INTEGRATIVE INFRASTRUCTURING FOR GLOBAL COLLABORATION

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Research paper

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Abstract

Technological growth has amplified the possibilities and necessity for collaboration across geographic borders. The sociotechnical systems which arise from and are developed to support such collaboration must transcend national boundaries, cultures and organisations. This paper is a response to the question of how we can make such sociotechnical systems flexible, sustainable and participative. To this end, we use infrastructuring (a mode of participatory design) as a theoretical framework for an action research intervention into the development of a Learning Management System (LMS) to support collaboration between Australian and Chinese universities. Based on our findings, we propose interweaving the concepts of infrastructuring and publics as an innovative, synergistic theoretical response to the challenges of implementing sociotechnical systems in a global context.

Keywords: Infrastructuring, Participatory Design, Global Collaboration, Action Research, Higher Education, Learning Management Systems (LMS)

1 Introduction

Technological growth has amplified the possibilities and necessity for collaboration across geographic borders. The sociotechnical systems which arise from and are developed to support such collaboration must transcend national boundaries, cultures and organisations. However, there are numerous challenges involved in developing and implementing sociotechnical systems in complex, transnational contexts. This paper addresses these challenges and asks the question: how can we make sociotechnical systems comprised of networks of actors from different institutions, locations and cultures flexible, sustainable and participative?

To respond to this question, the paper proceeds as follows. Firstly, we perform a literature review to identify the challenges involved in implementing sociotechnical systems in a global context. We also propose infrastructuring (Ehn, Karasti, Pipek, & Dittrich, 2014; Le Dantec & DiSalvo, 2013; Pipek & Wulf, 2009) as a mode of participatory design and as a theoretical starting point for thinking about these challenges. Next, we outline our action research approach. We then present a real-world problem situation of infrastructuring to support a transnational partnership between higher education institutions by means of a Learning Management System (LMS). Finally, we reflect on the practical and theoretical implications of our findings for developing sociotechnical systems for global collaboration.

2 Global Collaboration

To address the challenge of designing flexible and sustainable sociotechnical systems involving actors from different countries, we must first identify the barriers to which global collaboration gives rise. The ensuing review considers the barriers identified in IS literature. Sociotechnical systems which transcend national boundaries are becoming increasingly prevalent, facilitated by new technologies. Correspondingly, there has been an influx of IS literature on sociotechnical systems design for global
collaboration (Allen, Kern, & Mattison, 2002; Kirsch, 2004; Levina & Vaast, 2008; Romano, 2007; Sahay, Saebo, & Braa, 2013; Shin & Edington, 2007; Su, 2015). In global projects, factors which are constants at a local level may become variables, and these variables give rise to uncertainty, complexity and risk (Lam, 1997; Shin & Edington, 2007; Tractinsky & Jarvenpaa, 1995). A review of the literature reveals six variables for global sociotechnical systems implementation which may become barriers impeding successful collaboration: culture, language, time zone and location, politico-economic climate, organisational factors, and technical factors. These variables can be broadly grouped into internal and external factors, summarised in Table 1.

<table>
<thead>
<tr>
<th>External factors</th>
<th>Internal factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture</td>
<td>Organisational factors (e.g. competency of participants, governance structures)</td>
</tr>
<tr>
<td>Language</td>
<td>Technical factors (e.g. specific ICTs deployed)</td>
</tr>
<tr>
<td>Timezone and location</td>
<td></td>
</tr>
<tr>
<td>Politico-economic climate</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Internal and external variables for global projects

