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Modelling architecture in the world of expertise

Architecture and Studies of Expertise and Experience (SEE)

Architecture is an especially interesting area for the application of ideas about expertise because it spans many domains. Here we show how ideas belonging to Studies of Expertise and Experience (SEE) – principally the locus of legitimate interpretation (Collins and Evans 2007), interactional expertise (Collins and Evans 2002; Collins and Evans 2007) and a typology of trading zones (Collins et al. 2007) – can illuminate the distinctive features of architectural practice.

We consider interdisciplinary interactions that are routine within architectural practice – for instance, with structural engineers – as well as novel collaborations in which ideas rather than technical expertise are exchanged. This second category is exemplified by Pineda's collaboration with crystallographers.[1] Finally, we look at the relationship between architects and the wider public. In presenting this analysis, we draw on Pineda's experience as an architect who has collaborated with a range of technical disciplines and the experiences of Collins, Evans and Weinel as sociologists of science with a longstanding interest in interdisciplinary collaboration.

1. To read about the origin of this collaboration, see Pineda 2013.

Locus of Legitimate Interpretation

The idea of the Locus of Legitimate Interpretation (LLI) was introduced in *Rethinking Expertise* (Collins and Evans 2007: 119-21) to illustrate an important difference between scientific and artistic institutions: legitimate judgements about the quality of the work done in these different knowledge-making communities are made in different locations. Figure 1 shows where the LLI is located for an esoteric

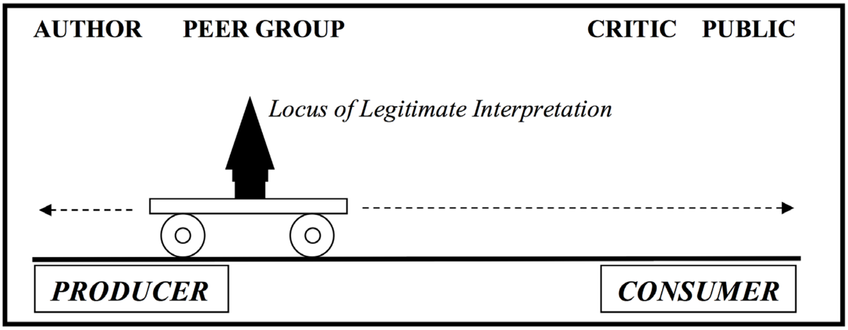

Figure 1: The moving locus of legitimate interpretation, science toward the left, arts toward the right (reproduced from Collins and Evans, 2007)

science. Here it is close to the knowledge producers, with only those in the same (sub) disciplinary group able to make legitimate judgments about its epistemic value. In contrast, if Figure 1 were to show the LLI for artistic professions, then the wagon with its vertical arrow would be located much further to the right, with both critics and the public – i.e. the consumers rather than producers – able to make legitimate assessments of a work's aesthetic or literary value. Indeed, for many kinds of such work, the opinions of consumers and critics is taken to be crucial, with the views of fellow artists and writers counting for nothing.

Other knowledge producing activities can also be classified in terms of the LLI. Technology, for example, has an LLI that is further to the right than science. This is because technologies, like artworks, are judged by consumers. The classic discussion of this is the development of the modern bicycle in which the 'progression' from the dangerous 'penny-farthing' or 'high wheeler' bicycle to the 'safety bicycle' with its chain linking front and rear cogs allowing gearing and a small driving wheel, was contingent on social norms in which speed and racing were counted as priorities over safety and comfort. It is only when, with the advent of pneumatic tyres, the safety bicycle could also be a racing cycle that the technology moved on; it was a matter of cultural norms and values not 'rational' progression towards an optimal design.[2]

2. See e.g. Bijker 1997 and Pinch and Bijker 1987

Architecture and its Expertises

We now use the concept of LLI to draw out the distinctiveness of architecture when compared to representative examples of the collaborations in which architects are routinely engaged. Figure 2 shows architecture in the centre and three different kinds of domain with which it interacts.[3] We work clockwise from 9 o'clock.

