared to vector-based panning (between nearest speakers), ambisonics shares the error equally in all directions, so listener localisation of the speaker-positions is less likely than for vector panning, for which the sound is either smeared for a source between speakers or perfect for a source at the speaker direction. Ambisonics on the other hand is "equally wrong" in all directions, so the speakers disappear to some extent.

For sharper panning, higher-order ambisonics provides narrower possible spatial patterns and provides the advantage of enabling asymmetric patterns for asymmetric arrays such as a 5.1 surround sound setup.

Bruce went on to describe the Reaper software and his WigWare ambisonic VST plug-ins, which provide separate cartesian and spherical-coordinate panners (encoders) and decoders (which are essentially lumped together in 5.1 and other multichannel panners). The two panner types have the same internals, and also provide basic distance simulation with cross-fade to the W omni signal when a sound is brought *inside* the speaker array (in ambisonic receiver terms, this is an omni source at the microphone position). Another WigWare plugin provides 4-channel reverberation using a traditional recursive filter algorithm.

To use the plugins in Reaper requires pairs of stereo tracks to be grouped as 4-channel buses for b-format output. Reaper has quick features such as track/bus copy and paste and bus templates so that ambisonic buses can be instantiated with ease, and automation is available to record and sequence trajectories. Furthermore, Reaper features an internal plugin scripting environment (JS) [1]. There are screencast demonstration videos of WigWare plugins running in Reaper available online on the Derby multichannel mixing wiki [2].

Bruce finished with an impressive demo using an African acapella choir panned discretely around the room, with some reverberation, which is pleasantly immersive/enveloping, quite diffuse and not too bright.

Bruce Wiggins, WigWare :

http://www.derby.ac.uk/staff-search/dr-bruce-wiggins

[1] http://reaper.fm/sdk/js/

[2] http://uod-true-multi-channel-mixing.wikispaces.com/Reaper+Tutorial+Videos

Matt Trevor, «!wii are the music makers!»

Matt presented his project named « wii are the music makers » after an Aphex Twin song, in which he uses a Nintendo Wiimote video-game controller [1] to perform live improvised, beat-based electronic music. The Wiimote contains several sensors including switches, a thumb joystick, 3-axis accelerometers, and an infrared camera, and Matt is able to access this control information via software called GlovePIE [2]. He then uses the control data streams within AudioMulch software [3], in particular, mapping buttons to switch various effects in and out of the audio processing chain, and using accelerometers and the joystick to vary continuous effect parameters. His source audio was a break-beat sample loaded in the LiveSlice beat-cutting plugin [4]. He was also using WigWare ambisonics processing plugins to pan sounds around the speaker array. Other controllers he has experimented with include the SpaceNavigator (Google Earth controller) [5]. He found CPU usage was sometimes excessive for all the effects he was running, particularly for 2nd order ambisonics.

For Matt, this project is all about improvisation and live jamming, not composition. However, several composers observed that it could provide useful supplements to more long-winded approaches to spatial composition. Matt personally found ambisonic panning was sometimes too discrete and occasionally wanted lower level spatiality. He also tried his setup with the Funktion One system at Glade festival, and found that the venue has a large effect on the resulting sound. He also noted that most venues are biased towards frontal (stage-focused) presentation, and he'd like to see more surround sound venues. In the future, he's taking the system to the UK Institute of Acoustics [6] and may work on music therapy ideas. He also has ideas for improved 3D graphical interfaces for working with 3D sound composition, citing the revolutionary 3D software desktop organiser BumpTop [7].

