ARCHITECTURE: "THE PRODIGAL SON"

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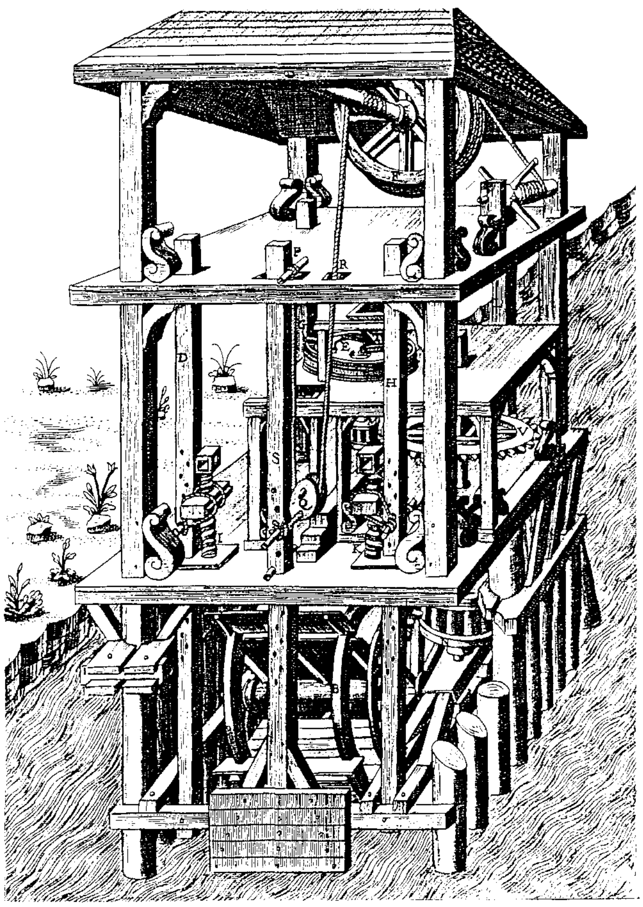


Plate #117. The Various and Ingenious Machines of Agostino Ramelli

INTRODUCTION

What does an architect do?
An architect draws things and gives the drawings of things to other people who build buildings.
A Pennsylvania third grade student[1]

Institutions create certainties, and taken seriously, certainties deaden the heart and shackle the imagination.
Ivan Illich[2]

The architectural discipline, including architects and interior designers, tenuously resides between the disciplines of construction and engineering. The traditional adage is that this position provides the proper platform to transcend mere building into architecture. This paper explores this platform from a professional and educational standpoint given the future context of rapid technological evolution. Technology is not only the actual artifacts of our culture and the processes of their making, but also includes the mental framework of thinking that results.[3] As technology evolves and expands, so does our mental capacity for knowledge and imagination. The complexity of technology, even now, has pushed construction and engineering beyond the empirical knowledge sphere of the architect and into the realm of abstraction. The majority of the American educational institutions, logistically unable to deal with technology directly rely on topical survey courses to build an introductory awareness. This results in the tendency to think *about* construction rather than *through* construction. When technology and construction become isolated activities not included as part of the design process, the capacity for technological imagination developed through the empirically inventive act of construction is lost. Utilizing the ideas of technological "imagination" and "invention" borrowed from other disciplines, this paper proposes that we consider ourselves "technologists" with the goal of developing an empirical understanding of technology and a "technological" process of design to take advantage of the possibilities of a complex and expansive future.

Kenneth Frampton in his article "Rappel a l'ordre: The Case for the Tectonic" proposes that the current degenerative state of our built environment results from a "tendency to reduce architecture to scenography."[4] Scenographic design attitudes, akin to empty formalism, result in "the total destitution of commodity culture," and a general "cultural degeneration." Architecture is unable to come to terms, support, or further the contemporary cultural condition. To reformulate a ground for our discipline, Frampton proposes that we return to a material base, "namely that architecture must of necessity be embodied in structural and constructional form," hence tectonic form. Through the reaffirmation of design as construction, in lieu of a formal construct, the discipline of architecture can better come to terms with the technological and multi-dimensional demands of our culture. Frampton's argument, however, is limited simply to a re-interpretative shift whereby "architectural form" becomes "architectonic form." Considered primarily as static artifact, the construction process and its role in design is not addressed. Without a tectonic process to reveal tectonic form, the "tectonic" becomes just as scenographic through its emphasis on final product and architecture thought of as commodity. A tectonic process, or technological process of design, requires first and foremost an acknowledgment of the primal relationship between the act of design and the act of construction.

