The Value of Fragmentation: A Critical Look into the Assembly of Design Structures

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By popular belief and academic endorsement, the design of buildings tends to be associated with a limited group of characters—architect and fellow consultant engineers—upon which falls the responsibility to formulate ideas and develop instructions for their consistent transformation into building artifacts. But if one looks at the reality of practice, it is not difficult to realize that the structure for procuring design is more open, and relies on a profusion of expertise distributed across the entire building sector. While the architect formally remains at the center of the design effort, specific duties can be, and often are, assumed by complementary parties—additional client advisors, program consultants, trade specialists, component suppliers, erection contractors, and information technicians—that fill specialized design knowledge niches.

So far, the literature on practice has not paid much attention to such contributions, instead remaining focused on the architectural firm, and explaining the practice of the project mostly through the practice of the architect (or the design/production team, when applicable).

Having the space or the time, one could show that the partiality of this view reflects the attachment of the literature to a distinct cultural paradigm—developed around the idea of architecture as a "profession"—which does not account, conceptually, for design fragmentation.

But is this an appropriate position, or does it fail to recognize that the proliferation of duties has the potential to affect the practice of design and the dynamics of the profession, and should thus be considered in the discussion on both?

With the idea of stirring some reflections along these lines, I am going to present the results of a study dealing with the fragmentation of the design team in a high-profile project —the Walt Disney Concert Hall. The work was developed at UCLA as part of a doctoral research concerned with the distribution of design responsibilities in the building process. The intent of the study was to demonstrate two things: first, that the composition of project teams and the allocation of duties could be examined according to criteria employed by industrial literature to analyze the dis-integration of production systems; second, that doing it would shed some light on extent of design specialization, and possible evolution of design structures.

Designed by Frank Gehry, and at the time still under development in Downtown Los Angeles, the Disney Hall made the perfect laboratory for this type of work. It was a complex endeavor in terms of program, constructional characteristics, and procurement strategies, which called for comprehensive building expertise and a variety of specialized knowledge.

Methodologically, the idea was to follow the design process, record all the contributions, and examine the structures of work behind them, trying to understand the reasons that kept things separate rather than together (that is, not under the same administrative structure). Whether this was accidental, based on the profile of the architect or on project-specific circumstances, or whether it responded to more substantial factors, which made independent practices necessary or preferable.

As imagined, the structure in charge of the design turned out to be very fragmented and heterogeneous. As contracts and other records indicate, over 30 entities, acting in various capacities and for different periods of time, helped architect, acoustician, and engineers, generating the information used

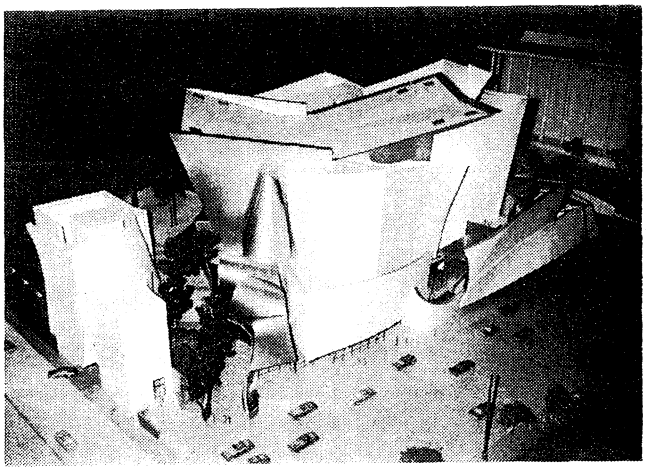

Fig. 1. A model of the Disney Concert Hall.

on the project. The final list of consultants, and the description of their duties, show that contributions were sought for every facet of the design problem, and involved parties with different profiles—traditional design professionals, independent experts, contractors, and technicians.