The external factors to be considered in global collaboration have been investigated in the literature both separately and collectively. Ali et al. review the use of cultural models in IS research, noting that studies with cross-cultural agendas have increased to respond to the demands of globalisation (Ali, Tretiakov, & Crump, 2009). In the context of offshoring, Levina and Vaast investigate the numerous overlapping boundaries and status differences that emerge and must be renegotiated amongst participants in global projects to “establish effective collaboration” (Levina & Vaast, 2008). Cross-cultural boundaries overlap because internal organisational factors are embedded in broader social and cultural environments (Lam, 1997; Levina & Vaast, 2008; Shin & Edington, 2007; Tractinsky & Jarvenpaa, 1995). For example, cultures regarded as having a high power distance may also favour more hierarchical structures of power within the workplace (Hofstede, 1980; Krishna et al., 2004; Levina & Vaast, 2008). In her investigation of a British-Japanese joint venture, Lam sheds light on the “tacitness” and the socially embedded nature of knowledge which lead to difficulty in knowledge transfer between organisations in different cultures (Lam, 1997). Studies have been developed which offer approaches for navigating the barriers involved in cross-cultural infrastructuring (Bird & Osland, 2006; Carmel & Agarwal, 2001; Krishna et al., 2004; Leonardi & Barley, 2008). For example, Su deploys Bird and Osland’s model of cultural sensemaking as a way of bridging cultural differences between employees and enabling effective collaboration (Su, 2015; see also Brannen & Salk, 2000). Language differences, differences in time zones and geographic distance are also often noted in the literature as potential barriers to effective collaboration (Carlile, 2004; Levina & Vaast, 2008; Orlikowski, 2002; Tractinsky & Jarvenpaa, 1995). Other researchers foreground the embeddedness of internal/organisational factors in the broader politico-economic climate (e.g. different governmental requirements affect how an organisation is run and may impede the implementation of sociotechnical systems in a global context) (Ives & Jarvenpaa, 1991; Levina & Vaast, 2008; Tractinsky & Jarvenpaa, 1995).

These external factors manifest at an organisational level, in organisational and technical factors. In the context of their specific offshoring case study, Levina and Vaast identify four organisational-level manifestations of national differences. They identify differences in competencies (in financial services and business software development); differences in economic resources between onshore and offshore companies; differences in interpersonal connections (access to business users and senior manager); and social differences within companies (e.g. attitudes to authority) (Levina & Vaast, 2008). Similarly, Brannen and Salk situate the Japanese and German organisations in their case study within their broader cultural environments to pinpoint the influence of culture on organisational factors (Brannen & Salk, 2000). For example, they contrast “the importance of the individual” valued in the German
organisation to the “importance of the group” valued in the Japanese organisation, highlighting how these differences may become barriers. Tractinsky and Jarvenpaa argue that aspects of organisational IT can be examined from either a rational or a behavioural/political perspective. Thus they identify power and control structures (organisational factors), and information processing and communication requirements (technical factors) as key internal factors, disparities between which may occasion challenges for IS in a global context (Tractinsky & Jarvenpaa, 1995). Biehl cites “diversity in legacy software components” and technical issues as hindrances to the success of global IS implementation (Biehl, 2007).

The barriers discussed above must be identified, and then dismantled or negotiated in global projects. Levina and Vaast argue that the “effectiveness [of global collaboration] cannot be measured by objective outcomes alone (e.g., whether the project was completed on time or on budget)” (Levina & Vaast, 2008). They follow Hardy et al. and define effective collaboration “as a process that (1) leverages the differences among participants to produce innovative, synergistic solutions and (2) balances divergent stakeholders’ concerns” (Hardy et al., 2005; Levina & Vaast, 2008).

### 2.1 Global Collaboration in Higher Education

We now narrow the scope of our literature review to the deployment of sociotechnical information infrastructures to support global collaboration in the context of higher education. This enables us to identify more precisely the issues which are salient to our case study. Despite the growing relevance of global collaboration in higher education to IS research (Calway & Kwansah-Aidoo, 2011; Chapman, 2005; Cogburn, Levinson, Rammarine-Rieks, & Vasquez, 2010), there is a paucity of scholarship in this area which this paper aims to address.

Cogburn et al’s 2010 study, like ours, explores collaboration between geographically distributed higher learning institutions using virtual organisation models. Cogburn et al consider an earlier, “historic” project which connected several universities around the world, the underlying goal of which was “to better understand the sociotechnical infrastructure required to support cross-national teaching and learning models […]” This aligns with the goal of our study, although our study places more emphasis on the process of designing and implementing a sociotechnical infrastructure to support cross-national teaching and learning models. Cogburn et al identify three focus areas for developing sociotechnical infrastructures “to support transnational teaching and learning models and to build human capacity for a knowledge-intensive global economy” (Cogburn et al., 2010): technical infrastructure; social processes and pedagogy; and administrative infrastructure. Cogburn’s focus areas are endogenous. The broader literature on global collaboration provides a foundation for understanding how these focus areas are embedded in external social, cultural and economic environments. Cronin et al., in a study on communities of practice and networked learning in higher education, cite “[c]reating a real sense of connection between seven disparate groups of students around the globe and building a platform of trust” as a key challenge of global collaboration through ICTs (Cronin, Cochrane, & Gordon, 2016). In line with the educational angle of Cronin et al.’s study, the challenge they identify falls within the scope of Cogburn’s second focus area – social processes and pedagogy.

