Tourist Sirens or Technological Beacons? On the Innovation Function of Large Public Buildings

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In 1972, a year before the completion of the Sydney Opera House, Melbourne artist Eric Thake produced a small linocut Christmas card—*An Opera House in Every Home*—in which he likened Australia's grandest building to dinner dishes stacked in the draining rack at the kitchen sink.

Eric Thake (1972): An Opera House in every home.

Unlike other analogical renditions of Jørn Utzon's icon—from billowing sails to leapfrogging turtles—this image reflects more than the application of poetic license or irreverent humor to otherwise controversial institutional endeavors. Obliquely, it poses the question of what the functions of large public buildings are or should be—a question that still resonates in the case of the Sydney Opera House as well as many of its younger siblings.

How should we look at and assess these extraordinary structures? As opportunities for unique works of art, vehicles for the production of collective identity, cultural billboards, or privileged laboratories for disseminable industrial research? The alternatives presented, of course, imply another question: What makes a public building significant—its presence, its development process, its effects?

The issue is tricky, because the theory and practice of civic works send out conflicting signals. If we look at the institutional characteristics of the construction sector, large public projects must be considered ideal innovation incubators within an industry otherwise known for its resistance to change: (1) their commissioning bodies are in a position of operational strength; (2) they are often developed not only to respond to a specific need but also to institute collective values and are, therefore, the object of community patronage; (3) their representational power and ad-hoc programmatic requirements combine to counterbalance cost-cutting strategies in construction; (4) the promoting agency has no interest in securing market advantages through innovation and should then be, at least in principle, open to its diffusion; (5) they are big, and thus have lengthy development processes and a larger-than-average period within which multiple product development cycles can be started and completed. In other words, it is the existence of these projects beyond short-term profit motives, private party interests, commercial transactions, market competition contingencies, and production routines that frees them from the socio-technical constraints that restrict most building activity.[1]

As a matter of fact, any pictorial history of building technology, component manufacturing, and construction management would show that large buildings with strong symbolic aspirations have made major contributions to such histories. Not necessarily by design, but because by diluting economic efficiency with size and representational power, these endeavors have often helped their promoters force procedures, challenge normative and conventional frameworks, spur or define new kinds of

linkages between industrial entities, create opportunities for component suppliers, trigger processes that may not have occurred (or that would have occurred at a different pace) had concerns been overwhelmingly economic, and, last but not least, ease cultural acceptance of particular materials and solutions. One could almost say that in order to fulfill their institutional duty and socioeconomic potential, public buildings *should* be innovative, *should* establish a technical legacy of some sort, even if this means reducing the objective efficiency of their production process when measured by private market standards.

Yet public discussion hardly ever considers major public buildings as testing grounds for the rest of the industry, harbingers of change, and breeders of new technology. We may remember the relationship between Labrouste's Parisian libraries and the architectural use of iron, between Le Corbusier's Chandigarh and Nehru's fledging concrete industry, or between California's School Construction System Development and modular prefabrication; but, in general, our focus centers on the building's designer, its inherent interest, and whether or not it stayed within budget, respected construction schedules, and opened on time. Very few would think of the British Museum as the place of the introduction of the modern bill of quantities (e.g. the list of materials and activities required for the execution of a project), Charles Garnier's Opera as a laboratory for drawing reproduction techniques, the National Art Schools in Havana as an experiment in industrial autarchy, the British House of Parliament as a critical chapter in the history of heating and ventilation systems, or the Twin Towers as the birthplace of construction management in building—yet that's what these buildings were.

I believe there are several reasons for this inattention. Architectural debate shows a distinct cultural predilection for "master" over "piece," a predilection facilitated by the confidentiality of the contracting system, which places much technical information out of reach even to those with specific related interests. This, combined with a limited awareness of the mechanics of the building sector, generates a perception that buildings of exceptional scope are industrial one-of-a-kinds, with little or no relationship to, and thus of little consequence for, the everyday and future workings of the industry at large. Hence, they hardly warrant in-depth studies of their broader impact.

