Crossing Disciplines to Address Urban Sustainability

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Abstract

This paper presents findings from an ongoing feedback exercise for Bridging the Gaps: Sustainable Urban Spaces. Bridging the Gaps (BTG) is a programme of activities designed to stimulate interdisciplinary research. The work was carried out at University College London (UCL) as part of an Engineering and Physical Sciences Research Council (EPSRC) funded programme. All of the EPSRC's Bridging the Gaps programmes aim to initiate and support interdisciplinary collaboration within a university. The programme at UCL was designed to create research collaborations that addressed problems in the area of sustainable urban spaces, an area that features complex problems that are often at the interface of different academic disciplines.

The programme initially focussed on building relationships in the three faculties which make up the UCL School of the Built Environment, Engineering Sciences and Mathematical & Physical Sciences, but subsequently brought in participants from other faculties.

Bridging the Gaps has brought together researchers working on different elements of a problem, allowing each of them to contribute approaches from their own discipline.

This paper presents feedback from participants in the programme. Respondents discuss their experience of cross-disciplinary working, and how important it is for their work. We address the question of whether the benefits are outweighed by the complexities of crossing disciplines, as well as investigating the role that programmes like Bridging the Gaps can play in making the process easier.

We will address the challenge of creating the correct conditions for interdisciplinary working and ways in which we can use our experience to minimise the barriers in the future.

The need for interdisciplinary working

Not all research problems respect disciplinary boundaries. While running the Bridging the Gaps programme we have encountered a broad range of approaches to the challenges posed by urban sustainability, all of which relied on expertise from at least two university departments.

As has been noted by others (Ramadier, 2004) the compartmentalisation of research communities that occurs as scientific fields develop, leads to the formation of different disciplines. Forming departments based around disciplines has the advantage of concentrating expertise and allowing limited resources to be allocated in ways that best suit the members of that department, sharing expensive equipment is only one example. Other benefits include the efficiency of communication and interaction that can occur within a discipline with a shared worldview (Bruce et al., 2004).

As universities grow and departments are formed, it is possible that research can become limited by the shared worldview, training, or investments made by a department.

There is a tension between the efficiency and focus afforded by working purely within a disciplinary, and the freedom to follow the needs of a research question afforded by cross-disciplinarity. It has been argued (Klein 1990) that working in disciplines puts limits on the questions that are asked and the methods employed.

There is also a pressure, from policy makers and funders, for the academic community to address complex socio-scientific problems. These are the kind of problems where it is unlikely that one discipline can provide the answer, making collaboration across departments a necessity.

Because of the socio-cultural, political, economic, or psychological context of real-world problems, it is often necessary to bring more than one point of view to a problem. Working across disciplines allows research teams to be formed around a problem, allowing problem-orientated approaches to complex problems (Brewer, 1999).

On a more practical note, it is often the case that a researcher's department just does not have that one piece of equipment, or the expert in an area, that they need to make progress on a research question.

Whatever the drivers for interdisciplinary collaboration, it is likely that it will be an increasingly important part of the research landscape.

I will leave aside the the interesting question of whether interdisciplinary working is just a practical necessity, or is it, as suggested by Eddy (2005), antedisciplinary, that is the first stage in the formation of new disciplines?

Another thing that I will not cover here are the (important) distinctions between multi-disciplinary, interdisciplinary and trans-disciplinary research, instead I will use the term cross-disciplinary to refer to all types of collaborations.