Programming and functional design for the various parts of the project—garage, hotel, auditorium, support spaces of the hall, and garden—were developed with the help of architectural firms, each specialized in the specific type. The design of several systems and isolated elements of the hall—vertical transportation, food facilities, lighting, security/phone, audio/visual, organ, and external maintenance—was also outsourced to specialists, either professionals or contractors. Detail (and sometimes conceptual) design of building components—curtain wall, glazing, roofing, exterior paneling—used the expertise of independent trade consultants, erectors, and suppliers. Technicians, craftsmen, contractors, and industry consultants developed procedures, engineered or built prototypes, and executed tests, to measure the performance of the design in terms of acoustics, vibrations, wind loads, weatherproofing, constructability, etceteras. In addition to the knowledge employed for the definition of the artifact, other firms were hired to perform particular design-related tasks. Production of contract documents and project administration were the responsibility of an executive architect; whereas control and organization of electronic data, coordination of written specifications, and code compliance were each assigned to other independent firms.

Architectural design
Frank O. Gehry & Associates

Engineering
civil (Psomas Associates)
traffic (Kaku Associates)
geo-technical (Law-Crandall)
shoring (Lehmer Associates)
structural (CBM Engineers)
mechanical (Levine/Seegel, Cosentini)
electrical (Brown Associates)
hall Acoustics (Nagata Acoustics)
overall noise control (Salter Associates)

Functional design
parking (IPD)
hotel (WATG)
hall/Back of the hall (TPC)
garden (Moline, Goslee Power)

Building components and systems
elevators (Lerch & Bates)
food facilities (Laschober & Sovich)
organ (Barone, Rosales)
lighting (LAM)
security/phone (Con-tech)
audio-Visual (Acromedia)
maintenance (Lerch & Bates)

Construction and fabrication
curtain Wall (Gordon Smith, Johanson)
stone support (Harmon Contract)
roofing (Gaines Associates)
stone selection (Heinlein/Inspecom)
stone fabrication (Furrer Marmi)
sheet metal (Zanher Metals)

Testing
hall acoustics (Nagata Acoustics)
general acoustics (Salter Associates)
vibrations (BBN)
wind engineering (Wind tunnel Lab)
stone (Heinlein/Inspecom)
sheet metal (Zanher Metals)
model making (Johnson Models)
mock-ups (Harmon, Sygma Bonnel, CRL)

Information management
construction documents,
project administration (Dworsky Associates)
cadd/catia systems (C-cubed)
coordination specifications (ANC)

Other
project management (Stegeman & Kastner)

Fig. 2. The contractual distribution of design responsibilities.

In the end, the design team resembled a large, flexible organism, centered around the work of the architect and a few other parties, but constantly attracting and releasing elements, forming and undoing collaborations on specific issues, and adding each contribution to the information capital of the project.

Reading this organization through the lenses provided by the debate on production systems was indeed possible, and made it clear that the fragmentation of the Disney team could be interpreted in light of specific elements. For the activities with a knowledge-base related to the architectural discipline, the most significant of them—practically informing the work of every design contributor—was the presence of *external economies*; that is, the possibility to achieve a more efficient use of resources by splitting the same production process into separate production units. This may sound obvious, given that the object of the study was a fragmented structure, but it is important to see what determined them.

External economies were generated chiefly by the interplay of three factors, that combined differently for each actor. One was *product complexity*. The development of most design tasks required a degree of specialization—expertise in the particular problem, knowledge of specific techniques—which was internal to the task and could not be achieved through generic architectural activities; which demanded dedicated training (often equipment), and, in the case of a generalist practitioner, would only be used for a however fractional part of the work. The investment in training, human resources or equipment, together with criteria of optimal use, demanded minimum scales of operations for the specific design trade that could not have been met by the architectural firm, due to the nature of its—essentially project-based—market. Internal specialization, in other words, would have created 'production imbalances' inside the firm.

Another factor, partially connected to the previous one was

technological sensitivity. The expression defines a situation where a product, or the technologies associated with it, are subject to frequent modifications, either because they have not completed their evolutionary cycle, or because change is a built-in characteristic of the work. Under these conditions, the trade tends to stay on its own for three reasons: (1) the acquisition of related expertise does not stop, and needs constant exposure to occurring developments; (2) it is difficult to monitor the evolution of the trade by using it occasionally, without specializing; (3) adjustments or variations in technology are likely to cause the obsolescence of both equipment and knowledge at a much faster pace than 'robust' environments, further increasing operating costs. Thus, along with product complexity, technological sensitivity favors the concentration of investment and training with specialized parties, that, by accomplishing larger scales of operations, can provide state-of-the-art expertise, while distributing services, and amortize costs, across a larger pool of clients than a vertically integrated firm. Technological sensitivity would define the majority of tasks in the Disney Hall, but acted as main outsourcing factor only in a few cases. In fact, the natural turbulence of many design trades had already determined their definition as autonomous specialties.

