

WORKSHOPS AS EMBYRONIC BOUNDARY OBJECTS FOR COLLABORATIVE UNIVERSITY-INDUSTRY INNOVATION IN CONSTRUCTION

Chris Stokes¹, Patricia Carrillo and Andrew Dainty

¹ School of Civil and Building Engineering, Loughborough University, Loughborough LE11 3TU, UK

The authors participated in different capacities in a project originally conceived for the transfer of knowledge from university-based research to the engineering-construction industry. The project's original aim was 'to collect knowledge from across the [...] portfolio' of a university research centre and re-package this knowledge to meet the business needs' of the member companies of an engineering-construction industry association. We took the opportunity the project created of exploring whether and how the social worlds of construction academics and engineering-construction industry practitioners might cooperate to create the conditions for collaborative innovation in spite of differences of a kind often deemed to be barriers to university-industry collaboration. Through an analysis of the project's unfolding between construction-industry and academic parties, we first reveal some of the apparent differences between them and then consider the possibility that boundary objects might facilitate cooperation for innovation without eliminating the differences. We pay particular attention to workshops as boundary objects.

Keywords: innovation, knowledge transfer, technology transfer, university-industry links.

INTRODUCTION

There is widespread agreement these days that knowledge produced by research is essential to much innovation and thus to sustainable economic growth. That agreement does not extend, however, to the ways in which knowledge should be produced. For the consensus about research governance that characterized the decades following the second world war, in which scientists were entrusted with the safekeeping of science, and politics was excluded from it (so that science could speak truth to power), is long dead. Policy researchers have collectively torn up the linear model of innovation now regarded as having underlain the post-war consensus and with it the usually unspoken assumption that basic science could be relied upon to keep society's larder stocked with the knowledge required for the innovations that would secure continued economic growth.

In its place, numerous conceptions of the proper place for research in society currently vie with one another. Mode 2 (Gibbons *et al.* 1994) is perhaps the best known and

¹ c.a.stokes@lboro.ac.uk

most widely admired. It has many adherents in the policy making community. Academic promoters are to be found in numerous disciplines, notably research policy and mainstream organization and management studies (OMS) in Europe. Others have stronger followings in the US, such as engaged scholarship (Van de Ven, 2007). The so-called co-production of knowledge is another close relative flourishing in Europe. After it won support in mainstream organization and management studies in the UK in recent years (see e.g. Knight and Pettigrew, 2008), several construction management researchers have recommended it as an approach to doing research in construction management (Stokes and Dainty, 2011). While they hedge their advocacy by endorsing co-production as a complement to, not a replacement for, other approaches, they nevertheless say that 'one thing is for sure' – that the CM research community needs more research in the co-production mould (Green, Kao and Larsen, 2010: 126).

In theory, the direct participation of potential beneficiaries (and possibly other stakeholders) in the co-production or mode-2 production of knowledge assures its exploitation. Nevertheless, whatever the merits of heterodox ways of organizing research, we presume that traditional forms of knowledge transfer will continue to thrive. Imagine a future landscape in which many more problems are solved through mode-2 and similar forms of knowledge production than at present. Leave aside whatever knowledge emerges from more orthodox endeavours. For the new knowledge produced in these problem-solving efforts would there not in general be more potential beneficiaries and/or stakeholders than could typically be accommodated as research participants? These will need to be served by knowledge transfer or variants of it.

We use the term 'knowledge transfer' here to refer to practices intended to bridge knowledge production and exploitation by transferring knowledge (or technology) once it has been produced from its producers to potential beneficiaries for subsequent exploitation. (This usage, usually associated with innovation, is different from the common and more generic usage in knowledge management, where 'knowledge transfer' usually refers to the movement of knowledge within a business or an industry and not necessarily for innovation.) Traditionally, knowledge-transfer practices were conceived of as working one-way like this. Their intent was dissemination, a word still frequently used unselfconsciously by academics. In recent years these practices have been joined by others promoted as surpassing or at least complementing unidirectional technology and knowledge transfer – for example knowledge exchange, knowledge brokerage (Meyer, 2010), knowledge mobilization (Levin, 2008) and K* (UNU-INWEH, 2012).