### 2.2 Infrastructuring for Global Collaboration

We now turn to infrastructuring to provide a discourse and theoretical foundation for exploring the challenges involved in the design and implementation of sociotechnical systems in a global context. Rolland argues that large-scale sociotechnical systems deployed in global contexts should be characterised as information infrastructures “because their deployment is often constrained by an installed base” (Rolland, 2000). Central to information infrastructures are standards: “limited set[s] of solutions to actual or potential matching problems directed at benefits for the party or parties involved, balancing their needs and intending and expecting that these solutions will be repeatedly or continuously used during a certain period by a substantial number of the parties for whom they are meant” (de Vries, 1999). Hanseth and Bygstad explore the growth in research on standards, which
they argue reflects a change in requirements of standards, due to a “rapidly changing world caused by, for instance, globalization processes”. New infrastructures must wrestle with the inertia of an installed base (Star & Ruhleder, 1995). When an installed base encompasses different organisational, technical and cultural processes, a tension arises between what Star and Ruhleder call a need for flexible, adaptable use on the one hand, and “the need for standards and continuity” (Star & Ruhleder, 1995). An installed base consists of not only technical artefacts but also social and institutional features (Iannacci, 2019; Star & Ruhleder, 1996). For example, in reference to e-infrastructure, Edwards notes that when developing new infrastructure, attention must be paid to not only the Internet and other existing systems but also to “human habits, norms, and roles that may prove intractable elements” (Edwards, Jackson, Bowker, & Williams, 2009, p. 366). The concept of information infrastructure has emerged to describe information systems shared by actors in a heterogeneous sociotechnical network, as large-scale information technologies have been increasingly deployed to facilitate information exchange in organisational and social practice (Hanseth & Monteiro, 1997). This wider view of information infrastructure encompassing more than IT is also used by Hanseth and Lundberg (Hanseth & Lundberg, 2001) in developing the concept of work oriented infrastructures. These are seen to comprise the shared resources of the community, consist of human and technological components, and have no strict boundary of what is infrastructure and what is not. This attention to the wider organisational context of a product or artefact to be implemented promotes sustainability and resilience (David Ribes & Finholt, 2007). This is especially important for projects involving global collaboration where cultural, organisational and technical differences increase the likelihood of project failure (Lam, 1997).

Pipek and Wulf extend the concept of work information infrastructure, devising a framework for infrastructuring, “a more comprehensive term for the creative design activities of professional designers and users” (Karasti and Syrjänen, 2006; Pipek & Wulf, 2009). Pipek and Wulf unpack the concept of work infrastructure and infrastructuring, tracing definitions through Science and Technology Studies (STS) literature. They use Star and Ruhleder’s eight salient characteristics of infrastructure as the foundation of their framework (Star & Bowker, 2002; Star & Ruhleder, 1996). Pipek and Wulf’s framework rejects the traditional designer/user dichotomy as well as the notion that design precedes use. It emphasises user innovation: a user is a “designer” who appropriates a new infrastructure for his/her local context. Thus in situ design, or design during use, takes place. To reflect this, they divide their model into two activity spheres (see Figure 2):

1) **work development activities** which consist of “all creative activities leading to the improvement of an individual’s or an organization’s own work practice, regardless of the purpose or goal of the work”;

2) **technology development activities** which consist of “all creative activities that contribution to the improvement of somebody else’s (individual or organizational) work practice, where this contribution is the main work purpose or goal”.

These activity spheres are organised around a “point of infrastructure”, which Pipek and Wulf define as the moment the infrastructure becomes visible to users. The point of infrastructure can be the result of either breakdown or “the local resolution of a reverse salient” (innovation). Although the model shows a single point of infrastructure, “points of infrastructure may show up repeatedly, perhaps even on a daily or weekly basis”. The model also captures the degree to which activities are targeted through its depiction of “infrastructural layers” of development activities (e.g. “infrastructural background work” is less targeted than “method-driven design activities”). Their model is reproduced in Figure 5.