One of the ideas behind Bridging the Gaps is that research can be more problem driven and less constrained by the resources of a particular department, and the difficulties in collaborating across departments.
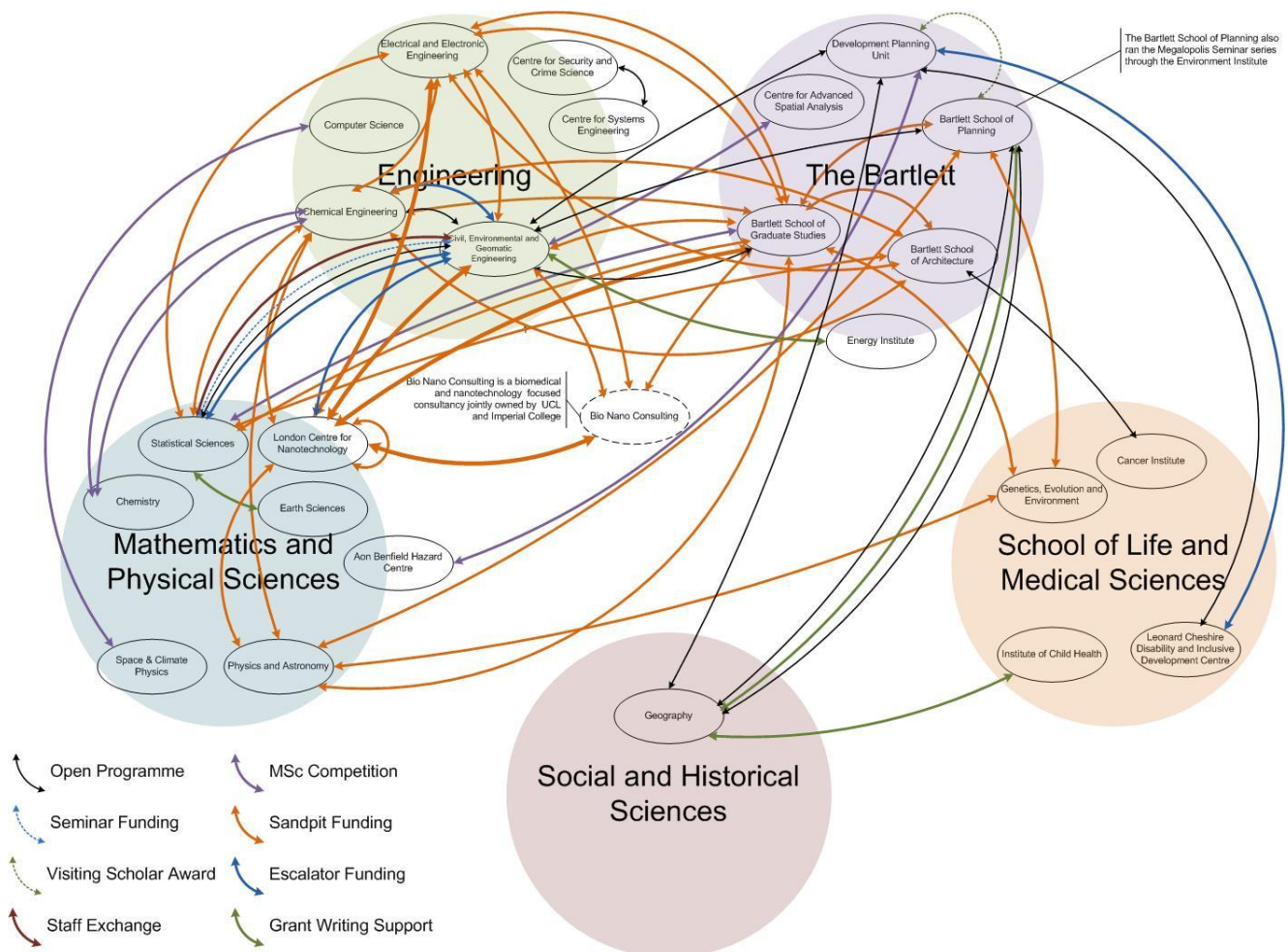
Context of the programme

University College London (UCL) is a large multi-faculty university spread across a number of sites. Many, but not all the departments are sited in central London, so even departments that are relatively near neighbours can be separated by busy city traffic.

UCL is a large enough institution to make it difficult to keep track of all the laboratories, equipment, technicians and research groups, let alone the research interests of the staff.

Overview of the programme

The diagram below gives shows the number and type of links that the Bridging the Gaps programme has made. The arrows show collaborations between departments, with the key in the lower left showing under which of the Bridging the Gaps programmes the link was made.

The programme initially focussed on building relationships in the three faculties which make up the 'UCL School of the Built Environment', 'Engineering Sciences' and 'Mathematical & Physical Sciences'. As the programme continued the programme began to bring in participants from other faculties. The range of research ideas has also grown to include the social, as well as technical, aspects of urban sustainability.