[1] http://www.nintendo.com/wii

[2] http://carl.kenner.googlepages.com/glovepie

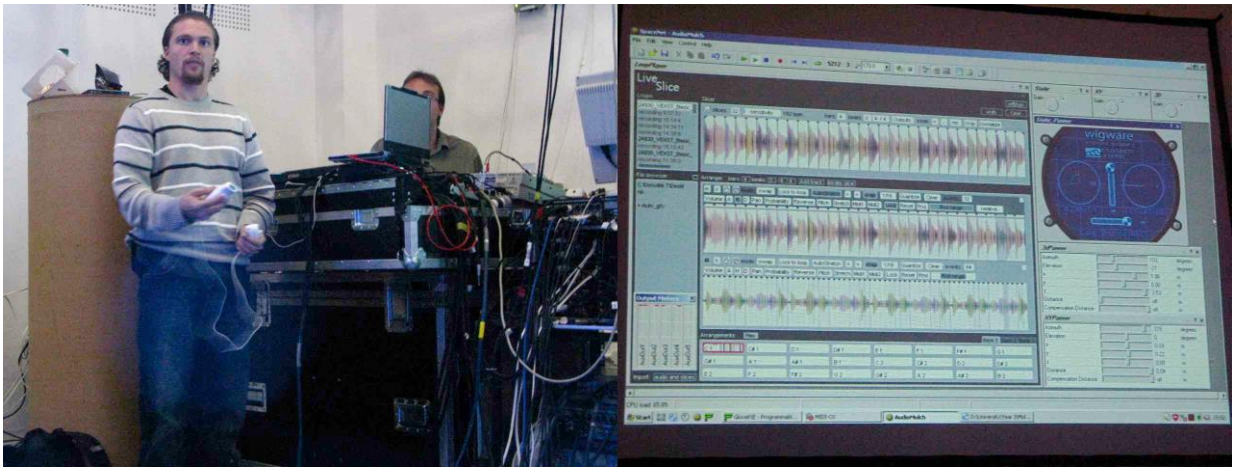
[3] http://www.audiomulch.com/

[4] http://www.livelab.dk/liveslice.php

[5] http://www.3dconnexion.com/

[6] http://www.ioa.org.uk/

[7] http://bumptop.com/



Matt Trevor and his AudioMulch setup including LiveSlice beat slicer and Wigware panning.

Chris Wilson, spatial music composition

Chris presented his composition for the ambisonic array. He found he was comfortable composing without realtime multichannel monitoring, because that's the usual mode of working for him and many composers anyway – for example, to compose for orchestra using only a piano. His piece came from a history of doing realtime collaboration in one place with another composer, with whom he now works across geographical distances. This situation fed into the present narrative/philosophy/concept, also related to a short story called « the great slow kings » [1]. He also described his inspirations for a previous work, based on sounds of a wheelbarrow from the bottom of the yard and pots filled with rainwater. He has thought also of David Tudor's [2] work with objects that interact with their environment.

For the present composition, he used long-wave radio, cups smashing, worked with space-time and tried to produce an oppressive natural environment, inspired by the jungle sounds of « raw natural selection at work » which precede the dawn chorus. He also mentioned an idea he'd like to use where the audience wears headphones in a room with a speaker array, so that sounds could be panned all the way from the external array right into the audience's ears.

Chris Wilson :

http://www.derby.ac.uk/staff-search/mr-chris-wilson [1]

http://lib.ru/ZELQZNY/TheGreatSlowKings.txt [2]

http://www.emf.org/tudor/Life/biography.html


Chris Wilson

Concluding remarks

Overall the workshop covered a lot of ground during the day, from two-channel (« stereo ») spatial sound through to several production techniques from perspectives of engineering, composition and live improvisation. There was a reasonable amount of discussion related to each presentation.

An improvement might have been the inclusion of further general discussion time, for example regarding attendees' personal experiences and wishes for the future development of spatial music production capabilities and techniques. More « hands-on » activity was also suggested. Some delegates also asked for a repeat event, and Peter has agreed to investigate this possibility.

14 Appendix 5 Report on Research Group activities

University of Derby

University Research and Research Degrees Committee

Annual Report of Research Groups and Centres

Please expand the template as appropriate: Please keep the report concise and informative. The deadline is Tuesday 9th June 2009.

1	Name of Research Group or Centre	**Signal processing and Applications Research Group (SPARG)**	Year	2009
2	Faculty responsible for the Research Group or Centre	ADT		
3	Director of Centre or Head of Group	Peter Lennox		
4	Principal Researchers	Researchers	Associate Researchers	
	Amar Bousbaine	Alex Gibbins	Simon Lewis	
	Ahmad Kharaz	Kristian Lane	Dave Wilson	
	Bruce Wiggins	Mike Brown	Duncan Werner	
	Tim Wilmshurst	John Crossley	Tom Spenceley	
	Dilan Jayaweera	Richard Hodges	Matt Trevor	
	John Redgate	Chris Wilson	Tony Andrews	
	Peter Lennox		John Newsham	

5	Progress during the academic year: (Overview, events organised, new or continuing collaborative partnerships, new projects, encouraging or inhibiting factors)
	• TIR and RIC funded projects have had direct and positive benefits on teaching facilities, curriculum content and delivery; students have had opportunities to be involved in interesting projects within and additional to their modules and have been engaged in practical research. They also appreciate that they have been involved with technologies that are some years in advance of existing commercial technologies. • Staff morale has improved (a) where research has directly fed into teaching and (b) where the effects have been indirect, i.e. in updating scholarship and expertise • "Spatial sound and music" International workshop with demonstrations, final event in the (EPSRC-funded) SpACE-Net series, September 2008. Staff and a few students who attended this were academically inspired; one said "*this* is what I thought I was coming into academia to do…" • Demonstration at Nanotech series of public presentations, 2008 • Development of world's first ambisonic orchestra, the Derby Laptop Orchestra (DLO) for experimentation and public dissemination • Member of Real Virtuality Network (EPSRC-funded) • Ongoing information exchange collaboration with Funktion One Ltd., Dallasmasters Ltd, University of York music Department, University of Sheffield Music Department, Dyer Audio Ltd • Commencement of KTP project with Davis Derby Ltd. **Inhibiting factors**: Estates inadequacies (sometimes severe), IT systems and infrastructure problems, all of which contribute to the disparities between estimated and actual workloads.
6	Individual honours (eg editorships/appointments to committees/guest lectures/conference keynote speaker)