The idea that knowledge production and exploitation need bridging by knowledge transfer or to be more intimately interwoven in new modes of knowledge production underlines their separation in the thinking and practice of researchers, policy makers and lay observers. One way this manifests itself is in explanations for why innovation systems are not more effective. Bruneel *et al.*'s (2010) categorization of barriers to university-industry collaboration is typical in seeking to attribute limitations of the innovation system to differences (actual and perceived) between what we might call, after the symbolic interactionists, 'social worlds'. This perspective usually neglects however the possibility of cooperation without consensus – without, that is, complete alignment of practices and elimination of differences. This is, of course, a possibility that Star and Griesemer (1989) reckon may be realized through systems of what they call 'boundary objects' combined with associated work practices such as methods standardization. Our aim is to assess the possibility that boundary objects might be

fashioned to coordinate the efforts of university-based construction researchers and engineering-construction industry practitioners to generate knowledge-based innovation and thus avoid the necessity of eliminating the differences. We pay particular attention to workshops as embryonic boundary objects.

As the knowledge-transfer project and the reflexive research we have been conducting on the back of that project are yet to be completed, this paper can make only a limited contribution. What we have been able to demonstrate on a practical level is the messy complexity that knowledge transfer can take on even in circumstances that on their surface may lead one to expect simple efficiency and even when we confine our attention, as we do here, to the early stages of collaborative university-industry innovation, that is the facilitation of tie formation between potential innovation partners. Theoretically, we consider the shaping of objects that may in time become boundary objects. We do this in particular by treating workshops which we organized, participated in and observed directly in our knowledge-transfer project as boundary objects in the making. The boundary object (Star and Griesemer, 1989) has become an extremely popular concept with all manner of social scientists and humanists. Frequently, however, researchers have neglected certain dimensions of the concept that Star regarded as important (Star, 2010). We have been careful to take full account these dimensions.

METHOD

Our study is based on the involvement in different roles of all three authors in the knowledge-transfer project whose unfolding we outline in the following section. Stokes, employed as a research associate, has the role of facilitator. Carrillo is the principal investigator, that is the academic who leads the project, controls the money in its budget and is responsible for its final report. She took over as principal investigator from another academic three months into the project when he retired; for the first three months, she was formally a co-investigator. Dainty is a co-investigator, that is an academic who is participating in the project alongside the principal investigator but without budgetary control and without ultimate responsibility for final reporting.

In the original proposal, the project is defined as a knowledge-transfer project and makes no provision for research. At the outset, however, the first principal investigator encouraged Stokes to regard it additionally as an opportunity for research. At first, the investigators and Stokes expected the topic that the project would offer the best chance to research would be communities of practice because of the importance the original proposal gave to communities of practice. As our account of the research below indicates, this expectation dwindled rapidly in the first months of work as negotiations between ITA and those engaged in the knowledge-transfer project at Erewhon led to a new focus on the use of existing ITA activities – in particular, workshops and ITA's annual conference – as the vehicles that would be used for knowledge transfer. The research element of the project is a case study of the knowledge-transfer project. Data was collected mainly by Stokes in a participant-observer capacity. Stokes and Carrillo had access too to a large amount of documentary data that had been accumulated by the research centre, ARC (see below). Their access was greatly facilitated by the research centre's coordinator, who knew his way around the structure of the data directories in which the data had been stored, so to speak. We have used pseudonyms for many of the actors involved in the project for reasons of confidentiality.

THE CASE

ARC and ITA

ARC was a research centre at Erewhon University funded for the ten-year period 1999–2009 by a research council. The researchers who held ARC grants came from several academic departments. Those in the construction department, more than half in construction management, received the second largest departmental share of ARC research funds. With it, they conducted more than 30 substantive research projects.

ITA is an international engineering-construction industry association. Mostly project-based businesses, members range from large multinational corporations to SMEs. They include clients, contractors and consultants. Its mission is the continual improvement of members' performance, for which it runs three main activities – an annual programme of events, including a conference and a series of one-day workshops; a set of communities of practice focused on different aspects of the engineering construction business, some formed to address a single issue then disbanded, others, formed long ago, focusing on an indefinite sequence of issues; and a publishing programme, which produces guides, training manuals and reports.

COPIER

A year before ARC was due to close, an academic in Erewhon's construction department obtained funding from the university for a knowledge-transfer project that aimed 'to transfer the knowledge created by [ARC] to the engineering construction sector through the creation of a [c]ommunity of [p]ractice (CoP) between [ARC] and [ITA]'. We shall refer to the project as COPIER. The funding came from a fund the university had won from the same research council that had funded ARC for its ten-year lifetime. One of several held by UK universities, it is specifically for work that overcomes the obstacles standing between the research the research council normally funds and its better exploitation.