Bridging the Gaps activities

The following are short summaries of the Bridging the Gaps funding opportunities.

- **Open Programme** – this provided small research funding to explore an urban sustainability idea (up to £2,000). This funding opportunity has produced a wide range of interdisciplinary research collaborations. It has also been the starting point for a number of continuing collaborations.
- **Seminar Funding** – funding to cover the costs of arranging interdisciplinary seminars. A series of six seminars approaching aspects of the megalopolis from a wide variety of academic disciplines, and a symposium on uncertainty in climate modelling have been funded under this scheme.
- **Visiting Scholar Award** – this fund covered the costs of bringing an internationally recognised speaker to UCL. The speaker, Professor John Friedman, had cross-disciplinary appeal and addressed an urban sustainability issue.
- **Staff Exchange** – this provided a follow on fund for the Open Programme participants, it paid for teaching buyout, allowing the participants to spend time in each other's departments while working on a cross-disciplinary research idea.
- **MSc Competition** – each award from this competition was awarded to a pair of academics. Awards were won for interesting urban sustainability research projects, the award (£6,000) was then used to pay an MSc student, co-supervised by the academics. The MSc student received funding for their course fees, and a small stipend, in return for providing research assistance.
- **Sandpit Funding** – Bridging the Gaps has held two sandpit events, each event has taken a group of academics out of their usual workplace for two days. Over the course of the sandpit, sustainability challenges and possible solutions were identified (based on nanotechnology in the first sandpit and networked sensors in the second). Research projects were then devised from the intersections of challenge and possible solution. Each sandpit distributed a fund of £30,000 between the research groups. The majority of participants in the sandpits did not know each other before the event.
- **Escalator Funding** – the escalator funds are only available to previous participants, and are designed to allow the most promising research collaborations to continue. Not all the escalator funding has been distributed at this point in time.
- **Grant Writing Support** – This fund provided a fund to help a pair of academics write a cross-disciplinary grant application. The funding was

used to pay for an assistant to work on the grant application with the researchers.

- **Champion's Events** – These events are held for our departmental representatives. A typical event involves a visit to a department where we find out about the work of their research groups. The links formed through these events are not included in the above diagram.

How the programme works

The most basic requirement for funding under Bridging the Gaps is that the money goes towards urban sustainability research that crosses disciplines. In most cases this meant that we were looking for an interesting research idea in the area of urban sustainability that came from two (or more) academics from different departments.

Another important requirement of the programme is that it is funding new research collaborations. To try and ensure that the programme helps to build new collaborations, funding has only been awarded to collaborations where the partners have not been funded on a research grant together.

We did not want to exclude people who knew each other, and in any case, this would have been very difficult to police. The programme would still be successful if it could take a pair of academics (from different departments) who had been discussing an idea, but who had, for lack of funding, been unable to take it any further than an interesting idea they had discussed over coffee.

The programme as a whole has seen a fair number of purely novel collaborations, for instance, most of the people who met at the two sandpits run by the programme had never met previously.

Different funding opportunities form different types of collaboration. For instance, funding opportunities like the MSc competition are more likely to bring together people who know each other. Whereas activities like the champion's network and the two sandpits bring together people who have never met. In fact in the case of the sandpit, we brought together groups of people who probably would not have met under other circumstances.

Each sandpit event had a focus on urban sustainability and a type of technology that could be used to address urban sustainability issues. In the first sandpit the area that we were examining for possible solutions was nanotechnology, while in the second we looked at the field of networked sensors.

We asked for an interest in sustainability issues, or a knowledge of the technology involved in the sandpit: nanotechnology for the first sandpit, and networked sensors for the second. In both cases most participants brought a knowledge of either the sustainability challenges or the targeted technologies, in a few cases a participant was well versed in both the technology and the challenges.