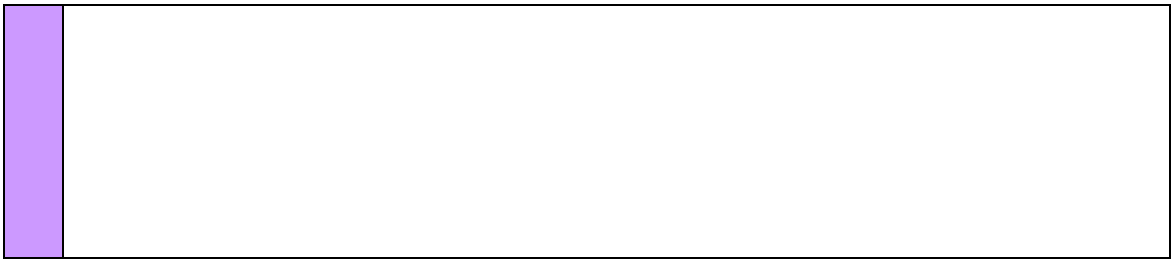
7	Publications and exhibitions (including monographs, authored books, edited books, journal papers, conference proceedings, UK and overseas exhibitions and other forms of performance)
	• Wilson, C. (2008) *Endlessly,* frame605media. • Wlison, C. The Jupiter Collision (2008) *Reason,* frame605media. • Wilson, C. The Jupiter Collision (2008) *Tearing Flames From The Sun,* frame605media. • Lennox, Peter P. (2009) *"*Spatialisation and computer music" in *The Oxford Handbook of Computer Music and Digital Sound Culture*, ed. Roger Dean Oxford University Press (in press) • Lennox, P and Myatt, T. *Concepts of perceptual significance for composition and reproduction of explorable surround sound fields.*. ICAD, (Montreal, Canada) Jun 2008 • Wiggins, B., (2008) *The Generation of Panning Laws for Irregular Speaker Arrays Using Heuristic Methods* . Proceedings of the 31st International AES conference, London, UK. • Wiggins, B., (2008) "*Has Ambisonics come of age?"* presented at International Conference of the Institute of Acoustics Brighton, UK • A Bousbaine and M.Shrud, "Modelling and Simulation of Automotive Interleaved Buck Converter, UPEC, 1st - 4th September 2009, University of Strathclyde in Glasgow, Scotland. • Bousbaine, G.Trigkidis "An Integrated Electro-Thermal Model of IGBT Devices (Experimental Validation)", UPEC, 1st - 4th September 2009, University of Strathclyde in Glasgow, Scotland. • A Bousbaine and M.Shrud, "Analysis and Simulation of a 42V Power System for Automotive", UPEC, 1st - 4th September 2009, University of Strathclyde in Glasgow, Scotland. • Bousbaine, P. Smeeton, "Diagnostic Testing using Partial Discharge Measurements on High Voltage Rotating Machines", UPEC, 1st - 4th September 2009, University of Strathclyde in Glasgow, Scotland.
8	University Grants, External Grants and Income Generation (including TIR grants, RICF and Excellence Awards, Research Council Grants, external contracts and other sources)

	Researcher	Source	Date of award	Amount
	Bruce Wiggins, Mike Brown	TIR	Jun 2008	£2.4K
	Amar Bousbaine	TIR	Jun 2008	£2.4K
	P.Lennox, Alex Gibbins	TIR	Jun 2008	£2.4K

	John Redgate	KTP	May 2009	£120K
	Ahmad Kharaz	TIR	Jun 2008	£2.4K
	P.Lennox, Chris Wilson	RIC	Sept 2008	£3.5K
	Tim Wilmshurst	RIC	Sept 08	£3.5K
	Tim Wilmshurst	TIR	Jun 2008	£2.4K
	Amar Bousbaine	RIC	Sept 2008	£3.5K