Commissioning institutions, on the other hand, have little interest in changing this perception and emphasizing the research and development component of their building projects. As the Olympic Games ritual periodically shows, large public buildings expose, almost by default, the technical infrastructure and strategic skills of the bodies in charge of their procurement. Public scrutiny of the project can easily translate into public scrutiny of its administrative practices and underlying policies. Under such circumstances, the natural sensitivity of building contracts is increased by the political ramifications of the analyses of why and how they have been carried out. Whenever possible, public administrations are thus keener to portray themselves as guardians of bureaucratic efficiency than as patrons of industrial (rather than formal) experimentation. The control of current expenditure is easier to convey (and thus more politically exploitable) than the uncertain future value of the investment, particularly when the profile of the project draws public attention. With their aura of monumentality, public buildings are good as spatial tributes to ideal institutions but risky as concrete reminders of actual ones. This duality results in emphasis being placed on big structures as objects of display and in difficulty tracing their relationship to everyday building.

Eric Thake might have then been right in posing the question of the function of public buildings, but he stood little chance of getting a proper answer. Even today, thirty years after that Christmas and despite the building's strong standing in the public domain, the public knows very little about the construction impact or the industrial relevance of the Sydney Opera House. We appreciate its value for tourism, but we don't know whether its cost, as well as the construction difficulties encountered in realizing the image of the building and the concepts underlying its architecture, have had any repercussions over, say, the technical capital of Australia or its manufacturing competitiveness. Predictably, the copious literature available does not help much. Most of the monographs on the Opera House still show much reluctance in detaching the industrial genie of the place from the genius of the architect. We can read everything about the building's intimate (yet partial) association with Utzon, but much less about the building as built.[2]

The four major titles produced on it recently, over twenty years after its completion, collectively devote only sixty-two out of 1,040 pages to the analysis of the post-Utzon phase of Australia's most significant piece of construction, which, however, took seven additional years to complete and gobbled up 50% of the total official expenditure.[3] Like many other structures of its kind, the Sydney Opera House has become a national logo shrouded in the myth of creation rather than the facts of its implementation: a monument to enjoy and to be proud of rather than a socio-technical experience to analyze seriously and to learn from.

The point I am trying to make is that the industrial externalities of public buildings are critical to gain a balanced perspective of the experiences that produced them and to add a layer of sophistication to the discussion on the social value of design.

Christo (1969-91): Wrapped Opera House, Project for Sydney

Let's look at the Sydney Opera House again. Its silhouette forms one of the definitive building icons of the 20th century. Yet to many it also represents a great modern example of institutional inefficiency and project mismanagement. Sixteen years of planning and fourteen of making, three distinct construction stages – sub-structure and podium (1959-62), shell structures (1962-67), paving, glazing and building fit-out (1967-73), a manifold increase in the 'original' (though completely artificial and ridiculously unrealistic) budget, and the dramatic replacement of Jørn Utzon before the end of Stage Two, all tell a story of unprecedented building complexity, industrial conflict, and political maneuvering.[4]

Now there is no doubt that conception and development of the building were the reasons for major delays in its completion, cost overruns, and conflicts between appointed professionals and public agencies, even though most of the negative myth is fabricated. The costs of the Sydney Opera House are not as disproportionate as popular culture has it: once indexed, the final cost of the complex was 20% more than the recently completed Federation Square in Melbourne or the Disney Concert Hall in Los Angeles, but 30% less than Lincoln Center in New York.[5] In addition, it was almost entirely funded from a dedicated lottery, which meant that the project was never a financial burden on the government and never diverted funds from other capital projects.

But regardless of the financial facts, this is only one part of the story. The other part—the industrial one—tells of an engrossing journey that generated broad knowledge, had enormous influence in the building sector, and left a profound legacy on construction.