The academic who wrote the proposal for COPIER left Erewhon unexpectedly before it started. COPIER consequently began several months late and with a substitute academic at its helm. Two important knock-on effects followed. First, by the time it began, the project had to be completed in one year, not the 18 months first planned. Secondly, a project coordinator was recruited three months after COPIER started on a six-month fixed-term contract to provide marketing and other support to the project leader and the research associate.

In spite of substantial existing links between Erewhon and ITA, the first weeks of the project saw not only its fundamental shape but its very existence threatened. ITA's officers, it transpired, could recall only barely, if at all, having heard of the project or the knowledge-transfer idea behind it. Without their cooperation, COPIER could not proceed. The director of ARC, academic leader of COPIER for its first three months (until retirement), responded by holding discussions with ITA managers and, with two of the authors (Stokes and Carrillo), re-worked the proposal, written for internal university use only, into a form in which it could be respectably presented to a forthcoming ITA board meeting.

The resulting document retained the original proposal's knowledge-transfer aim, a list of the ARC projects likely to be of most interest to ITA members and a list, slightly modified from the original, of the activities by which the aim was to be realized. The main ones were: 1) a web-based repository of the knowledge produced by ARC repackaged for easy search and assimilation by practitioners; 2) masterclasses, which

the COPIER team hoped would appeal to ITA members, used as they were to masterclasses ITA had long been running for them; 3) contributions to ordinary workshops in ITA's annual workshop programme and its annual conference; and 4) one-to-one knowledge packages, comprising an expert diagnosis of the knowledge needs of a member company followed by advice on how to realize them.

Towards the end of COPIER's first month, the ITA board meeting took place. In presenting the revised proposal, the COPIER team, anxious to win the board's approval and so avoid the closure of the project, emphasized that the set of knowledge-transfer activities it outlined was open to negotiation. They welcomed ITA and its members to propose modifications to them or indeed additional activities – activities with which they might be more comfortable.

In a bid to give some momentum to the process – fundamental to this knowledge-transfer project but now behind schedule – of identifying interests shared by ARC academics and ITA members, the team also presented a one-page summary of a single ARC research project – a project the team judged likely to be one of the most amenable to industrial application. Written in plain language, it was divided into sections – abstract, start and end dates, background, approach, results, stage of development, application domains and intellectual property – and ended with a table with contact details for the lead researcher, a list of collaborators and a list of related ARC projects. If acceptable to ITA, the team suggested, the format could be used for summaries of all 30-odd construction-related ARC projects.

The ITA board responded positively to the proposal. They were receptive to the project summary too but requested a set of briefer summaries for the ARC construction research projects in the first instance to save time. The COPIER team produced the summaries in tabular form and ITA sent a copy to each of their communities of practice with a request for an initial indication of the projects of most interest to them. When this drew no useful response, ITA sent the project summaries to the ITA contact at each of its members. After this too failed to get a response, ITA and the COPIER team met to decide how to keep the project alive.

At this meeting the decision was made in a straightforward manner. The ITA managers leafed through a printed copy of the project summaries, picked out projects they thought most likely to interest their members, and invited the COPIER team to organize the next regular ITA workshops with themes derived from their selection of ARC projects. The invitation to run ITA workshops surprised the COPIER team but with three and a half months of the project already behind them they accepted. In what follows, we focus on the organization of the workshops that stemmed from this decision, which came to be central to COPIER. We touch on other parallel COPIER activities only in so far as they help in our analysis of workshop organization.

WORKSHOPS

If, as the ITA managers hoped, the roughly monthly frequency of ITA's workshops was not to be disrupted, the first ARC-ITA workshop would need to take place in two month's time. The discussions and negotiations that took place between the COPIER team and the ITA managers over the next few weeks as the former tried hurriedly to organize that first workshop turned up several differences that challenged their agreement. The innocuous label 'workshop', it emerged, held different meanings for the COPIER team and the ITA managers. For academics, workshops are primarily occasions, staged towards the end of a research project, for what they often still term

'dissemination' (in spite of its one-way knowledge-transfer connotation) of their research findings. ITA workshops, as the COPIER team learned from attending two in the weeks following their agreement, were occasions for construction-industry professionals to hear from industry peers how they or their company had handled a particular problem or implemented a new process and what the results had been. The following are some of the differences that most struck the COPIER team.