9	Planned developments over the next three years
	The plan is to raise a small amount of funding to re-launch the group's website, with comprehensive and up-to-date listings of publications, research projects, staff skills and interests. This is pre-requisite for the medium-term goal of engaging in "public projects" that are visible, interesting to non-specialists as well as specialists and involve a greater degree of collaboration. Collaboration has always been an important feature of how we operate, and we would like to 'build on our strengths'. An example of this kind of project is the recently-launched Derby Laptop Orchestra (DLO) project. This is a world first in that it is explicitly a 3-d sound orchestra. Importantly, it is intended as a research vehicle for exploring aesthetic, perceptual and technological issues, and a fundamental ingredient is that outside composers, engineers and musicians should be involved in experimental pursuits. There is also interest in developing a sustainability project featuring signal processing for energy control, and one group member has just secured the first KTP project that the group has had for some years. The group is moving towards the development of larger-scale research projects, involving proposals for external funding and the use of paid postgraduate studentships. The core skills of the group have been reinforced in the areas of power electronics and power systems, through an influx of new staff, reflected in the successful launch of the KTP project. Strengthened relationships with external collaborators will continue to be developed. We have an ambition to work towards Research Centre status, broadening our skills and, especially, fostering interdisciplinary dialogue and research projects.

10	Conclusions (Overall progress in the current year and prospects for next year)
	Many colleagues in the electronics and sound subject group express enthusiasm for increased scholarly and research activity; this reflects the fast-changing nature of the technologies with which we must be conversant, but also a core belief that it is the proper business of academics to be at the forefront of knowledge in a chosen field. However, the near-unanimous opinion is that the main inhibiting factor is a prevailing lack of comprehension of teaching and assessment workloads, especially where many of the resources and systems we rely on operate suboptimally. The new building at Markeaton Street continues to suffer from teething problems and physical resource inadequacies. Lack or progress in these areas has had a depressive effect on staff morale. Consequently, although there are signs within the University of a positive attitude towards encouraging research and scholarly activity, some are very sceptical that this attitude will actually translate into tangible help. Some feel that they may be *instructed* to conduct research rather than *facilitated*; others reserve judgement, whilst none are unreservedly optimistic. There is a substantial issue of trust which cannot be dealt with at 'ground level'. An important restriction which must be comprehensively addressed is that of communication. The group needs better visibility and information exchange within and beyond the boundaries of the University in particular, and academia in general. Some years ago, the group administered its own website – the site was small but always up to date. However, this facility was removed (by the University) in the process of centralising such resources. The server was switched off and the site disappeared for a year. Even now, the process of updating the site is cumbersome, unresponsive and time-consuming; the site is two years out of date, which reflects badly on any research group and especially on one that specialises in technology. The group must be seen to be approachable and dynamic; the primary requirement is for staff time. This is the first year when the subject group have not been hampered by subject reviews, large-scale programme validations, estates and facilities reconfigurations and so on. It is also the first year that staff in the subject group can see how it might even be possible to actively pursue their academic interests. Morale is steadily improving (though cautious scepticism remains). There are several naturally-evolving special interest clusters, and these are healthy precisely because of cross-fertilisation of ideas between them. Currently, almost all the subject group staff members are contributing ideas and volunteering skills to the DLO project.



Please submit the completed Annual Report by e-mail to the Research Office by Tuesday 9th June 2009. Researchoffice@derby.ac.uk Thank you. Paul Bridges.

15 Appendix 6: SPARG report 2010

University of Derby

University Research and Research Degrees Committee

Annual Report of Research Groups and Centres

Please expand the template as appropriate: Please keep the report concise and informative. The deadline is Tuesday 9th June 2010.

1	Name of Research Group or Centre	**Signal processing and Applications Research Group (SPARG)**	Year	2010
2	Faculty responsible for the Research Group or Centre	ADT		
3	Director of Centre or Head of Group	Peter Lennox		
4	Principal Researchers	Researchers	Associate Researchers	
	Dr. Amar Bousbaine	Alex Gibbins	Tom Spenceley	
	Dr. Ahmad Kharaz	Kristian Lane	Tony Andrews	
	Dr. Bruce Wiggins	Mike Brown	John Newsham	
	Tim Wilmshurst	John Crossley	John Rudd	
	Dr. Mahmoud Shafik	Dr. Richard Hodges		
	Dr John Redgate	Chris Wilson		
	Dr. Peter Lennox	Simon Lewis		
		Dave Wilson		
		Duncan Werner		