Le Dantec and DiSalvo draw on this notion of infrastructuring as theorised by Ehn et al. (Le Dantec & DiSalvo, 2013). Le Dantec and DiSalvo interweave infrastructuring with the concept of “attachments” and “publics”, arguing that infrastructuring leads to the constitution of publics formed through attachments to shared issues. He defines a public as “a particular [and heterogeneous] configuration of individuals bound by common cause in confronting a shared issue” (Le Dantec & DiSalvo, 2013). Bringing “publics” into infrastructuring discourse shifts the focus from product design to “capacity
building and associative politics” (Le Dantec & DiSalvo, 2013). Le Dantec and DiSalvo’s argument is suited to cases of global collaboration for two reasons: (1) their definition of publics connotes the “plurality of voices, opinions and positions” which is especially marked in projects involving transnational stakeholders and (2) they shift the focus away from product design towards negotiating stakeholder interests to optimise environments to support and sustain new infrastructures.

In sum, infrastructuring provides a discourse and a theoretical foundation for navigating the barriers involved in global collaboration. These barriers must then be “mediated in practice” (Levina & Vaast, 2008). Actors implementing transnational sociotechnical systems must also “[balance] divergent stakeholders’ concerns” and look for “innovative, synergistic solutions” for “leverag[ing] the differences among participants” (Hardy et al., 2005; Levina & Vaast, 2008). Each of these theories in the literature on infrastructure offers different insights into the challenges of infrastructuring for global collaboration; they may be synthesised to provide innovative solutions. In this paper, we explore these possibilities by deploying an action research approach guided by Pipek and Wulf’s integrative infrastructuring framework (itself grounded in the broader literature on infrastructure and infrastructuring).

**Figure 1.** Pipek and Wulf’s infrastructural layers of technology development activities (Pipek & Wulf, 2009)

### 3 Research Approach

#### 3.1 The Research Method: Action Research

Action research is widely used in sociotechnical analyses. It is an interventionist approach which combines practical problem solving with the expansion and generation of theory (Baskerville & Wood-Harper, 1996; Checkland & Holwell, 1998; Hult & Lennung, 1980; McKay & Marshall, 2001). In action research, the researcher works within a conceptual framework to solve or ameliorate a realworld problem situation. During this process, the researcher is actively involved in the project and collaborates with participants (Baskerville & Wood-Harper, 1996; McKay & Marshall, 2001). Action research is traditionally conceptualised as a cycle linking theory and practice (Baskerville & Myers, 2004; Baskerville & Wood-Harper, 1998; Checkland & Holwell, 1998). However, in response to criticisms of action research as “little more than consultancy”, McKay and Marshall propound a reconceptualisation of the process of action research as a dual cycle: a research interest cycle superimposed on a problem solving interest cycle (see Figure 1). Their model re-emphasises the theoretical function of action research.
McKay and Marshall’s model of action research, which separates research method (research interest cycle) from problem solving method (problem solving interest cycle) provides a mechanism for using Pipek and Wulf’s infrastructuring framework in the context of a project involving global collaboration. Table 2 aligns McKay and Marshall’s elements of an action research intervention with elements of the case study reported below.

<table>
<thead>
<tr>
<th>Framework of ideas (F)</th>
<th>We draw, broadly, on a relational perspective of infrastructure informed by the Science and Technology Studies (STS) tradition, and specifically, on key ideas in infrastructuring literature, including Pipek and Wulf’s integrative infrastructuring framework and perspectives of actor involvement (Pipek &amp; Wulf, 2009), and Ribes and Finholt’s scales of infrastructure (Ribes &amp; Finholt, 2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research method (M_R)</td>
<td>Action research guided by Pipek and Wulf’s integrative infrastructuring framework</td>
</tr>
<tr>
<td>Problem solving method  (M_PS)</td>
<td>Soft Systems Methodology (SSM) techniques, needs analysis, prototyping workshops and evaluation survey feedback</td>
</tr>
<tr>
<td>Real-world problem situation (A)</td>
<td>Challenges in integrating disparate sociotechnical environments in projects involving global collaboration, and managing and governing the processes around this</td>
</tr>
<tr>
<td>Real-world/specific instance of A (P)</td>
<td>Integrating LMS platforms in heterogeneous sociotechnical contexts to support transnational collaboration between Australian and Chinese universities</td>
</tr>
</tbody>
</table>