- Crystallography is a domain of specialist, scientific expertise that has not, in the past, contributed to architectural practice and whose LLI remains separate from that of architecture. Here we use crystallography to represent any scientific discipline that might be used in this way.
- Structural engineering represents a domain of specialist, scientific expertise that is routinely called upon and integrated into architectural practice and can be seen as belonging within its LLI. In a more extensive treatment we might also look at other kinds of engineering and whether the relationships between architects, builders and other specialists whose practical experience may contribute to the design process, is similar.[4]
- The third domain comprises the everyday users of buildings along with the public and critics. These do not contribute to the design process directly but do make an important contribution to the evaluation of architecture and therefore contribute to architecture's LLI.

In Figure 1, the professional domains of crystallography, structural engineering and architecture are represented by three black dots surrounded by heavy circles. In all three cases, the dots are the professions themselves and, in the cases of crystallography and structural engineering, the circles represent the boundaries of the principal Loci of Legitimate Interpretation (LLI) that pertain to them. Both crystallography and structural engineering are typical sciences so their LLI is close to the producers of knowledge. Thus in both domains it is other practitioners, i.e.

3. The two domains of crystallography and structural engineering have been chosen because their contrasting relationship with architecture. Whereas relations between architecture and structural engineering are frequent and routinized, the interaction between architecture and crystallography depends on the initiative of Pineda and colleagues and required external funding.

4. By specialist we mean, for example, the contribution a professional chef might make to the design of a commercial kitchen or the role of healthcare professionals in the design of a hospital ward.

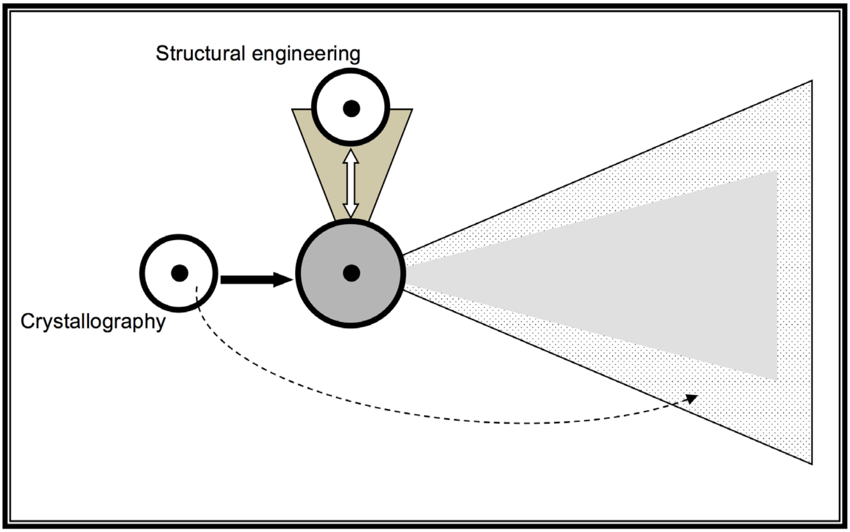

Figure 2: Architecture plus crystallography with Loci of Legitimate Interpretation

either other crystallographers or other structural engineers, who peer-review papers and who judge whether the technical claims made – the new knowledge – is of a high enough standard to be published.

The LLI of architecture is more complicated. In Figure 2, architecture and its 'local LLI' is represented by the grey-shaded circle in the middle. We have made this circle a little larger than the others because while the initial judgments of architects' work are made by other architects, the whole architectural profession has rights when it comes to judging architectural output – the quality of a bridge design is not judged exclusively by bridge designers, just as the quality of an office building is not judged exclusively by the designers of office buildings. In the case of architecture, the 'local LLI' is the whole profession rather than a narrow group of specialists as would be the case in say, physics, where gravitational wave physicists would have little in the way of licence to criticise low-temperature physicists or solid-state physicists.