5	Progress during the academic year: (Overview, events organised, new or continuing collaborative partnerships, new projects, encouraging or inhibiting factors)		
	Progress Good spread of publication and conference attendances. Ongoing KTP progressing well. DLO umbrella project has generated some interesting student research projects. Previous TIR and RICF projects continue to generate course content, students appreciate exposure to leading-edge academic material. **Inhibiting factors**: Timetabling inflexibility has excluded some potentially valuable conference attendances and public presentations. Administrative duties have a severe impact on scholarly activities. This has been the first year (since TIR and RICF funds were introduced) that the group has had poor results in securing project funding.		
6	Individual honours (eg editorships/appointments to committees/guest lectures/conference keynote speaker)		
7	Publications and exhibitions (including monographs, authored books, edited books, journal papers, conference proceedings, UK and overseas exhibitions and other forms of performance)		

- Bousbaine, A, Trigkidid G, Benamrouche P.N. 2009. An Integrated Electro-Thermal Model of IGBT Devices (Experimental Validation). Proceedings of the 44th International Universities Power Engineering Conference.
- Smeeton, P, Bousbaine A. 2009. Diagnostic Testing using Partial Discharge Measurements on High Voltage Rotating Machines. Proceedings of the 44th International Universities Power Engineering Conference.
- Shrud, M, Bousbaine A, Elazrag A, Benamrouche N. 2009. Analysis and Simulation of a 42V Power System for Automotive. Proceedings of the 44th International Universities Power Engineering Conference.
- Bousbaine, A, Shrud M. 2009. Modelling and Simulation of a Two Cell Automotive Interleaved Buck Converter. Proceedings of the 44th International Universities Power Engineering Conference.
- Gibbins, A. 'Touchline" - A fully interactive Television graphics and audio effect generator for the Nike "Show Your 5" national five-a-side football competition webcast, Alexandra Palace.
- Hodges, R (2009) 'Music Education and Training: ICT, Innovation and Curriculum Reform', in Music Education with Digital Technology ed. J. Finney and P. Burnard, Continuum Press. ISBN: 0826420710
- Wilson, C. (2009) Multichannel sound design for theatrical production of Much Ado About Nothing, Buxton, October 2009. RICF funding supported with journal article currently in development.
- Wiggins, B., Spenceley, T. (2009) Distance coding and performance of the mark 5 and st350 soundfield microphones and their suitability for ambisonic reproduction. Reproduced Sound 25 - Proceeding of the Institute of Acoustics, Vol 31, Pt 4.
- Wiggins, B. (2009) Future Proof Surround Sound Mixing Using Ambisonics. Presentation given at the Forum for Innovation in Music Production and Composition, Leeds College of Music, UK
- Lennox P (2009) Spatialisation and computer music in The Oxford Handbook of Computer Music and Digital Sound Culture (Oxford University Press)
- Lennox P (2009) The Emotional Contents of Space in the context of Spatial Music. Presented at International Conference on Music and Emotion (ICME) September 2009, Durham UK
- Wilson, C and Lennox, P. Presentation of Derby Laptop Orchestra Technologies at the Creative Exhibition, Mansfield 26 Feb 2010
- Wiggins, B. (2008) Screencasts for Education using BB Flashback and Adobe Captivate. Presentation given at Faculty of Arts, Design and
- Al-Habaibeh, A., Al-Azmi., A and Redgate, J. Rapid design of tool-wear condition monitoring systems for turning processes using novelty detection, Int. J. Manufacturing Technology and Management, Vol. 17, No. 3, 2009 p232-45.

- John Redgate, Amin Al-Habaibeh, Dilan Jayaweera, Daniel Tarrent, Philip Pickering, Modelling the Reliability of Electrical Power Systems from Data Derived by Infrared Thermography, Proceedings of IRF'2009, 3rd International Conference on Integrity, Reliability and Failure, Porto, 20-24 July 2009, P0475, ISBN 9789728826215

- Accepted paper: REDGATE John1, AL-HABAIBEH Amin, SU Daizhong, WILMSHURST Tim, Accepted: Evaluation of Component Reliability Using Data Derived From Infrared Thermography, 3rd International Conference on Advanced Design and Manufacture

(ADM2010), September 2010.

- Wilmshurst T., Spenceley T. Low Power Lab: Demonstrating Low Power Embedded Techniques. Embedded Systems Conference, October 2009. Farnborough, UK.

- Wilmshurst, T. Designing Embedded Systems with PIC Microcontrollers: Principles and Applications. (sole author). Chinese Translation. Posts and Telecoms Press. ISBN 978-7-115-18265-4/TN. 2008.