1. The ITA managers believed that the COPIER team would be able and willing to enlist the speakers for their workshops from construction businesses that had collaborated in ARC research. The lead COPIER researcher had later to make clear that this would likely not happen because researchers are rarely comfortable risking their relationship with collaborators by asking favours of this magnitude of them.
2. Their annual subscription fee entitles member companies to send delegates to ITA workshops free of charge. Non-members must pay a substantial fee. The COPIER team argued, however, that it would be wrong to charge ARC-ITA workshop delegates because the research findings to be disseminated came from publicly-funded research. ITA made concessions for Erewhon construction academic delegates but insisted on charging others as normal. Otherwise, they feared, ITA members would think they were subsidizing non-members.
3. The COPIER team proposed to hold the first workshop at a conference centre on Erewhon's campus, which they had used before and rated highly. The ITA managers were not in favour. They usually choose hotels at or near airports for workshop venues. As an international body, they need to make their events accessible to delegates outside the UK. They worried too that a university venue might deter some by creating the impression that the workshop would be academic.
4. A researcher who showed interest in leading an ARC-ITA workshop was one of the few ARC researchers who had worked with ITA in the past. He suggested the workshop comprise short presentations from six to eight industry speakers. Accepting the task of enlisting one from a blue-chip engineering construction company, he suggested ITA would enlist the others through their industry contacts. The ITA managers were not sympathetic, because they had passed organization of the workshops to the COPIER team and expected them to enlist the speakers and because the proposed format deviated too far from the model they were accustomed to, with three or four speakers in the morning and breakout group exercises in the afternoon.

These were not the only differences COPIER encountered. Some of the ARC researchers were unenthusiastic about participating in COPIER at all. Several, for example, had completed their ARC-funded research some time ago. One explained that he had already disseminated the findings of his research in events he organized for industry towards the ends of his projects and if he now presented those findings in new workshops, some in the audience might ask why he was re-presenting old research findings.

BARRIERS AND BOUNDARY OBJECTS

At the time of writing (the ninth month of COPIER), one ARC-ITA workshop has been held, another is to be held next week and for the one other, due in month 12, speakers have been engaged and a venue provisionally booked. To the best of our

knowledge, no strong new innovation-oriented connexions between ARC researchers and ITA members have arisen (yet) as a result. One might respond by looking for evidence that barriers to innovation through university-industry linkages are getting in the way. Are there not signs in the ARC-ITA differences described above, for example, of a cross-boundary ‘mutual lack of understanding about expectations and working practices’, one of the barriers defined by Bruneel *et al.* (2010: 862). On the other hand, the differences that surfaced in the organization of the workshops has not (yet) led to their abandonment, even though the differences have not been uniformly eliminated. What then of the possibility suggested by the notion of the boundary object that the cooperation can flourish without consensus between cooperating social worlds? Might ARC and ITA cooperatively produce innovation without first restricting their collaboration to work for which they can find a consensus?

Susan Leigh Star coined the term 'boundary object' for an object (not necessarily a material one) through which the work of more than one social world is coordinated (Star, 1989; Star and Griesemer, 1989) in the crafting and working out of what for at least one of those social worlds is a ‘coherent problem-solving enterprise’ (Star and Griesemer, 1989: 392). It has, of course, been taken up by many since and spread from science and technology studies to many other fields. (See Trompette and Vinck (2009) for an overview.) Organization and management studies (OMS) has been among the most receptive, and, as Zeiss and Groenewegen (2009) point out, those in OMS who make use of the concept, like researchers in other fields, frequently turn to one particular passage in Star and Griesemer’s paper for their definition of the boundary object: ‘Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites.’ (Star and Griesemer, 1989: 393)

In a recent paper, Star clarified some matters that were not very clear in that 1989 paper. Defining the boundary object now as having three dimensions, she hinted that very often other researchers who have used the term had recognized only one. This is the boundary object’s interpretive flexibility, something she thought the boundary object had become ‘almost synonymous with’ (Star, 2010: 602). Of the overlooked two, one has to do with the ‘material/organizational structure of different type of boundary objects’. Boundary objects are – or, one might say, bring in train – a set of working arrangements, which vary from one to another. As such, the concept is most useful in studies at the organizational scale (Star, 2010: 612–613).

The third dimension follows from the plastic-yet-robust aspect of boundary objects. Between social worlds, a boundary object is ‘ill structured’ (Star, 2010: 604), which is to say it has no single clear, precise meaning or use or significance. Within each of those social worlds, however, it has a more specific use and is ‘therefore useful for work that is NOT interdisciplinary’ (Star, 2010: 605; emphasis in the original). So members of the cooperating social worlds switch – Star says ‘tack’ – continually between the ill-structured interdisciplinary and customized disciplinary forms of the object.