But other social groups can also make legitimate judgements about architectural work and these relationships are represented by the various triangles and arrows linking architecture to different domains of expertise and experience. For example, the LLI for architecture must also include the views of the structural engineers, at least insofar as the engineers' expertise gives them a warrant to say whether or not a particular structure will stand up. So we have to extend a segment of the LLI vertically so as to include them – the vertically orientated triangular shape in Figure 2. Note, however, that because crystallographers provide inspiration rather than information or judgment, there is no such shape stretching out to the left. Second, but equally important, are the similar shapes stretching out far to the right of Figure 2, where we find the consumers of the technology and the public and their representatives – the architecture critics who write in the Sunday papers and the like. The inner grey triangle are the consumers, who live in the houses, the tower-blocks and the offices. The larger triangle are the public and the critics.

We now draw on the other concepts identified in the introduction – interactional expertise and trading zones – to explore in more detail how architectural practice works with and distinguishes itself within these different kinds of collaboration. We begin with crystallography, as this represents the kind of collaboration that might occur at the start of the design process. We then consider collaborations between architects and engineers – more typical of the implementation phase of a design – and the final evaluation of the completed structure by users, professional critics and public more generally.

Architects and crystallographers

Although the collaboration between architects and crystallographers is the most unusual it is also the most straightforward to analyse. The collaboration is asymmetrical with knowledge flowing from the crystallographers to the architects – as represented by the black block arrow. The architects wish to utilise geometries contained in crystallographic datasets, learn about molecular geometry and simulate the dynamics of crystalline formations. The architects hope the collaboration will give rise to new kinds of designs. The crucial point is that the LLI for crystallography and the LLI for architecture remain distinct.[5] Ideas flow from crystallography to architecture where they are then evaluated against the standards of architectural practice not

5 It is, of course, possible that ideas might also flow from architecture to crystallography. For example, crystallographers might get inspiration in their turnabout potential new crystal structures. Should this happen, the LLI would remain within the crystallography community and would not include any architects.

crystallography. The crystallographers have no rights as experts to make epistemic judgements about the structures created though they might comment in their role as members of the general public (the fine dashed arrow in Figure 2).
To understand how two groups with very different specialist languages and practices, can coordinate their actions for the benefit of both we introduce the idea of a 'trading zone'. The term was originally put forward to explain how theorists and experimenters worked together in physics and how new, hybrid disciplines like biochemistry are created. The idea draws on an analogy with commercial trading between different societies who want to exchange goods but who speak different languages. Such trading zones can work through the creation of a shared 'pidgin' language that mixes elements from each of the native language. Overtime, this shared language becomes richer and more sophisticated – a 'creole' – and, in some cases, a new hybrid community is formed.[6]

The creation of a new, inter-language is only one possibility, however, and there are other ways in which stable 'trading' relationships can be achieved. These are explained by Collins, Evans and Gorman (2007) who distinguish between four trading zones types, based on two organising dichotomies: interacting groups can either be homogeneous or heterogeneous and the interaction can either be based on voluntary cooperation or coercion (see also Gorman 2002, 2010). The architects' interaction with the crystallographers is best described as a voluntary cooperation involving two relatively heterogeneous groups – a 'fractionated trading zone' according to Collins et al. (2007: 660-662). Cooperation within such a fractionated trading zone can be organised around in-depth and shared linguistic practices or around shared material objects that may have different meanings and uses for the different groups.[7] Collaborations around shared objects are often characterised as involving 'boundary objects'(Star and Griesemer 1989), while collaborations based on shared linguistic understanding would be based on 'interactional

6 The term 'trading zone' was coined by Galison (1997) but he restricted the analysis to interactions via 'interlanguages' -- pidgins and creoles.

7 This distinction between material object and linguistic practice serves as a heuristic and is not as clear-cut as it might seem (see Collins et al. 2007: 661).

expertise' (e.g. Collins 2004 and Collins and Evans 2007).[8]

In the case of the crystallographers, and other such sources of architectural inspiration, it seems likely that the trading zone has been created through common boundary objects rather than through interactional expertise.[9] In the case being analysed, a shared interest in geometry binds architects and crystallographers, even though the databases of crystalline formations around which their interactions are based mean different things to the two different groups. For crystallographers, the formations are used to predict and understand the properties and use of crystalline materials. In contrast, an architect like Pineda values the geometry of crystalline formations for understanding such things as the scalability of the geometries, their use in the creation of spaces and objects at the scale of human perception, and the possibility of experiment based on the data.