- Wilmshurst, T. Designing Embedded Systems with PIC Microcontrollers: Principles and Applications. Second Edition. Newnes. ISBN 978-1-85617-750-4. November 2009.

v8 University Grants, External Grants and Income Generation (including TIR grants, RICF and Excellence Awards, Research Council Grants, external contracts and other sources)

Researcher	Source	Date of award	Amount
Richard Hodges	TIR	2009	£2.5K
Alex Gibbins, P.Lennox,	TIR	2009	£2.5K
John Redgate	KTP	2009	£100K
Chris Wilson	RICF	2009	£3.5K
Tim Wilmshurst	TIR	2009	£2.5K
Amar Bousbaine	RICF	2009	£4.2K

9	Planned developments over the next three years
	PROSPECTIVE: SPARG currently covers a wide field of subject interests, reflecting the diversity of the Electronics and Sound subject group. Whilst signal processing remains at the heart of the group's activities, there are two main themes emerging: electrical and electronic engineering on the one hand, and developing media technologies on the other. For the sake of clarity of identity (especially in respect of externally recognised identity), we foresee these two main themes determining the identity of **two** research groups. To bring fresh energy to the research landscape, both groups will have new leadership. Each group will provide an environment for postgraduate study in the subject area. We propose a new research group with a mandate that explicitly occupies the technical end of the spectrum covered by the Subject Group, i.e. Electrical and Electronic Engineering and their applications. There are 6-8 staff members who will become contributing members of this group. The other (extant) group will focus on combined art-and-science research, taking in signal processing for sound, music, video and multimedia technologies, where aesthetics, perception cognition and behaviour are intrinsic. There is a group of around 8 or 9 staff members who will form membership of this group. Joint membership of both groups will be actively encouraged, where this is appropriate. It is proposed that these changes will be initiated during the summer of 2010. Both groups will be keen to be considered for contribution to REF, either alone, or in collaboration with each other, or other groups.
10	Conclusions (Overall progress in the current year and prospects for next year)
	The next 12 months promises to be challenging, with the requirement for revalidation of all the Subject Group programmes in order to conform to the new blueprint; wholesale restructuring of content and delivery mechanisms of up to one hundred modules will be required. Development of the Subject Group's new MA (currently in Validation assessment) will also absorb considerable time and energy. Scholarly activity and new research projects might prove difficult to prioritise.

PETER LENNOX

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EDUCATION

- PhD University of York, Department of Music.
- Cert. Arts of Theatre, University of Sheffield.
- Cert. Management Studies, Sheffield City Polytechnic.

PROFESSIONAL EXPERIENCE

- **2002 to date**: University of Derby, Derby, UK. School of Technology, Faculty of Arts, Design and Technology

S**enior lecturer**: undergraduate and postgraduate. Subjects: auditory perception and psychoacoustics, audio systems, multi-channel sound, research and scholarly methods, introduction to computer applications. Leader for independent studies final year projects/dissertations (150 students).

In total, the School has approximately 450 students.

Director of Signal Processing Applications Research Group (SPARG) Research areas: Signal processing for virtual audio applications. Spatial sound development; new musical interfaces. Perception and psychophysics. Modelling human perception in artificial environments.

Head of Technology Foundation Programme. Academic leadership, curriculum design and management and industrial employer liaison.

- **1998 to 2002** *Lecturer*

▪ Associate lecturing at the University of York, Bretton Hall University College, Derby University, Sheffield Hallam University (Northern Media School). Subject: *Perceptual Technologies Artificial spatial sound: perception and implementation.*

- **1998 to 1999** York Arts Centre. York, UK. *Director* – Developed the York Digital Arts Centre which was the forerunner of the Sightsonic Digital Arts Festival

ADDITIONAL ACTIVITIES

1997 Northern Media School – *Visiting researcher*. Investigating multimodal technologies and practices

1996 to 1998 University of York, York, UK

Research in development of navigable spatial sound.

- An iterative approach combining engineering, psychophysics and cognitive theory in development of large-scale listening environments and auditory displays

Previous experience:

- Live events design, technical staging and management.
- Film Production: *Production assistant, 2nd assistant director, 1st assistant director, production manager*
- Early working experience in engineering and oil industries

PROFESSIONAL MEMBERSHIPS

Member of the Faculty Research and Research Degrees Committee (FRRDC).

Member of the University Research Ethics Committee (UREC)

Member papers review committee, International Conference on Auditory Display (ICAD08)

Member of the Audio Engineering Society (AES).