Table 2. Elements of action research intervention

3.2 The problem situation

The problem situation outlined here involves collaborative articulation partnerships between an Australian university (UniAU) and two Chinese universities (UniCN1 and UniCN2). Actors in the project thus included UniAU, UniCN1, UniCN2 and agents. Each of these actors was punctualised and comprised of administration, executive bodies, academic staff, ICT systems and support, students and families of students. Via these partnerships, students from UniCN1 and UniCN2 complete the first two years of their degree at their home institution and then complete their final two years of study at UniAU. Students who are part of this articulation program graduate with two degrees, from their home university and from UniAU. The higher level objectives of collaboration are to enhance the curricula and teaching practices of Chinese partner universities; develop the academic competencies of Chinese articulation students; increase the international student population at UniAU; and to establish a joint research program going forward. The intervention involved the development of an IT artefact in the...
form of content in a Learning Management System (LMS) unit, owned by UniAU and integrated with LMS platforms at UniCN1 and UniCN2. As a complement to course specific digital content that students would use in their studies in China, the ‘Pathway to UniAU’ LMS unit was designed to support a range of activities of the partnership, including education support, marketing, student administration and student experience. It contained information and resources designed to facilitate the transition of Chinese articulation students to UniAU; for example, information about course options; equivalent UniAU teaching materials and sample assessments to guide Chinese students’ learning; and information about UniAU’s teaching styles and academic values. The major content areas are summarised in Table 3.

<table>
<thead>
<tr>
<th>UniAU experience</th>
<th>UniAU Business School experience</th>
<th>Academic skills development</th>
<th>Learning materials for credited units</th>
<th>Pre-departure information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Welcome video from the Dean</td>
<td>Academic integrity learning module</td>
<td>Introduction to learning materials video</td>
<td>Information about course options</td>
</tr>
<tr>
<td></td>
<td>Overview of UniAU Business School (rankings, accreditation, corporate partners)</td>
<td>Study skills videos</td>
<td>For each UniAU credited unit:</td>
<td>Study plan selection system</td>
</tr>
<tr>
<td></td>
<td>Information about Business School-specific student services, experience and opportunities</td>
<td>Research techniques learning module</td>
<td>o Interactive video introduction from unit coordinator</td>
<td>Information about accommodati on</td>
</tr>
<tr>
<td></td>
<td>Alumni profiles</td>
<td>English language support services</td>
<td>o Sample learning resources (e.g. recorded lectures, problems, questions, case studies, assessment rubrics)</td>
<td>Student health insurance options</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Interactive quizzes for selfassessmen t</td>
<td></td>
<td>Orientation information (including campus map and handbook)</td>
</tr>
</tbody>
</table>

Table 3. Major content areas in the LMS unit

Karasti et al. extend Star and Ruhleder’s definition of an information infrastructure to propose that an information infrastructure becomes transparent when it exists as an accessible, ready-to-hand installed base that enables envisioning future usages (1996). Following this, the pathway unit and the integrated LMS platforms are envisioned as an infrastructure to seamlessly support present and future collaboration between UniAU and its partners. While the integrated LMS will not be used as a platform for remote online delivery of courses, it will be used in support of face-to-face teaching and students will make use of the pathway resources on an ongoing basis according to their needs over a two-year period.

The goal of the project was to enact a sustainable infrastructure capable of supporting the broader collaboration objectives, through the design, implementation and evaluation of the LMS. The pivotal issue was how to navigate organisational and technical barriers to incorporate the diverse and potentially conflicting interests of transnational actors into the process of infrastructuring. Unlike domestic projects involving a single institution, this project established networks of actors across institutions, cultures and geographic borders.
Digital support was required to support these networks of actors for collaboration, and an LMS unit was designed for this purpose on UniAU’s Blackboard. This LMS unit was then replicated on the LMS platforms at the Chinese partner universities (see Figure 4). However, in integrating the LMS unit with platforms at UniCN1 and UniCN2, barriers were encountered. Students at UniCN1 and UniCN2 could not seamlessly access UniAU’s LMS site for several reasons. Firstly, partner university students were not formally enrolled in UniAU’s programs until the end of their second year of study. Furthermore, firewalls in China restricted access to websites readily accessible in Australia, e.g. YouTube. As a result, although at UniAU YouTube videos were frequently embedded in UniAU LMS units as audiovisual resources, YouTube videos could not be embedded in the LMS platforms at UniCN1 and UniCN2. The Chinese partner universities also used their LMS platforms differently in daily practice. While the use of LMS for teaching is standard practice for all courses at UniAU, this was not the case at UniCN1 and UniCN2. Thus there was no culture of digital learning and to ensure that students at UniCN1 and UniCN2 made use of the unit during their studies in China.