Architects and engineers

The interaction between the architects in the grey circle and the structural engineers at the top of Figure 2 is rather different. Although the cooperation is still voluntary, the collaboration is more symmetrical, more frequent and based on a much higher level of shared understanding. For this reason, although we would still classify the collaboration as a fractionated trading zone, it is one based on interactional expertise rather than boundary objects. To understand how such collaborations work, we need to explain 'interactional expertise' (Collins, 2004; Collins and Evans, 2007; Collins and Evans, 2015). Interactional expertise is fluency in the language that describes a set of practices rather than proficiency in the practices themselves. In most cases, high levels of linguistic competence are accompanied by extensive practical experience so it is true that most interactional experts will also be 'contributory experts'. It is, however, important to maintain the analytic separation between interactional expertise (i.e. language) and contributory expertise (i.e.

8 See also e.g. Collins 2004, Collins and Evans 2015 and Collins and Sanders 2007.

9 Of course, this may change over time, with crystallographers and/or architects becoming increasingly knowledgeable about the other's domain. Even if this does happen, however, the LLIs remain separate.

practice) so as to understand the existence of 'special interactional experts' who have learned the language without mastering the practice. These include managers of technical projects who understand the domain well enough to make sound decisions even though they do not practice within it (e.g. Collins and Sanders 2007), anthropologists and sociologists who are deeply embedded in the community they are studying but who do not engage in all its cultural practices. Architects fall into this category when they collaborate with specialist experts whose practices they understand but cannot replicate.

Interactional expertise allows us to understand the relationship between an architect like Pineda and structural engineers and other specialists with whom he must routinely interact. The claim is that becoming a successful architect involves developing a high degree of interactional expertise in building engineering and related disciplines. In other words, the expectation is not that architects are able to do all the calculations done by the engineers, but that architects are able to understand the domain of engineering well enough to design buildings that are structurally sound, ask engineers the right kind of questions and make judgements about whether or not an engineer is being reasonably or unreasonably risk-averse when he or she says a proposed structure cannot be built. In some cases, this may lead to a more symmetrical relationship as engineers may also need to develop some interactional expertise in the world of architecture so as to contribute effectively to the translation of design ideas into finished structures. The double-headed white block arrow that links architecture and engineering represents the mutual possession of interactional expertise in the other's professional domains.

Note, however, that the development of interactional expertise on the part of the architect does not make them contributory experts – that is to say knowledge producers – within the domain of structural engineering; peer review within engineering remains the preserve of engineers. In contrast, engineers can determine the structural un-soundness of a design and thus render it 'unbuildable' under a given set of constraints (for instance, a budget limit)[10] . Of course, when the engineering questions are routine, then architects can do the work of structural engineers. For example, Pineda says he could design and build a simple structure without consulting an engineer, using well-known materials and standard span-to-depth ratios for the calculation of beam profiles. The crucial point is to see that the situation would be very different if the project was generated through the use of complex geometry. In this case, Pineda's *structural intuition* may allow him to know that the structure is viable and he may even be able to speculate about the dimensions of the structural elements, but he would not be able to fully analyse the structural performance of his design, or to define the optimal structural thicknesses in millimetres.
If a large project of this kind were to be commissioned and prepared for construction, Pineda would be acting negligently if he did not bring an engineer into the project team.