A third factor was defined by *external linkages*, or functional interdependencies between design responsibilities and other activities external to the task. In many cases, the knowledge, the ability to generate adequate information, perform a certain task properly, or efficiently, depended on these connections with other functions, usually precluded to the architect. Trade and system consultants would be competent at providing package specifications, or detailing the project, in light of their work as inspectors, failure analysts or maintenance contractors; sub-contractors could be effective and interested in developing components' engineering proposals building on proprietary technologies; suppliers could design sub-components by considering fabrication constraints, etceteras. In general, external linkages would generate advantages that depended on the "organizational scope" of the service provider.

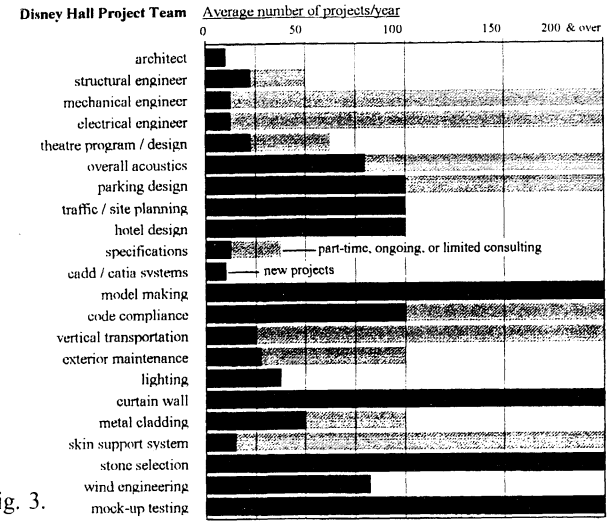

Fig. 3.

Each of these factors contributed to creating a problem of compatibility between the profile (or the conditions) required to perform the particular task efficiently, and the nature of the architectural work, or—which is the same—the structure of the (generalist) architectural firm. Vis-à-vis this scenario, the "network" pattern characterizing the project team offered the most appropriate solution to carry out the work. Fragmentation assured the structure the flexibility it needed to pursue different economies: it provided the ability to specialize—that is to achieve labor configurations most suited to each task—while coping with structural differences, managing innovation, minimizing financial exposure, and maintaining necessary interdependencies. In addition, the agglomeration of expert parties reduced the probability of technical shortcomings, and with it, the risk of liability exposure. Last, the cost of the transactions needed to bring the scope of the work together—in theory one of the major deterrents to fragmentation—did not constitute a sensible drawback: the inter-organizational nature of the building process already implies high levels of transactional activity as well as informal cooperation and repeat-work ties between parties.

Every other element of the project played a minimal role in determining the composition of the team. Only a few entities were hired with the purpose of integrating skills or functions needed inside Frank Gehry's office. Except for the executive architect, Dworsky Associates, the expansion simply reflected a trajectory of growth, and those involved were incorporated in the permanent structure of the office soon thereafter.

The situation of the market is slightly different. It was not a factor in the specific distribution of responsibilities, for, in most cases, the conditions determining dis-integration advantages would have remained, no matter the increase of work in each firm. From a larger perspective, however, one could say the market had a role in the formation of the network. Some of the specialties at work on the Disney were a direct result of the restructuring of large firms in the early 1970s, which caused a partial spin-off of the employment into independent consulting. Moreover, the development of a strong retrofitting industry in the last twenty years helped establishing and sustaining other specialties that were on the team.