Member of the Spatial Audio Engineering Creative Network (SpACE-Net)

Member of the Board of Directors of the UK and Ireland Soundscape Community (UKISC)

SELECTED PUBLICATIONS

- "Spatialisation and computer music" Lennox, Peter P. (2008) *in The Oxford Handbook of Computer Music and Digital Sound Culture*, ed. Roger Dean to be published by Oxford University Press
- *Concepts of perceptual significance for composition and reproduction of explorable surround sound fields.* Lennox and Myatt, presented at the International Conference on Auditory Display, (Montreal, Canada) Jun 2007
- *"A perceptual approach to the composition of meaning in artificial spatial audio*." Peter Lennox and Tony Myatt presented at the 30th International Conference of the Audio Engineering Society on *Intelligent Audio Environments*, (Saariselkä , Finland), March 2007
- Doctoral Thesis: "*The Philosophy of Perception in Artificial Auditory Environments: Spatial Sound and Music.*" submitted University of York October 2004. Supervisor: Dr. A Myatt

AREAS OF INTEREST

1) Place perception: spatial representation of objects, organisms, behaviours, features, opportunities, distance, movement and threats

2) Strategic attention and inattention in real and artificial environments: natural foreground and background distinctions.

3) Individual differences in spatial cognition. Deficits, development and plasticity in spatial cognition

4) Sensory substitution and equivalence in spatial representation

5) Causal cognitive mapping and spatial imagery: egocentric and allocentric representations

6) Auditory distance perception, depth of field, height perception, spaciousness, enclosed-ness, adjacent-space perception, auditory looming, passing, departing.

7) Intuitive physics in audition: weight, structure, shape, texture and consistency.

8) The role of ambient sound field characteristics in cognitive mapping.

9) Exploratory behaviour: ambulant perception, interrogation of environments.

16 Appendix 7: Teaching Informed by Research (TIR) Project:

TQEF Teacher Fellows & TIRs Final Report

Faculty: Arts, Design and Technology

Theme: Learning resources development from research outputs

Names: Peter Lennox, Alex Gibbins, Bruce Wiggins, Chris Wilson

"Composing and Capturing 3-d Soundscapes'

Dr Peter Lennox and members of the Signal Processing and Applications Research Group (SPARG) developed a project that involves students in research-based learning, based around a TIR-funded project to assemble Very Large Artificial Soundscapes.

16.1 Outputs and outcomes

"The key ingredient in this project is the attempt to motivate students to take the initiative in 'research-based learning'. That is, beyond the requisites for performance within the taught modules via assigned work, students are encouraged to pursue knowledge for its own sake. The aim is to focus students' attention on the project at hand, rather than on the teaching-and-learning process. The primary aim is to engender creativity when thinking about technical, perceptual and artistic problems."

16.1.1 Objects of evaluation:

1. Does the use of practical exemplars help to 'make sense' of abstract theory?
2. Is the balance of *appropriate* (sometimes competing) theories more apparent when theories are physically explored?
3. Is creativity within a technological context *improved* by combining theoretical and practical exploration?
4. Does taking an exploratory approach complement more traditional, prescribed (taught) methods?

A cohort of <50 final year BSc students within the Electronics and Sound subject area of the School of Technology were given access to proprietary hardware/software solutions (developed within the School) to enable them to capture and manipulate large natural sound fields. Their task was to develop novel and innovative solutions to uncommon spatial sound problems.

Informal listening tests were devised by the students, and used to ascertain whether their implementations achieved to aimed-for perceptual results.

Reflective discussions between student teams took place, where the applicability of "text book theories" in these particular practical examples was examined; it was found that not all theories were equally weighted when describing the implementations.

However, the use of small assessment points and detailed student questionnaires was abandoned as too time-consuming; these activities tended to inhibit the 'flow' of the students' efforts.

16.1.1.1.1 Perceptual veridicality:

The design criteria included paying close attention to perceptual veridicality for sources and environment-features in terms of size, orientation, direction and distance, for the majority of possible perceiver positions. A further test was that perceivers were to be encouraged to explore, walking around inside and outside the displayed sound field. The results were then auditioned in suitable large-scale venues, giving the students opportunity to evaluate and fine-tune the results.

16.1.1.1.2 Results and feedback

The results showed that it is theoretically possible to mount *very* large **navigable** sound fields and that the principles are (unlike domestic technologies) upwardly scalable to an unknown limit. The students had no technical precedents to follow, and developed their solutions empirically through 'trial and error' methods. They subsequently theoretically analysed the psychoacoustic results.

Students indicated that classroom-taught theory 'came alive' and gained relevance.

All students involved 'put in extra hours' to achieve what they wanted, indicating that this was irrespective of assignment grades.

They were especially pleased to have devised something *new*, beyond what is technically feasible in existing commercial technologies.

Some students, on their own initiative (having completed their course), continue development of these ideas and have indicated their wish to return to explain their projects to next year's cohort.