Again, as with the crystallographers, it is possible that collaboration with architects leads to innovations with engineering. For example, many well-known architectural projects, from the CCTV Building in Beijing to the Phaeno Centre in Wolfsburg, have required paradigm-changing developments in engineering including the development of new materials, the combination of technologies, or the invention of new structural types. From a sociological perspective, the important point is that these new engineering knowledges and practices are evaluated by engineers – i.e. the LLI remains close to the knowledge-producing engineers – and it is only once it has been certified within this community that it becomes available for architects to use to create new designs or apply retrospectively to existing structures.[11]

Architects and Public

When we move to the relationship between architecture, the consumers and the public we are no longer talking about interactions based on formally recognised or specialist expertises. Instead, we have moved to a situation in which the LLI is now on the right-hand side of Figure 1 and in which it is the experiences of everyday life that licence evaluations about the success or otherwise of a design or a style. In the case of architecture, this tension is manifested in the very different evaluations that might be given by professional peers and the wider society whose views about what constitutes a 'good design' can, and often do, differ markedly. In the UK, the most well-known of these public critics is probably Prince Charles, who is famous for his opposition to many contemporary designs, but a more telling example of the effects of public perception on architecture is provided by developments such as Thamesmead in London.

Thamesmead was inaugurated by the Greater London Council (GLC) in 1968 as a "*town of the 21st Century*"[12] . It was the GLC's flagship project and was thought of by its creators and by the architectural community as a new 'garden city',

10 Elsewhere, Collins, Evans and Weinel (2015:3) refer to the expertise relevant for this kind of contribution as 'technical referred expertise'.

11 For example, the Millennium Bridge, a pedestrian bridge over the River Thames in London and designed by Foster + Partners was inaugurated on 10 June 2000 and had to be closed after just two days due to an unexpected lateral vibration that Arup (the structural engineers) had not predicted. After much investigation, Arup concluded that problem was caused by a 'positive feedback' phenomenon, known as synchronous lateral excitation, in which the natural swaying of pedestrians caused small oscillations in the bridge, which in turn caused people on the bridge to sway in step, increasing the amplitude of the bridge oscillations. In order to make the bridge usable, Arup had to innovate in the design of dampers – a technology that had been developed to reduce the oscillation of towers under the effect of seismic forces – that were then fixed underneath the bridge. These devices were designed to absorb the lateral oscillations caused by the swaying of pedestrians.

12 Hakes (2014) offers a complete historical review of the changing public perception of Thamesmead.

13 'Thamesmead Ceremony: A Great Day for Pioneer Family', Kentish Times, (5 July 1968)

full of opportunities and community spirit. During its early years, the unashamedly brutalist design of Thamesmead was surrounded with a sea of positive publicity in which the GLC was congratulated for its '*boldness*' and '*imagination*'.[13] This honeymoon period was short-lived, however, and within just a couple of years the positive headlines were displaced by press and media coverage depicting crime and antisocial behaviour. This trend became a downward spiral when, in 1971, Stanley Kubrick used Thamesmead as the backdrop for *A Clockwork Orange*. Now the clean geometries and vistas conceived by the GLC as a place where communities and gardens would flourish were seen as a cold, dark place and the ideal location for gangs, crime and ultra-violence.

The importance of the extended LLI of architecture is that the Kubrick's interpretation of Thamesmead's architecture was embraced and legitimated by the wider public. Of course, public evaluations are not always so negative or destructive. Architects, are thus torn in many ways. One way is that their experience leads them to consider themselves a profession with a refined aesthetic sense whose design choices deserve more consideration than that of the ordinary citizen but the example of the arts suggests that a profession that produces objects for consumption, especially public consumption – which buildings are – may not be able to maintain such a view. A more extended treatment would compare architecture with other professions which involve designs which answer to consumers, critics and the public and we could also bring in regulatory bodies. One can immediately see that a diagram not too different to Figure 2 could be used to represent the motor industry where fashions in cars are in tension with engineering considerations and with safety and pollution regulations. The same could apply to the relationship between chefs and restaurant critics. The fashion industry would make another interesting comparison with much less emphasis on technical input and regulation and at a much shorter time scale. Thinking about architecture and its relationship to other professions in terms of how knowledge moves between them and where the locus of legitimate interpretation lies not only helps us understand the different ways in which collaborations can succeed it also helps to illuminate the tensions and dilemmas that make architectural expertise so multi-faceted and complex.

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