Figure 3. Relationships between actors at UniAU and partners

Figure 4. Technical integration of UniAU-owned LMS with partner university platforms

3.3 Problem solving method

At the inception of the project, the project team was formed and funding was obtained from a UniAU-based initiative for transforming teaching and learning. The project proposal was negotiated through meetings and discussions with partner universities’ international executive bodies, LMS
support staff and agent directors. A participative approach to design was employed to engage as many stakeholders as possible. The problem solving method deployed in the project combined Soft Systems Methodology (SSM) analysis techniques (Checkland, 1989; Checkland & Holwell, 1998; Wilson & Van Haperen, 2015), user requirements analysis (Maguire & Bevan, 2002), prototype demonstrations and evaluation survey feedback (Céret, Dupuy-Chessa, Calvary, Front, & Rieu, 2013; Maguire & Bevan, 2002). These major design activities are outlined below:

- **SSM analysis** – Two SSM workshops were held with a cross-section of actors at UniAU’s Business School. The first workshop focussed on the entire collaboration project and participants created rich pictures to interpret and learn about the relationships between stakeholders. This workshop surfaced a wide variety of actors, their interests and potential areas of conflict involved in the collaboration. In the second workshop, participants devised root definitions and models of broadlevel activities derived from these root definitions. These models were used to guide both the implementation strategy of the broader partnerships project and of more specific projects including the development of the LMS infrastructure. The second workshop also developed the preliminary agreed content structure for the LMS pathway unit.

- **User needs review** – Following the development of the preliminary requirements, the proposal for the project was presented to students at UniCN1 and UniCN2 who were then invited for their feedback on what content they would find helpful in an LMS unit designed to help them prepare for their studies at UniAU. This was administered via an online survey.

- **Content curation and development** – Pre-existing UniAU materials were curated based on the results of the needs analysis. These materials included videos on essay writing, online modules about academic conduct and a sample student newsletter. Content was also developed specifically for the LMS unit, e.g. videos of UniAU Business School staff, quizzes and study plan selection system.

- **Systems testing** – The LMS unit was tested on each platform (UniAU Blackboard, UniCN1 Moodle and UniCN2 Blackboard). Technical problems were identified and resolved, such as embedded MP4 videos autoplaying on UniCN1 Moodle and UniCN2 Blackboard which instead had to be made available as downloadable links. Content uploading and administration processes were also refined.

- **Prototype demonstration** – A prototype of the LMS on UniAU Blackboard and UniCN1 Moodle was demonstrated to stakeholders at UniAU, including the International Office, Engineering and Science faculties and student experience services staff at UniAU’s Business School. A later iteration was also demonstrated to students and academics at UniCN1 and UniCN2, and to representatives of the international partner institutions of UniCN1’s agent.

- **Evaluation survey feedback** – UniCN1 and UniCN2 students studying at UniAU were granted access to the prototype platform and solicited to provide feedback on the LMS unit by means of an online survey. Questions were a mixture of multiple choice and qualitative responses, and asked students what they would have found useful while in China for preparing for their studies at UniAU. Questions included evaluation of content as well as of the usability/navigability of the unit. Survey feedback was used to tailor the unit.

At the time of writing, the full availability and formal launch of the LMS platform and pathway unit to students at UniCN1 and UniCN2 is imminent – awaiting the commencement of the next teaching period.

### 4 Reflections on the problem solving interest cycle

The problem situation reported in this action research intervention involved the design sustainable infrastructure to support collaboration between an Australian university and its two Chinese partner universities by means of an LMS. The infrastructure includes the various LMS platforms, digital content, a variety of governance and administrative processes, and the education and work practices of
a wide range of actors including technical personnel, academics and students in different organisational and cultural contexts. The various techniques which constituted our problem solving method brought to light several barriers to be dismantled and issues to be negotiated. These issues were not discrete but interrelated. The incompatibility between LMS platforms, for example, had strategic overtones: UniAU, which used its LMS for all university courses, had a more recent version of Blackboard than UniCN2, where digital use was sporadic.

- **Gaining cross institutional support for the integrated platform** – The collaborative partnerships between UniAU and UniCN1 and UniCN2 were negotiated by different agents and without reference to the use of digital infrastructure. It was therefore necessary to convince the leaders of each institution of the value and potential of an integrated platform to enhance the broader collaborative partnerships.

- **Incompatibility between LMS platforms** – The different LMS platforms had different capabilities. This resulted in limitations in uploading and integrating content. For example, UniCN2 Blackboard (CN version) did not have the same functionality as UniAU Blackboard, so the LMS unit had to be rebuilt as it could not be transferred directly. Similarly, elements of UniAU content could not be directly replicated in the Moodle platform of UniCN1.