Acknowledging Star’s point that when boundary objects facilitate cooperation, they usually do so in sets or systems rather than alone (Star, 2010: 602), we now consider whether the ARC-ITA workshops can properly be likened to boundary objects. First we look at the framing of the cooperation and the set of boundary objects involved. Then we look at the three aspects Star attributes to boundary objects in turn.

Of the multiple ways in which we might frame cooperation between Erewhon's construction department and ARC on the one hand and ITA and its members on the other, we choose one in which innovation is the coherent problem-solving enterprise on which these different social worlds work together. We prefer innovation here to knowledge transfer. The latter smacks too much of the academic perspective; on the whole, ITA members, for example, do not, we suppose, concern themselves with anything they call 'knowledge transfer'. They do, however, do innovation, for example by improving existing or creating new products or services. So too do construction academics. They seek to publish original (i.e. innovative) work and increasingly to engage users and other stakeholders, often industrial, in that work's exploitation. Recall the aim of the fund awarded to Erewhon by the funding council that funded ARC. This fund, the source of the COPIER grant, was to overcome the obstacles between the research funded by the research council and its better exploitation.

The workshops are the object in which we are primarily interested, but they operate in concert with other objects we might tentatively identify as boundary objects (without examining them here in the same details as workshops). Here are two examples. There is what the revised COPIER proposal called a 'web-based knowledge repository of the new knowledge created by [ARC]', a collection of COPIER-developed 'snapshots' rendering ARC findings 'readily searched, understood and assimilated by [ITA] members'. This includes the brief summaries of the 30-odd construction-related ARC projects prepared by the COPIER team and sent by ITA to its communities of practice and its members. Repositories are one of the classes of boundary object listed by Star and Griesemer (1989: 410). Another boundary object in the COPIER collaboration is innovation itself, which appears to fit the ideal type class of boundary objects also listed by Star and Griesemer (1989: 410).

Of Star's (2010) three aspects of boundary objects, we can quickly dispense with interpretive flexibility. Workshops clearly exhibit interpretive flexibility. For many construction academics, workshops are, among other things, a means of disseminating a research project's findings to groups of stakeholders towards the end of the project. Events labelled 'workshops' have been a normal feature of the annual programme of events ITA organizes for its members since 2010. In that year, ITA substituted workshops for the masterclasses they had been running for several years. They saw in workshops the possibility of a more egalitarian activity. Usually one-day affairs, they are events of two halves. In the morning, a handful of experienced engineering-construction industry practitioners give presentations on a practical construction-management topic, each followed by time for questions from the delegates. In the afternoon, delegates do exercises related to the topic in small groups. These are designed to stimulate peer-to-peer learning. This is a key element of the rationale and the characteristic that not only distinguishes ITA workshops from their (discontinued) masterclasses (and from academic dissemination workshops) but also constitutes an important selling point. ITA managers believe it attracts new delegates – delegates they feared were being put off in the past by the master-pupil impression conveyed by the term 'masterclass' and by their one-presenter format.

The second of Star's three aspects – their material and organizational structure and the work practices they entail are less easy to make out in the not-yet-routinized relationship still developing between the COPIER team and ITA. We can nevertheless discern some of their lineaments. The plain-language summaries of ARC projects and their compilation mentioned above are an obvious example. As COPIER proceeded,

other tasks the COPIER team performed in organizing ARC-ITA workshops (and similar events, such as a session at the annual ITA conference and a one-day seminar for a learned institution not connected with ITA), recurred often enough to appear liable to become a regular requirement. A notable example was the compiling of thumbnail biographies of ARC researchers (and non-ARC speakers where appropriate). These were included in the flyers used to publicize the workshops and attract delegates. They often made a point of stressing the researchers' connections with industry, identifying companies they had collaborated with in their research and any companies they had worked for in the course of their careers. The COPIER team drafted them where possible from biographical material the ARC researchers had on their university web pages, but they took pains to remove from them elements they thought unlikely to appeal to industry practitioners as opposed to fellow academics.