A small selection of the research ideas that have been funded by Bridging the Gaps is shown below:

Natural ventilation for greener and healthier buildings (Open Programme)	Bartlett School of Graduate Studies and Civil, Environmental and Geomatic Engineering
Investigating the potential of the slime mould organism [Physarium polycephalum] as an architectural-biological sensor and indicator of environmental change (Open Programme)	Bartlett School of Architecture and The Cancer Institute
Building a system schematic and simulation model of the London water supply and its dependence on the Thames Basin (Open Programme)	Civil, Environmental and Geomatic Engineering and Chemical Engineering
Questioning the sustainability of post-industrial urban landscapes (Open Programme)	Bartlett School of Planning and Geography
Enhanced laboratory experiments and field study for street-scale pollution dispersion modelling (Escalator Fund)	Civil, Environmental and Geomatic Engineering and Statistical Science
Children, Well-being and Disability: Re-visiting India (Escalator Fund)	Development Planning Unit and Leonard Cheshire Disability and Inclusive Development Centre
Community Mapping in Hackney: Community use and appropriation of Hackney Marsh, London (Open Programme)	Development Planning Unit and Civil, Environmental and Geomatic Engineering
Climate and Uncertainty Symposium (Seminar Funding)	Civil, Environmental and Geomatic Engineering and Statistical Science
Contribution of rooftop rainwater harvesting to the water supply-demand balance in London - a case study. (MSc Competition)	Civil, Environmental and Geomatic Engineering and Centre for Advanced Spatial Analysis
A New Hydride Fuel Cell Hybrid for Zero Emissions Vehicles. (MSc Competition)	Chemical Engineering and Chemistry
Duracoat: Using nanoscience to protect wood (Sandpit)	Bartlett School of Planning, Genetics, Evolution and Environment, Physics and Astronomy and Bartlett School of Graduate Studies
Climate change and the burden of water-related disease: evidence from urban areas of East Africa (Grant Writing Support)	Geography and The Institute of Child Health

What's my energy footprint? (Sandpit)	Civil, Environmental and Geomatic Engineering, Computer Science and Electronic and Electrical Engineering
Geographical Perspectives on Planning the Sustainable City (Open Programme)	Geography and Bartlett School of Planning

The selection above, taken from the 38 collaborations funded so far, gives an idea of the range of the topics covered by participants in the programme.

The Bridging the Gaps programme at UCL includes an assessment of the impact of our initiatives, what is presented in the next section are results from preliminary feedback. The final reporting for this programme will include quantitive data, including the number of papers and presentations, and applications for external grant funding. This paper, however, reports on the results of short feedback questionnaires and interviews with some of the participants of the programme.

Results

We were interested in how well Bridging the Gaps had been received and how effective it had been in fostering interdisciplinary collaborations.

Feedback was sought in four different areas: firstly details about the participant, including previous experience of collaborating with different departments; secondly, feedback about the research idea, particularly the importance of cross-disciplinary collaboration; thirdly, feedback about the role of Bridging the Gaps funding; and finally, about future plans for collaboration.

The feedback we have gathered so far includes participants from the sandpit events, the MSc competition and the open programme.

About the people

The feedback makes it clear that some participants are absolute newcomers to cross-disciplinary collaboration, while others see it as an absolute necessity for their research area.

> "It is essential to work with other departments as most of the research topics involve multi-disciplinary collaboration…" (LC)

The process of cross-disciplinary working was seen by most as broadly positive.

> "Collaboration across disciplines and departments is most of the time very fruitful as it provides you with an opportunity to complement skills and knowledge." (PH)

This is perhaps not surprising, as we are seeking feedback from a group of people who have not only been interested enough in cross disciplinary working to apply to the scheme, but who have also been successful in their application.

Even so, a number of difficulties with the process of cross-disciplinary working were expressed. For example one respondent (NK) found that collaboration can be "quite frustrating ... there is a reason why there is a gap", he explained that "sometimes it is impossible to build bridges, people can become entrenched".

A further issue is that most activities associated with the collaborations are in addition to the participant's usual duties. The time required for the collaboration was cited in a number of cases.

> "cross-disciplinary working can be very time consuming" (NK)

> "Researchers may spend time transferring knowledge to cross-disciplinary colleagues ... with no immediate benefit." (KJ)

Another negative was related to the longer term prospects of a collaborative research project, in particular the chances of securing significant external funding for the research idea.