- **Engaging UniAU and UniCN academics to develop content** – Academic staff from both UniAU and Chinese partner universities in the development of content, to ensure it met the needs of Chinese students and was tailored to help them prepare for their academic experience at UniAU.

- **Copyright concerns** – Copyright laws and policies occasioned issues for the distribution of content. Content created by a third party could not be made accessible outside of UniAU and recorded lectures containing third-party content could not be uploaded to servers not owned by UniAU. This restricted curation and provision of content in the LMS unit.

- **Differences in how students and staff at UniCN1 and UniCN2 use their LMS** – UniCN1 and UniCN2 were at different stages of digital use and students were thus at different levels of technical competency. Consequently, there was a need to devise a program for engaging academics and students to make use of the platform.

- **Different bureaucratic environments at different universities** – Arrangements for technical support as well as administrative support for teaching practices varied across the partner universities. Therefore different processes and governance structures at partner universities had to be negotiated with personnel beyond those who were initially involved in establishing the partnership agreements.

5 **Reflections on the research interest cycle**

The findings from our action research intervention support existing research on sociotechnical systems design for global collaboration: constants in a domestic context may become variables in a global context, resulting in barriers to be negotiated or dismantled (e.g. firewalls in China restricting access to websites accessible in Australia, as in our project). Moreover, global projects involve numerous and diverse actors with diverse (and divergent) interests. Our findings also indicate that infrastructuring, with its emphasis on creating good environments for future use, provides a theoretical foundation for understanding how new systems and standards must wrestle with the inertia of an installed base in order to become flexible, sustainable and participative (Star & Ruhleder, 1995). Thus Pipek and Wulf’s integrative infrastructuring model takes into account activities which take place before the point of infrastructure (in the foundational and preparatory phases). This is the current point of the LMS integration project. Moreover, their framework conceives of users as “designers” who will appropriate a new infrastructure after the point of infrastructure (in the in-situ phase). In brief, their model comprises the following:

- Temporal dimensions (foundational, preparatory and in-situ phases surrounding the point of infrastructure)
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- Spheres of activity (culture of design and culture of use)
- Directedness of activities (infrastructural layers of development)

Pipek and Wulf demonstrate the operationalisation of their framework through a longitudinal case study of a groupware infrastructure in a German state government (Pipek & Wulf, 2009). While their framework is suited for use in a domestic project, it does not factor in the diversity of actors who comprise the installed base in a global project. These actors will use and appropriate a new infrastructure according to their (potentially disparate) interests, increasing the likelihood of breakdown or failure. The findings of our action research intervention suggest that it may be useful to see Pipek and Wulf’s spheres of activity (cultures of design and use) as made up of more narrowly defined “cultures” or focus areas. To this end, we draw on Ribes and Finholt’s three “scales of infrastructure (Ribes & Finholt, 2009): enacting technology, organising work, and institutionalising.

Ribes and Finholt describe these scales as sensitising concepts which “serve to remind the analyst to look across the full breadth of participants’ activities as they go about the task of enacting infrastructure” (Ribes & Finholt, 2009). In this paper, we propose four focus areas, which are loosely correlated to Ribes and Finholt’s three scales: technology (enacting technology), education (organising work), administration, and governance (institutionalising). These focus areas are not discrete but continuously affecting and affected by one another; for example, discrepancies between the technical capabilities of partner universities’ LMS platforms may impact on the selection and development of content. Neither do the focus areas align precisely with Ribes and Finholt’s scales. Rather, the scales undergird our definition of focus areas by providing a conceptual basis to ensure our “analytic gaze” is broad enough to encompass all infrastructuring activities (Ribes & Finholt, 2009). Our focus areas are also based in part on the three focus areas whichCogburn proposes for supporting transnational teaching and learning models through ICTs: technical infrastructure, social processes and pedagogy, and administrative infrastructure (Cogburn et al., 2010).

During the phases of infrastructuring, these focus areas are sites where issues are formed and the (potentially conflicting) interests of diverse actors are occasioned and negotiated. The interactions of actors in these spaces are similar to what Le Dantec and DiSalvo call “publics”. A public is “a particular configuration of individuals bound by a common cause in confronting a shared issue” (Le Dantec & DiSalvo, 2013). The concept of publics captures the heterogeneous, evolving, conflictual conglomerations of actors involved in global projects. In our project, publics (i.e. groups of actors) coalesced around our four focus areas and more broadly within Pipek and Wulf’s spheres of activity up to the point of infrastructure. Table 4 outlines these publics, describing each in terms of focus area, actors it comprises, and issues to which actors formed attachments (thus bringing the public into being). It is important to note that this table does not reflect the constant evolution of publics. Finally, we argue that this phenomenon of publics coalescing around the four focus areas is generalisable: in Le Dantec and DiSalvo’s words, “[a]ttractions to issues delineate a public and create resources for action” (Le Dantec & DiSalvo, 2013).