Whether by industrial design or by architectural default, Utzon's poetic response to the initial brief combined with his technical approach to the development of the project to turn the Opera House into a hitherto unimaginable precedent-setting exercise that continued even after his resignation. Its procurement process implied or induced solutions that could not be inferred from, or which required extensive modification of, existing practice in five different areas: building form and typology, building materials and systems, building assembly, design engineering and construction surveying, and project management. And since the architectural idea tended to integrate problems rather than keep them apart, almost each one of the over four-hundred contractual contributions to the building and 165 companies participating in the project had to adapt and react to it by incorporating formal and technical constraints that would not have otherwise been part of their standard concerns.[6]

In industrial engineering, the procurement process of the Opera House would be categorized as a case of 'concurrent product development,' where change inevitably takes place in bundles, and where its agents come from the various sectors contributing to the project's infrastructure: in this case trade

contractors, specialist consultants and component suppliers, coordinated by the work of the main design professionals and the principal contractor.[7]

But unlike industrial design and manufacturing, where every small change is immediately patented (and thus recordable), construction works more subtly, and generally through 'federative' environments - structures where information is diffused but not necessarily codified, is often produced in small informal batches, has an incomplete and tentative character, by-passes hierarchical processes, takes time to mature, and percolates almost invisibly into work practices. For this reason, it is difficult to calculate the overall technical value generated by a building such as this, unless one follows its various supply chains and the evolution of the solutions it triggered. But we can at least suggest its latitude.

The work carried out on the Sydney Opera House during and after Utzon's tenure brought about and verified the validity of new labor practices, site erection strategies, system assembly techniques, mechanical systems configurations, environmental policies, and more. Aside from its well-known structural solutions for the shells and amongst other applications, the building was the first of its kind in Australia to use computer-based three-dimensional site positioning devices, geothermal pumps, tower cranes, chemical anchors, non-competitive tendering, life-cycle engineering, parametric design (e.g. the use of governing equations to model a design), and critical path methods. It created the need for new consulting entities such as Unisearch, the testing laboratory at the University of New South Wales, which became one of the first organizations in the world established to commercialize university research and support technology transfer. It helped certain companies build profile and expertise that would be used around the world. It also allowed international firms such as Arup, Freyssinet, Haden Engineering, Stenseen Varming, and others to plant the seeds for their future strong presence in the region.

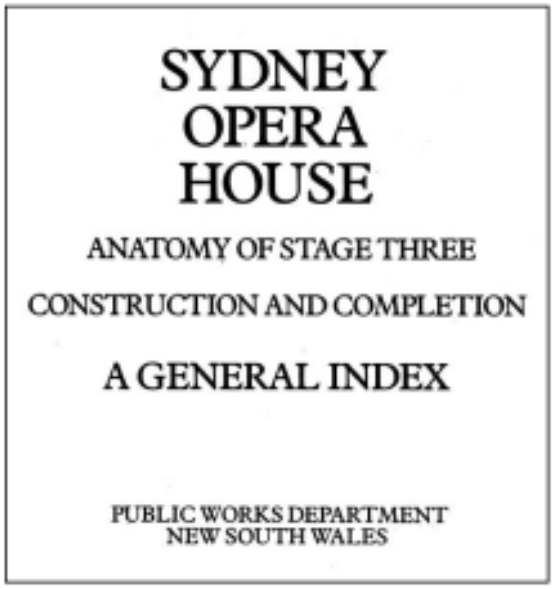
Moreover, what was not appreciated at the time has become standard practice today, with most of the issues generating controversy in the 1960s now successfully adopted by the industry: in particular, the essence of Utzon's project management criteria ––*de facto* pre-qualification of bidders, use of scope drawings, performance-based design assistance from trade specialists, mock-up testing, and on-the-job skill development - currently permeates the official policies for public building work by the original Sydney Opera House client, the Public Works Department of New South Wales.

This goes to show that, although not as evident as its formal influence on several famous auditoria and waterfront congress halls, the Sydney Opera House had critical but unheralded contributions to make to the practice of building and building procurement. One could trace, for instance, specific connections between the Sydney Opera House and the cooling systems of office space in Sydney's central business district, the nickel-copper lateral bolts of its segmental arches and the equipment used in offshore oil drilling platforms, or the design of its podium and the crushed aggregate stone industry in Australia. Such connections may not have directly spun off into domestic applications, but they have a lot to do with the construction of cities and the generation of economic and social wealth.