The architecture of the hall determined the large agglomeration of design trades but not their procurement. The analysis of the project team showed that the organization of consulting was independent from stylistic aspects. Except for a limited number of cases, the composition of the team reflected the presence of a consolidated market beyond the project. For most participants, the difference between the Disney Hall and standard practice amounted to length and extent of involvement (and consequent contractual agreements), a result of the very high level of integration between design aspects. None of them, though, was required to modify customary scope of work to suit the specific endeavor. Tasks performed were all in line with the specializations implied. Interestingly, for a good part of the project

team, the existence of a market was based on the presence of conditions analogous to those found in the auditorium, that is, the need to work on unique solutions by using highly normative knowledge. If the Disney Hall was unusual in the variety of design problems it had put together, it represented a normal project for the consulting sector when considered specialty by specialty.

In the end, this study showed that the composition of design knowledge for an architecturally unique building, conceived by a renown architect with an idiosyncratic approach to the discipline, was very elaborate, but had very little to do with either element. Its assembly depended, for the most part, on factors outside the control of architectural practice, on logics internal to the building product, its anatomy and evolution, and to the ways in which the industry organizes to produce it. In this sense, the Disney Hall could be taken as a window-case of existing specialization.

The linkages of the latter to the individual trades rather than the architectural firm were reiterated by the review of the project-and-client lists of the various team members. Each company had collaborated with all types of architectural firms and building markets. The same technical expertise had been requested by corporate offices and boutique-like ateliers, for speculative developments as well as architectural showpieces. This not only for particular trades such as theatrical systems, food facilities, or noise control, but also for parking, curtain wall, maintenance, specifications, vertical transportation, code compliance, and so forth.

The supply of these services underscores the intrinsic contradiction of design fragmentation: on one side, the substantially similar behaviour of very different architectural firms - buying the knowledge on the market to solve specific design problems - confirms its structural separation from conventional practice. On the other, the expertise available on the market betrays a strong contiguity with the work of the architect, so much as to suggest the erosion of its scope.

Time limitations keep us from going into the chronological aspects of this scenario. Suffice it to say that the framework outlined is relatively recent: in their current format, independent design specialties rarely go back more

	theatre program/design	hall acoustics	overall acoustics	parking design	hotel design	glazing	specifications	conditioning systems	model making	code compliance	vertical transportation	exterior maintenance	lighting	audio-visual systems	phone/security	curtain wall I	curtain wall II	metal cladding	skin support systems	stone selection	stone fabrication	Venice Biennale mock-up	utility pre-bid proposals	roofing/waterproofing	vibration/noise control	wind engineering	mock-up testing
Characteristics of the task:																										
knowledge external to building	●	●	●						●				●		●	●			●		●	●				●	●	●
requiring specific techniques of work	●				●	●				●	●	●								●				●	●			
need for dedicated equipment			●	●						●	●	●		●								●	●				●	●
technologically sensitive	●	●	●					●	●		●	●	●	●	●	●			●	●		●			●			●
ongoing relationship with architect or pm					●		●	●	●		●	●	●			●	●	●			●		●		●			
minimum/optimal scale of operation			●	●	●			●		●	●	●	●												●			
presence of external linkages	●							●			●	●	●	●	●	●	●	●	●	●	●	●	●	●				
assumption of liability	●				●	●		●			●	●					●			●								
Reasons for non-integrating:																												
functional specialization	●	●	●	●	●				●			●	●	●	●	●		●		●					●	●	●	
product complexity										●						●	●		●				●	●				
technological instability								●	●		●	●													●			
economies of scope	●							●		●	●	●	●	●			●		●	●	●	●	●	●				
differing economies of scale	●				●	●		●		●	●	●	●												●			

Fig. 4.

than thirty years, and most have been in existence for less than twenty.

More important to the economy of this discussion is the fact that, for as recent, this decentralization pattern has no reasons to lessen its extent. The building process is likely to maintain a structure that favors the achievement of external economies (both in scale and scope), and the expansion of horizontal niches: the normative framework of design seems to grow constantly; building performance requirements have been getting more diverse and demanding, technically as well as functionally; the use of conventional, i.e. site-related technologies, is being reduced overall, to the advantage of manufactured systems and components with a shorter innovation cycle; and the industrial dispersion of the building artifact increases the weight of "external linkages." To this set of conditions, it might be added that architects' low retribution contributes to the contraction of design time and workloads with the professional component. Perhaps consequently, the latter seems to be getting used to the availability of external resources, adjusting work and internal expertise accordingly. Interviews with consulting firms from different sectors have shown that the conditions leading to the use of specialists are changing. Until a few years ago, their engagement mostly concerned complex or financially demanding projects; today's trend includes also informal approaches to less important buildings, where the same specialists provide consulting services by sitting on pin-up reviews with the project team.