The key findings are that this approach to learning did indeed enthuse the students, make theory easier to understand, help the students to refine their thinking by using questions rather than remembering facts. Whether the students were more creative – in terms of aesthetics or problem solving, is ultimately not measurable; however comments from observers outside the education endeavour indicated that there was a general *impression* that they were very creative in devising technological solutions.

16.2 Dissemination

The solutions devised by the students will be used as teaching material, as starting points for future experiments and as exemplars in external demonstrations (for instance, in FE colleges with whom we would like to have a relationship)

Students demonstrated their projects at the final spACE-Net International Workshop on Spatial Sound and Music hosted at the University of Derby in September 08 and received accolades from researchers (at an international level) for their approach to novel solutions.

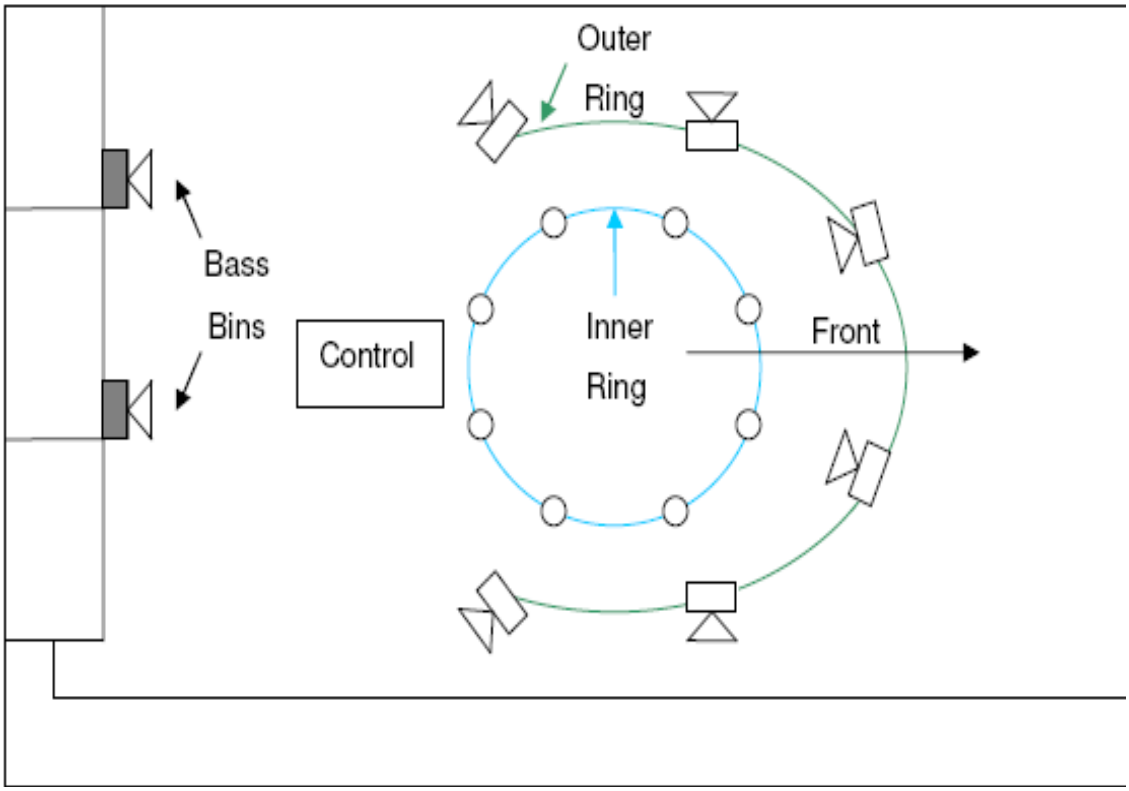
As a result of this dissemination, the research group is in discussion with a company who are interested in possible continuations of these experiments.

A poster was shown at the university LTA conference 2008.

Example 1 : A formula one race track

Example 1 involved recording a segment of Castle Donington motor racing track, using an array of Soundfield ™ and 10 hypercardioid microphones. The signals, time-aligned and spatially scaled down in a 10:1 ratio (so 800m was depicted as 80m), were depicted using 16 loudspeakers.

Comments "*stunningly realistic*" and "*…the Ferrari nearly ran over my toes as it left the track…*"



16.2.1.1.1

Example 2 : The bowling alley; a one:one mapping of a 'line event'
–

A lane of a 10-pin bowling alley in use. Twenty speakers were used to display the virtual bowling lane in a corridor. Visitors (randomly positioned along the corridor) were encouraged to point at the ball as it progressed (which they did with great accuracy) and to anticipate the crash into the virtual skittles (which they also did). An unintended result was that visitors tended to *subconsciously* move out of the path of the heard object.

PICTURE 1 microphone positions

PICTURE 2 – project setup