If we attempted an input-output project analysis that took all the possible linkages into account, the budget increase or the return on the investment for the Opera House would perform quite competitively against other publicly funded enterprises. In 1963, for example, four times the current budget of the Opera House was used by the Australian Government to secure the future delivery of twenty-four F111 jet fighters. In 1973, the year the Opera House was opened at the same cost as the initial military contract, the latter had grown by two-and-half times, with only six planes delivered amid major technical difficulties.[8] In 1964, when the expected cost of the Opera House was 34.8 million Australian dollars, 40 million of the same currency bought the Royal Australian Navy a U.S.-produced 4,500 ton destroyer, which, after christening Australia's engagement in Vietnam, was decommissioned, sunk, and turned into an artificial reef in Tasmania in 2002. By every possible parameter, and notwithstanding its planning flaws, the Sydney Opera House would be likely to show better productivity, technology transfer, and product life-cycles than its lavishly funded and seldom questioned military counterparts.

Without the benefit of systemic industrial reflection, however, the accounting ghosts of seemingly out-of-control architectural invention and non-sci-

The Perth Class destroyer in the Sydney Harbour.



entific management have produced a Sydney Opera House 'syndrome' - that is a government obsession with the respect of agreed routines, predetermined quantities, and appropriate procurement strategies• - which had a major dampening effect on the institutional planning of future projects and the policies that went with it. If we examine the major civic buildings of the last thirty years in Australia - from the Federal Parliament House to the Olympic Games structures, to the National Museum - we recognize that prescriptiveness of the brief, speedy realization, resolution of internal conflict, minimization of trade union action, reduction of uncertainty, and emphasis on existing local labor become the determinants of their architectural planning, with final cost audits—looking at expenses rather than opportunity results—sanctioning their success or lack thereof.[9]

That information concerning the development of technology could play a major role in the public evaluation of the building was actually recognized by Hall, Todd, and Littlemore—the architects in charge of completing the project after Utzon's departure. In 1973, at the end of construction and one year after Thacke's linocut, they produced'"the Green Book," an index of the materials, technologies, and companies used through the project""to collect and collate data for future use . . . and to record the contribution to the construction of the complex by the building industry."[10] But with the government feeling protective about things that had worked and that had not worked, the document was never properly advertised or followed up. It was only in 1997 that New South Wales' Premier and Minister for the Arts Bob Carr announced that in an endeavor to reflect the Government's commitment to open and accountable administration, all the construction records of the Opera House, irrespective of their age, were to be open to the public.[11]

Perspective of the Melbourne Docklands

However, state and local governments' discomfort with the lingering negative associations of the Sydney Opera House cost overruns persists, even after the discovery of the cash-in potential of formal stunts. Lest it relive its saga, administrative

Australia has forgotten about Sydney and become transfixed with Bilbao. Obligingly, the deindustrializing city of Geelong in the state of Victoria sends officials to the Guggenheim board in New York to convince them to commit a new branch to their region, even though, not unlike Bilbao, this does not mean that the Guggenheim would pay for the building. Likewise, the developers of the master plan for the large docklands area in Melbourne leave the central wharf open to a Bilbao-like structure, duly suggested in the model by Gehry-reminiscent sails. Utzon and Sydney cannot be a precedent; they are made conspicuously absent and left to tourist brochures.

This brief excursion is meant to highlight the importance of industrial debate. When the indirect construction of comparative advantage through design-based research is not considered, building cost and architectural image become the sole defining terms of the discussion on public buildings. Control of costs and time signal administrative efficiency and respect for taxpayers, while the recognizability of the building artifact measures the possibility for future dividends. Technological innovation potential is paid some cautious and generic lip service in public relations publications but generally without bringing its relationship with funding into the picture.

The risk, within this simplified environment, is that the inevitable costs of extraordinary buildings become the subject of budgetary economic rationalism rather than industrial vision: architectural invention is expensive and time-consuming but justifiable when its ceosts can be amortized either through direct revenues or the acquisition of buzz-generating, crowd-drawing symbolic capital. We build for contemporary versions of Henry James's Daisy Miller, drawn to the Coliseum by its broody atmosphere, and oblivious to the practical importance of its architectural orders over four centuries of construction.