> "despite [pushing] for more of it ... the research council peer review system hasn't entirely caught up with the reality of cross-disciplinary research." (RC)

This sentiment was echoed by KJ, who felt that cross-disciplinary grant applications put the applicant in "double-jeopardy" as the review panel would come from two or more research communities.

Overall, most participants felt that the negative factors were outweighed by the positive factors, and that this style of working was already necessary (in the case of LC), or soon would be:

> "it is inevitable that more cross disciplinary interaction is going to have to take place." (RB)

AO suggested that "if the problem is of a truly cross-disciplinary nature ... then the benefits will definitely outweigh the complexities."

NK felt that balancing the positive and negative factors was "very subjective" and choosing whether or not to work across disciplines was "about one's professional objectives and the things that make one's job worth doing."

About the ideas

In almost all cases the participants had not made a previous attempt to get funding for the research idea. In many cases this is because the exact idea did not exist before the participants became involved with Bridging the Gaps, in the case of the sandpit activities, described above, the ideas were generated as part of the event.

However, in some cases, the research idea, or elements of it are already being pursued, "this project is half related to some ongoing work" (RB).

Most respondents cited the value of a cross-disciplinary approach to their research idea. In the case of AO the research required theoretical understanding

of both chemical engineering and nano-scale processes related to energy conversion, making "a cross-disciplinary collaboration … necessary".

The reasons for seeking cross-disciplinary collaboration include the requirement for equipment or expertise that did not exist in the participants own department:

> "Energy efficiency is a function of many factors not studied in computer science departments" (KJ)

> "it allowed us to bring in … staff from other departments [with] skills that we would have been unable to provide ourselves" (PH)

> "Positive value … access to laboratory facilities to use specialist equipment" (LC)

As well as bringing in expertise, the collaboration was also seen as an opportunity for learning for the participants, LC commented that "I have gained … understanding outside my background".

Also cited was the ability to share laboratory facilities, or equipment. For example, JT found a benefit was that "the equipment in the two groups is shared and the researcher benefits from it".

RB felt that cross disciplinary working allowed him to take his "research into different areas and to a bigger audience", while AO felt that Bridging the Gaps had helped her to gain a "broader vision of the possible impact of her research".

A disadvantage of forming wholly new collaborations, such as happened at the sandpit events, was revealed, NK commented that the collaboration might not continue after Bridging the Gaps, as the topic "is too remote from my current research".

About Bridging the Gaps funding

In some cases Bridging the Gaps funding, or an activity run by Bridging the Gaps was essential to starting the collaboration. For instance, JT thought that his collaboration involving nanostructured catalysts "would have been very difficult without [the Bridging the Gaps sandpit]". More simply NK told us that "The entire project would not have been possible without Bridging the Gaps funding".

For KJ, the programme not only made introductions that would not have been possible otherwise, but also funded a research student to work on the project.

In other cases although it wasn't necessary, Bridging the Gaps did provide the impetus to start the collaboration.

> "[The MSc competition] did provide the incentive … and we might not have been creative enough to think of the idea on our own!" (RC)

> "it would have been much harder to get started [without Bridging the Gaps]" (RB)

Another option for the participants is that the research would have gone ahead in a different form, PH thought the work would have been "much more limited with less resources".

The resources provided by the programme translated into time (through teaching buy-out), research assistance, software and equipment.

In addition to the direct benefits, some participants gained skills from the other people that they were working with, JT reported that he had picked up the skill of how to "efficiently prepare for large funding" from another member of his group.

In the future

The final area covered by the feedback was the future plans of the participants. Do the participants plan to take their ideas further, and will they continue working across disciplines after their involvement in the programme is at an end?

In general respondents reported that as a result of Bridging the Gaps funding they were more likely to apply for external grant funding for cross-disciplinary work, or that they had previously been active or interested in applying for cross-disciplinary research funding.

An example of the latter response comes from PH, "[cross-disciplinary working] was already part of my working practice", however, involvement in the programme has made her "think a bit more about cross-disciplinary research with other people at UCL.".

Cross-disciplinary working also introduces participants to different ways of working, "I liked the straightforward way physical scientists approach things" (NK).