We think it important to point out that neither of these tasks (and the resulting summaries and biographies) should be taken at present to have stabilized. They are still open to re-negotiation, to revision, refinement and even abandonment in the light of feedback from workshop delegates or second thoughts on the part of the COPIER team. So they point to the ongoing development of what might turn out in time to be boundary objects. The third aspect – the tacking back and forth between between the ill-structured interdisciplinary and customized disciplinary forms of the object – raises some evocative difficulties. It requires, in Star's formulation, that the disciplinary forms of the object have uses that are not interdisciplinary. For example, in Star and Griesemer (1989), the standardized forms that amateurs completed and submitted to the Museum of Vertebrate Zoology along with the animal specimens they obtained served a purpose within their own social world that did not depend on the scientific use to which they were put by the museum's director. Star and Griesemer do not say what this use was but we might surmise that they conferred kudos on the collectors among their fellows much as reports that amateur birdwatchers nowadays submit to county recorders do.

For most objects identified as boundary objects, the object is used in its different social worlds largely out of site of the others and this no doubt helps in avoiding the necessity there otherwise might for endless negotiation between social worlds. Because workshops like the ARC-ITA workshops involve the co-location in time and space of members of the different social worlds involved in the common problem-solving enterprise, they have not enjoyed what we might call the privacy of more run-of-the-mill boundary objects. In other words, much of what ARC researchers might do in or to a workshop as a part of their disciplinary customization of the form will inevitably be visible to industry practitioners attending as delegates and to ITA managers who are present. Where such practices do not agree with their conception of a proper ITA workshop, they may prompt new negotiations over the form of ARC-ITA workshops.

With only one ARC-ITA workshop held so far, it would be premature to pronounce on whether this renders workshops strictly inadmissible as full-blown boundary objects in accordance with Star's (2010) definition. We imagine that the impressive openness of the workshop form in general means that it may well accommodate arrangements that minimize the visibility of social-world-specific features of the disciplinary uses of boundary objects and thus enable them to work as boundary objects nevertheless. We shall be observing developments in this regard very closely in the remaining months of the COPIER project.

CONCLUSIONS

'Each social world has partial jurisdiction over the resources represented by that object, and mismatches caused by the overlap become problems for negotiation' (S&G, 1989:412)

REFERENCES

- Bruneel, J, D'Este, P and Salter, A (2010) Investigating the factors that diminish the barriers to university–industry collaboration. "Research Policy", **39**, 858–868.
- Cooper, A, Levin, B and Campbell, C (2009) The growing (but still limited) importance of evidence in education policy and practice. "Journal of Educational Change", **10**, 159–171.
- Gibbons, M, Limoges, C, Nowotny, H, Schwartzman, S, Scott, P, Trow, M (1994) "The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies". London: Sage.
- Green, SD, Kao, C-C and Larsen, GD (2010) Contextualist research: iterating between methods while following an empirically grounded approach. "Journal of Construction Engineering and Management", **136**(1), 117–126.
- Knight, L and Pettigrew A (2008) Explaining project outcomes in collaborative research: initial findings from an AIM study [conference presentation]. Presented at Advanced Institute of Management Research conference "Conference on High Impact Collaborative Research", 24 April 2008, CBI Conference Centre, London.
- Meyer, M (2010) The rise of the knowledge broker. "Science Communication", **32**(1): 118–127.
- Orr, J (1986) Narratives at work: story telling as cooperative diagnostic activity. "CSCW '86: Proceedings of the 1986 ACM conference on Computer-supported cooperative work", 62–72.
- Star, SL (2010) This is not a boundary object: reflections on the origins of a concept. "Science, Technology and Human Values", **35**(5), 601–617.
- Star, SL and Griesemer, J (1989) Institutional ecology, "translation," and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–1939. "Social Studies of Science", **19** (3), 387–420.
- Stokes, C and Dainty, A (2011) Knowledge co-production in construction management research. In Egbu, C and Lou, ECW (Eds.) "Proceedings of the 27th Annual ARCOM Conference", 5-7 September 2011, Bristol, UK, Association of Researchers in Construction Management, 117–26.
- Trompette, P and Vinck, D (2009) Revisiting the notion of boundary object. "Revue d'Anthropologie des Connaissances", **3**(1), a–v.
- UNU-INWEH (United Nations University Institute for Water, Environment & Health). (2012) KStar. [4 May 2012]
URL:<http://www.inweh.unu.edu/River/KnowledgeManagement/KStar.htm#KStar>
- Van de Ven, A (2007) "Engaged Scholarship: A Guide for Organizational and Social Research". Oxford: Oxford University Press.
- Zeiss, R and Groenewegen, P (2009) Engaging boundary objects in OMS and STS? Exploring the subtleties of layered engagement. "Organization", **16**(1), 81–100.