Architectural commentaries are not immune from the equation of building costs with tourism benefits. Several years ago, for instance, with an article in the *Los Angeles Times*, then dean at UCLA Richard Weinstein defended the financial sacrifices required by the *Walt Disney Concert Hall* by arguing that, in light of the links between culture and commerce, great cities demand great (as in implicitly expensive) buildings, as Sydney showed.[12]

My problem with approaches such as these is not that they are not convincing, but that they are partial. By blending aesthetic sophistication and architectural populism while shying away from technical analyses of the industry, they reduce our ability to articulate the need for technologically intelligent architecture and industrially meaningful opportunities. Without perceivable linkages between localized costs and general benefits, eventually only entertainment complexes and transportation terminals will become objects of industrial research and architectural development. All the other types of commissions without a direct link to income generation or tourist parks—from schools to hospitals, incinerators to libraries, town halls to ministries—are likely to result in building projects with a limited innovation mandate, or else with private and sometimes vested patronage.

Los Angeles newspapers – 1992/1994

Thake's dishes, in the end, are important as a light, suggestive reminder of what the import of architecture for building can and perhaps should be. They invite a perspective that could enhance our understanding of the reach or limitations of civic buildings, strengthen the rationale for them, and help us discriminate between relevant and not-so-relevant examples. In fact, the distinction between

innovation and invention is important here. Thake's image surmounts the concept of "invention" (the introduction of new practices) and suggests that "innovation" (the adoption of these practices beyond their point of introduction) is what most counts. [13] For a public building to be innovative, then, formal idiosyncrasy or technological experimentation are not enough: it must affect the rest of its industry.

For the moment, a good step in that direction could be to espouse and support an unadulterated technical review and criticism of constructed architecture, one that celebrates the work done here and now while following its repercussions later and elsewhere.

For this to happen, the birth of the committed *building reader* may have to coincide with the strategic death (or temporary kidnapping) of the architectural author.

NOTES

[1]. I have discussed the innovation advantage of institutional buildings in: "Cost vs. Investment: Architecture, Technical Knowledge and the Socialization of Value," *Center 11—Value 2,* Michael Benedikt, ed. (Austin: The University of Texas Press, 1999), 130–141. Useful terms of reference are: Marian Bowley, *The British Building Industry: Four Studies in Response and Resistance to Change* (Cambridge, University Press, 1966); Graham J. Ive, Stephen Gruneberg, "The Contracting System," in: *The Economics of the Modern Construction Sector* (London: MacMillan Press, 2000); David M. Gann and Ammon J. Salter, "Innovation in Project-Based, Service-Enhanced Firms: The Construction of Complex Products and Systems," *Research Policy* 29, 2000, 955–972.

[2]. Interestingly, the most complete account of the Sydney Opera House as built is the illustrated children book-like publication by Michael Pomeroy Smith, *Sydney Opera House – How it was built and why it is so* (Sydney, William Collins, 1984).

[3]. The books I am referring to are: Françoise Fromonot, *Jørn Utzon, architetto della Sydney Opera House* (Milano: Electa, 1998); Philip Drew, *The Masterpiece—Jørn Utzon: A Secret Life*, (South Yarra, Victoria: Hardie Grant Books, 1999); Philip Drew, *Jørn Utzon and the Sydney Opera House: As it Happened 1918–2000* (Annandale, New South Wales: Inspire Press, 2000); Peter Murray, *The Saga of Sydney Opera House* (London: Spon Press, 2004).

[4]. Utzon's involvement with the Sydney Opera House started in 1958 and finished in 1966. At that time, the estimated cost of the building was 50 million Australian dollars. The building was completed in 1973, under the supervision of Hall Todd and Littlemore, at a cost of 100.9 million Australian dollars. If one considers 1954 prices, the year when the decision to build it was made and the initial budget was set, the third stage of construction (between 1967 and 1973) took 35% of the overall building cost. In 1954, the initial budget of the Sydney Opera House was three million Australian dollars. When adjusted to price and real cost indexes using 1954 as a base, the final cost of the building comes down to 55.9 million Australian dollars. But it was not until 1961, if not 1963, that cost estimates could be considered real. The adjusted cost of the building from this moment increased almost fourfold, from 15 to 55 million Australian dollars — 20 million before Utzon's departure and 20 million after.