The arguments contained in these pages serve to clarify three things: (1) The amount of design expertise allocated with specialties is conspicuous, enters all aspects of the building problem, and responds to clear logics, that make one expect the stability, if not the further consolidation, of the picture. (2) The distribution of design responsibilites does not simply reflect production duties; it implies a geography of knowledge behind them, which is not duplicated in the architect's office, because the motor of design specialization is the generation of economies. This puts the specialist in a position of relative authority whenever his knowledge is needed. But, (3) once fragmented, the nature of the knowledge is transformed. Specialization, in fact, tends to produce the separation of technique and language, and a distinction between product and project design. With the raison d'être of design specialties being the pursuit of horizontal economies of scale or the accomplishment of external linkages, technical knowledge becomes associated either with a "class of products" or with outside activities; both imply a degree of conceptual autonomy from the individual project, broader in scope, and from the professional practice associated with it. In other words, the specialization of design creates an infrastructure that relates to the building—its types, parts, or procedures—more than it does to the architect. It is perfectly normal that Frank Gehry & Associates uses the same consultants as SOM, because the work of these consultants is not related to the architectural firm, but comes with, accompanies, the technicalities of the building problem. The architect

is a "variable," while the technical apparatus of support is the "invariant."

Now, if the detachment from the project confers expert status in these conditions, it also implies cultural neutrality, which is what extends its validity across the industry. Specialized design decisions, then, tend to stand naturally outside the value system of architecture—centered around the project—and much closer to a generic idea of functional efficiency, at the very time the architect relies on specialists to provide informed advice. This leads us to the reason why the fragmentation of responsibilities is an important topic of discussion in architectural practice.

On one side, the idea of a technical infrastructure independent from the architect brings up a host of issues related to the profession and its dynamics: the possible relation between decentralization of knowledge and the organization of the professional market; the validity of the equation firm size/expertise which has characterized the history of modern American practice; the possibility of different growth trajectories; the necessity to acknowledge the functional diversification of architectural firms; the ability of design specialization to open windows of opportunities for professional labor markets; and the position universities should take in this context.

But, operatively, it poses the problem of how the two domains, technical and semantic, can interact in the definition of the building artifact. The presence of an "expert" component has shown its ability to affect the architectural space of the project in opposite ways, by establishing product-based restrictions and developing efficient solutions, or by bringing the realm of possibilities to a new, higher, dimension—by putting knowledge to the service of the architecture. What determines these results? The clout of the architect, the design occasion, the organization of the work, the relationship with the consultants, their profile, or the definition of what constitutes architectural material and what does not? The evolution of a technical cast does not create these questions, but it makes answering them a relevant task for the profession.

In summary, this quick inventory indicated the richness of the issue, and the number of critical directions that a perspective on specialization may set us off to. Following them was not in the intentions, nor in the power of a short paper, and a structured discussion around each of these topics will have to be adjourned to future occasions. As a temporary conclusion, however, we can offer the three methodological indications that came out from this reading.

The first is that the study of architectural practice must expand beyond the architectural firm. Since exogenous patterns do affect the intellectual space of the profession, the focus of the investigation must be broadened to include all the factors with an impact over the operative domain of the architect. (The expansion of the critical debate should, of course, enter the educational environment, not only to build an awareness of the conditions in which architectural practice operates, but also to provide a chance to make choices with regard to one's role in it.)

The second indication is that individual building projects provide fertile fields of analysis, which can yield a wealth of information hardly obtainable otherwise, and should therefore be used to the advantage of such studies.

The third is that the framework defined in this way can be examined by using critical categories that belong to production-oriented environments, but can help figuring out the logics of the work, and the likelihood of certain futures. "It may be objected—paraphrasing a vintage Manfredo Tafuri—that such an economic reading of (design) production is other than the reading of architecture as a system of communication." But, as he replied then, "when wishing to discover the tricks of a magician, it is often better to observe him from behind the scenes rather than to continue to stare at him from a seat in the audience."