<table>
<thead>
<tr>
<th>Focus area</th>
<th>Actors</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>• LMS platforms</td>
<td>• Incompatibility between LMS platforms</td>
</tr>
<tr>
<td></td>
<td>• UniAU eLearning Manager and LMS platform support</td>
<td>• Language barriers in uploading content</td>
</tr>
<tr>
<td></td>
<td>• UniCN LMS platform support</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Agent LMS contact</td>
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</tr>
<tr>
<td></td>
<td>• Chinese firewalls</td>
<td></td>
</tr>
<tr>
<td>Educational experience</td>
<td>• UniAU academics</td>
<td>• Differences in how students and staff at UniCN1 and UniCN2 use their LMS</td>
</tr>
<tr>
<td></td>
<td>• UniCN academics</td>
<td>• Copyright issues</td>
</tr>
<tr>
<td></td>
<td>• UniAU curriculum committee</td>
<td>• Engaging UniAU and</td>
</tr>
<tr>
<td></td>
<td>• UniCN students</td>
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</tr>
</tbody>
</table>

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There is a distinct political dimension to Le Dantec and DiSalvo’s conception of publics which differentiates it from other concepts such as stakeholders. Our approach to linking actors to the activities of infrastructuring is to a large extent pragmatic. However we wish to emphasise that in any infrastructuring endeavour there are practical concerns through which the political interests of actors will be surfaced. In each of the focus areas that were identified in the LMS integration project, in order to resolve issues and conflicts, it was necessary to negotiate the outcomes that were acceptable to all parties.

In sum, following Le Dantec and DiSalvo, we interweave the concepts of infrastructuring, publics and attachments (Le Dantec & DiSalvo, 2013). We argue that this provides an “innovative, synergistic” theoretical solution for “leveraging the differences among participants” in global projects (Hardy et al., 2005; Levina & Vaast, 2008). Le Dantec and DiSalvo state,

[I]nfrastructuring enables a public’s members to identify and address issues in an ongoing manner, creating a sociotechnical response that relates the current context of the public to the future context the public is trying to attain. Infrastructuring thus can be used as one of the key components to sustaining a public over time (Le Dantec & DiSalvo, 2013).

We build on this argument: not only can infrastructuring be used as a component for sustaining a public over time, but using the concept of publics to grasp the complexity and heterogeneity of networks of actors in global projects can help us to understand how to establish good environments to sustain an infrastructure over time. The concept of publics makes it clear that it is neither necessary nor possible to resolve all the tensions and conflicts between actors. However, it is both necessary and possible to identify focus areas based on shared issues around which publics can form. These publics, however contentious, uneven and permeable, can thus confront these issues together to enact a collectively envisioned future (Le Dantec & DiSalvo, 2013).

For the LMS integration project discussed in this case, there will inevitably be further in-situ design that will occur as the students and academics use and appropriate the resources available. Recognising that the installed base has been developed around focus areas of interest and involving ‘publics’ alerts the project team to potential issues and the ability to manage and respond to the concerns of participants.

### 6 Conclusion

Infrastructuring focuses on the process of designing for (future) use and of negotiating interests to establish an environment optimised for in-situ tailoring and appropriation by users who are also...
innovators (Ehn et al., 2014; Le Dantec & DiSalvo, 2013). Thus infrastructuring is concerned with creating durable and enduring information systems (Karasti, Baker, & Millerand, 2010; D. Ribes & Finholt, 2009). As the findings from our action research intervention indicate, this emphasis on sustainability through negotiating and incorporating interests is important for projects involving transnational actors, where disparities in social and technical contexts may lead to project failure.

While infrastructuring projects will be idiosyncratic with regard to the contexts and objective that they are dealing with, the integrative infrastructuring model proposed in this paper provides the basis for a methodology and framework which can be applied in any transnational project involving diverse sociotechnical environments. It offers one solution to the issue of enacting sustainable infrastructures in a climate where global collaboration through ICTs is becoming increasingly prevalent.

References