[4]. These are my own elaborations, partly based on information contained in: Alex Kouzmin, "Building the New Parliament House: An Opera House Revisited?""*Working Papers on Parliament*, *Canberra Series in Administrative Studies* 5, Geoffrey Hawker, ed. (Canberra: College of Advanced Education, 1979), 115–171. They do not consider differences in square footage.

[5]. Operatively, the integrative nature of the project generated peculiar technical dynamics. On one side, technologies that could be considered 'robust,' in the sense that had so far proved themselves reliable good practice and relatively insensitive to incomplete information or errors of design, manufacture, assembly or use, were transformed into technologies with a much more refined (and hence les resilient) expected performance, sensitive to inappropriate development and less than flawless application, and thus requiring careful engineering. On the other side, technologies with precise scope, demanding the use of capital intensive equipment, and subject to factory quality control, had to be introduced to bring the behavior of particular sections of the building back to acceptable levels of 'robustness in use and performance' over time. (I am using the term 'robust' in the sense employed by Steven Groak in'"The decline of robust technologies in the building industry,""*Building Research and Practice*, 3, 1990: 163-169.)

[6]. See: Alex Kouzmin, 1979; Graham Winch, "Zephyrs of Creative Destruction: Understanding the Management of Innovation in Construction,""*Building Research and Information* 26: 4, 2000: 268–279; Sarah Slaughter, "Implementation of Construction Innovations,""*Building Research and Information* 28: 1, 2000: 2-17; Paul Nightingale, "The product-process-organization relationship in complex development projects,""*Research Policy* 29, 2000: 913-930.

[7]. Today, while the Sydney Opera House is embarking on a A$69 million renovation program, the federal government has announced the replacement of its 1960s era fleet with upgraded F/A-18 Hornets by 2010, followed in

2012 by a new generation of US F-35 Joint Strike Force fighters at an estimated overall cost of 12 to 15 billion Australian dollars.

[8]. The only exception is the competition for Melbourne's Federation Square, the brain child of the conservative Victorian state government in the mid-1990s which, possibly in light of seemingly unassailable leads in the polls and apparently strong economic performance, attempted to establish an explicit (albeit mostly rhetorical) connection with the Sydney Opera House and technological innovation. It eventually lost the elections.

[9]. New South Wales Public Works Department, *Sydney Opera House: Anatomy of Stage Three Construction and Completion, A General Index* (Sydney: Public Works Department, 1973). Today it is the best source of information on the industrial context, along with the celebrative brochure of the general contractor, The Hornibrook Group, *Building the Sydney Opera House* (Sydney: Hornibrook Group, 1973).

[10]. See: "The Sydney Opera House (1),""*Archives in Brief* 28 (New South Wales State Records, October 1999).

[11]. Weinstein Richard, "Great Cities, Great Public Works," *Los Angeles Times*, August 30 1994, B7.

Australia's foremost architectural thinker Robin Boyd, incidentally, had used a similar line almost thirty years earlier, in the 21 September 1965 edition of the *Sydney Morning Herald*, to praise Utzon's project while criticizing Welton Becket's contemporary proposal for the *Los Angeles County Music Center* (1960–1967), guilty of looking like the hotel Becket's office was designing at that very same time in Melbourne (the Southern Cross, unceremoniously razed last year). Boyd, of course, did not know that the Music Center would cost L.A. county taxpayers more money than New South Wales residents, since only 9% of the Sydney Opera House was financed through public expenditure—mainly used for bridge financing purposes—as opposed to the 40% required by its Los Angeles counterpart.

[12] V. W. Ruttan, "Usher and Schumpeter on Invention, Innovation and Technological Change,""*Quarterly Journal of Economics*, November 1959, 596–606.