CONSTRUCTION PRODUCTIVITY IMPROVEMENT THROUGH A COMMON UNDERSTANDING OF THE PARTS OF BUILDINGS

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A forty-year decline in overall productivity in the US construction industry has contributed to this country's decidedly lackluster showing in what should be a global marketplace for our services. Some of the reasons for this decline have been commented on: the increasing complexity of what we are building, the lack of research and development efforts and effective technology transfer within the industry, and the lack of specialized training for our construction work force. It has been pointed out, however, that the greatest improvements in productivity within the construction process will not be achieved by concerning ourselves exclusively with the technological problems of specific job-site operations but by looking also toward improvements that reside at the level of planning and management. Overall job productivity and cost effectiveness require intelligent planning decisions made as early as possible in the design process, where effective correlation between design concept and architectonic reality is most difficult to achieve. Current pressures have created increasing demands for faster planning and construction, greater cost effectiveness, and improved building performance; these challenge industry professionals (architects, engineers, consultants, quantity surveyors, construction managers, constructors, etc.) to remove the isolation in which they have typically worked. As the tasks and responsibilities of these specialists are continually reduced and refined, efforts to maintain mutually supportive relationships between them must be predicated in their common goals. Each specialized contribution to a building project, although focused on its own set of criteria, has an inherent interest in the facilitation of the construction process and the final end performance of the building as a spatial phenomenon. The physical building, as it is experienced both in the process of construction and in actual use, is the basis for a logical subdivision and analysis of its own parts. A consistent understanding of the definitions and organization of the physical parts of a building by all specialists involved in the project will foster a strong reading of the fundamental relationships between the professional participants and their collective effort as well as between the material parts and the whole building. A useful hierarchy for the conceptual and administrative development of a building project is suggested by the spatial disposition of the actual parts comprising the building. This hierarchy of parts inspires the classification method proposed here. The generic disposition of formally distinguishable material objects in space thus becomes the paradigm at once for their own conceptual subdivision into intelligible units and for an understanding of the administrative relationships among the efforts of the participants involved in the project.

In order to derive a common language for the development of the construction project, professionals must study the organizational scheme of the physical parts of a building according to its hierarchical distinctions from ***whole*** to ***systems*** to ***components*** to ***eleme****nts.* A typical building may incorporate a number of systems including, for example, Foundation, Frame, Envelope, Partitions, and Services. Although each is a distinct and clearly definable part of the building, the physical interrelations between these *systems* is critical since they must all fit together as a coherent whole, properly joined to insure their integrity in all kinds of anticipated conditions. The relationships between the various professional specialists who contribute to the design and construction of these systems is similarly critical.

The *systems* can he subdivided into *components.* For the foundation there are footings, foundation walls, grade beams, and slabs-on-grade, etc. For the frame there are columns and beams or bents, joists, rafters, purlins. bracing, spandrels, sub-floor, etc. Envelope may be comprised of sheathing and siding panels, windows, insulation, decking, roofing, gutters, sealants, and flashing, etc. Partitions are made up of interior walls, doors, flooring and ceilings, stairs, elevators, and fixtures of various kinds. Services include mechanical equipment, shafts and ductwork, electrical and data wiring, building controls and alarms, fire protection systems, piping and plumbing equipment (these are subservient to the internal space-defining parts). In turn the *components* can be broken down into *elements* of increasing number and specificity.

This method of classification of the fundamental physical order of the building’s parts in their locational relationships suggests an organizational order for the development of the construction project itself. Such a generic subdivision of the physical parts and assemblies of buildings can allow specialized attention by each member of the project team to individual parts independently, but without losing sight of the underlying structure which binds them together, in an association of constructable and well functioning systems.

An examination of the design of the envelope *system* of a building can show how this classification method helps to maintain a sense of unity across disciplines. In the case of the envelope's siding *components,* the architect focuses upon the way they express the building's mass and its proportional subdivision into formal units. The architect is also responsible for the thermal and moisture protection of these *components,* as achieved through the detailing and connecting of their constituent *elements.* The junction of the roofing and siding *components* within the envelope *system* will warrant special attention because of the critical nature of their interdependent behavior. The design of the envelope *system* requires also a structural engineer, who analyzes the panels' statical functions as diaphragms resisting shear forces and transmitting their lateral loads to adjoining members. The engineer also calculates the specific dead loads that these *components* will contribute to the *systems* to which they attach as well as the structural effectiveness of the fasteners used to make such connections. Though addressing different concerns, both the architect and the engineer can maintain a consistent view of the subdivision and organization of their efforts, as informed by the way the building will be constructed and experienced in use. Questions of constructability are thus inherently anticipated in the earliest stages of design development where abstract and conceptual considerations must be understood in terms of common, practical objectives.

A format for written specifications can likewise be modeled after the organization of building parts rather than after comparatively abstract notions like material type or qualities like "moisture protection" and "finishes." Organization of specification sections according to an assumed sequential work of conventional trades, while advantageous to subcontractors who find it convenient for their bidding, actually detracts from a focus on the actual building as end product of our work. More important than the separation of labor specialization is the rational division of building parts, their form, location, and expected performance. With a solid understanding of "what' is to be done, the question of "who" shall do it can, in turn, be answered. The subdivision of *systems* into *components* and *elements* of *components* clarifies the process of quantity surveying, procurement, construction process planning, and quality control, suggesting that the relative spatial disposition of the constituent parts of the building is as important as the parts themselves, Once on the construction site, we can be assured that the physical assembly and erection process itself has been well thought through in the design, planning, estimation and procurement phases that preceded it and not as an afterthought. Here the parts of design conception, engineering, and planning are also the parts of construction and end use.

Thinking of a construction project in terms of ordered hierarchies of information is not new. Large and complicated systems are routinely broken down into more manageable pieces. Given the growing diversity of specialized considerations which comprise the building organism today, however, the difficulty arises as to how practitioners can communicate amongst one another and make intelligent and effective decisions early in a project's development. Like the builders of the Tower of Babel, we all seemingly speak a different language and need a common reference against which to compare notes. The conceptual division of the building into parts according to their physical disposition in the constructed work is a logical choice for the basis of a taxonomy that informs not only the construction project's physical structure but also the administrative organization of its design. This framework encourages the interaction of many specialists according to the locational interaction of the building parts which, though specific and technical, must work interdependently within a coherent organism. The renowned architect and theorist of the early Renaissance, Leon Battista Alberti, observed:

"All the power of invention, all the skill and experience in the art of building are called upon in compartition; compartition alone divides up the whole building into the parts by which it is articulated, and integrates its every part by composing all the lines and angles into a single, harmonious work that respects utility, dignity, and delight"[1]

Now, as in the fifteenth-century, a clear understanding of the subdivision of the physical parts of a building and a commitment to their coherent reading in all phases of the design and construction process will significantly improve construction productivity.

1. Alberti, Leon Battista, On The Art of Building in Ten Books. trans. by Joseph Rykwert, Neil Leach, and Robert Tavernor, MIT Press, Cambridge, MA, 1991, p.23.