In some cases Bridging the Gaps involvement is leading directly to an application for a larger fund. LC, for instance, has found that Bridging the Gaps "is helping us to get some preliminary results that can support [an application to] a larger fund such as FP-7 or EPSRC."

As part of the feedback about future plans, the respondents were asked to identify obstacles to cross-disciplinary working.

AO identified the challenge as finding someone who can look at "exactly the same question ... but from a different perspective."

A response that has come through from both this exercise, and informal feedback, was lack of funding, summed up by LC as "Money is the huge obstacle".

The issue of time was once again raised when suggesting what might help future collaborations.

One participant (NK) wanted "more time available to do research in general". An alternative to giving academic staff more time to do research, through teaching buyout, for instance, is to provide research assistance, AO suggested a fund that

would pay for short-term research assistance "to explore whether certain ideas would work".

Information about what is available across the university, in terms of both people and equipment, was suggested as something that would assist collaborations.

PH thought that "better knowledge about other departments and … staff" would assist cross-disciplinary working.

LC wanted to have access to a list of "all the specialist equipment held by UCL", as this would not only avoid the risk of duplication, but could also act as a guide when seeking partners for a collaboration.

RC stressed the importance of being open to the other participants in a collaboration. He feels that collaboration can work when the parties are " genuinely interested in collaborating and learning from each other." Whereas collaborations are less successful when the interest is in the "multidisciplinary pot of cash and [the team] cobbles together a proposal without taking the trouble to talk to each other in detail beforehand".

Another obstacle (mentioned by NK) was the disciplinary nature of the Research Assessment Exercise (RAE), a periodic review of the quality of the quality of a university's research. The RAE, and its successor the Research Excellence Framework (REF), can have a significant impact on a department's funding. This is a similar concern to the concern about panels assessing research grant application.

Continuing feedback

The Bridging the Gaps programme, and gathering feedback, are ongoing exercises. A fuller exploration of the issues will be possible at the end of the programme.

Conclusions

It can be seen that the participants in the Bridging the Gaps programme were open to the idea of cross-disciplinary working. In some cases this style of working was already familiar to them, in others it was seen as a vital component of their research.

It is recognised that we have a self-selecting sample in this work, it is probably no surprise that people who took the time and effort to make an application would be aware of cross-disciplinary research, and find it attractive enough to want to get involved.

However, this was not the only focus of the feedback exercise. Participants not only identified positive aspects of cross-disciplinary research, they also highlighted the negative factors, particularly the time taken and the complexities involved.

The value of this feedback exercise lies in identifying areas where the benefits of the approach outweigh the negative aspects, and ways in which the barriers to collaboration can be overcome.

Apart from funding, and some preliminary work does not require large amounts of funding, it seems that the most valuable thing for researchers is information. Information about who is interested in collaborating on research, and information about what facilities are available. Running the Bridging the Gaps Champion's Events has shown us how quickly researchers come up with ideas for collaborations when they meet research groups and get a chance to hear about their research.

Some of the barriers mentioned, such as "entrenched" individuals, are difficult to address, and others, such as peer review, are beyond the scope of the university. However, it seems it would be possible to lower the barriers to crossing disciplines by compiling and maintaining a database of research groups and available facilities. Another useful piece of intelligence is upcoming grant funding opportunities for cross-disciplinary research.

A useful exercise would be to maintain the network of departmental champions, or something like it, after the programme has finished, although networks such as this do require some maintenance.

Looking beyond the university, it is clear that the participants in this research feel that the increasing calls for cross-disciplinary research, encouraging researchers to network and collaborate, must be matched by a system that understands cross-disciplinary research. At the moment, there is clear frustration that many aspects of the system (grant proposals, journal reviewers and Research Assessment Exercises) seem to undervalue cross-disciplinary working, or at least be unsure of how to properly assess it.

In conclusion, it is clear from this exercise that cross-disciplinary working is seen as the future, or indeed the present, for many of the participants. It is also clear that cross-disciplinary working presents challenges beyond the usual responsibilities of an academic staff member.

At its best, the Bridging the Gaps programme, has allowed researchers to take a more problem-focused approach to the urban sustainability issues. It has done this by overcoming the barriers associated with crossing disciplines, and allowing intelligent people, with different skills, to focus on the same problem.

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