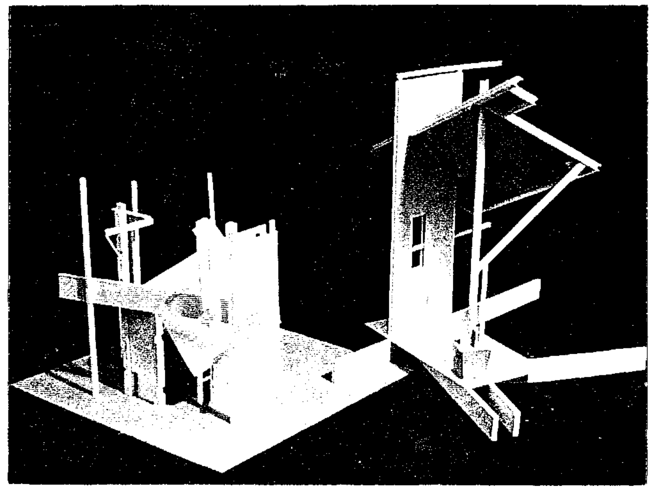
RIFT BETWEEN ARCHITECTURE AND CONSTRUCTION

...building, after all, is primarily a craft, a practical rather than an academic pursuit.
Crinson and Lubbock

AIA Document A201, General Conditions of the Contract for Construction defines the responsibilities of the Contractor and Architect during the construction phase of a project.[5] Per Article 3.3.1: "The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract." Conversely, per Article 4.2.3: "The Architect will not have control over or charge of and will not be responsible for construction means, methods, techniques, sequences or procedures, or for safety precautions and programs in connection with the Work, since these are solely the Contractor's responsibilities." For the architect to become involved in "means and methods", the inventive act of construction, is to violate the construction contract and assume professional risk. One must assume, and hope, that the construction documents are imbibed with, and generated through, an understanding of construction. The requirement to stay clear of the means and methods of construction breeds an attitude of hesitancy whereby the architect purposely avoids the difficulties of construction. This hesitancy reinforces the status-quo nature of the built environment as it is safer, more economical, and less threatening to remain within the bounds of known construction types. The instigation of unique building systems in the search of a more vital architecture becomes a risky endeavor. The future holds a distant past.

The rift between architecture and construction defines, in fact, a key boundary of the profession. Crinson and Lubbock, in *Architecture—Art or Profession? Three Hundred Years of Architectural Education in Britain*, chart the development of the architecture educational institution, and its relation to the profession, dating from Sir Christopher Wren to the present.[6] While specifically focused on the British condition, the book chronicles the evolution of the profession as a purposeful diversion away from the actuality of making and alliance with the building trades toward a discipline of intellectual rigor. With numerous "arts and crafts" rearguard movements notwithstanding, the consistent drive over the last three centuries has been to define architecture as distinct from both construction and engineering. To receive the accolades bestowed upon an esteemed legal, quantifiable, and specialized profession, it became necessary to cast aside construction as a meaningful and empirically known activity. The professional license became the crowning proof of competency. Architects were not to be builders and makers, but rather intellectual managers of the built environment activated with the knowledge to deal with the more pressing social, political, and cultural problems of the day.

The American educational institutions have become the only initiation routes to professional licensure, following the policies of NCARB and enforced by the NAAB. I will argue that when qualification for the licensing exam was not limited to an accredited institution the groups of participants who came by way of apprenticeship, construction, fine arts, or other assorted backgrounds offered a wealth of experience making architecture a well rounded and more imaginative discipline. The architectural specialization embodied a platform of differences rather than similarities. Of late, those persons not interested in the initiation route have had to find recourse in the allied fields such as interior design, industrial design, graphic design and environmental design. Interior design will soon follow architecture's lead in throwing out diverse backgrounds in establishing its own professional licensing requirement. It seems that in preparing for the future, the architect has limited the vision of the profession to a very fine, distinct specialization. This specialization, unfortunately, is not founded in a direct understanding of technology or construction, and as such, may limit our versatility in exploring the opportunities of the future.


Phase One: Tectonic Language Constructions. Darren Murrey, Washington State University. The beginnings of a crane.

TECHNOLOGY

Modern technology has apparently given us the possibility of doing anything, and we can use any building material as a stage designer uses cardboard.
Eladio Dieste[7]

The nature of form is inlaid in the process of making.
Giuseppe Zambonini[8]

A tectonic process for design, or a technological process, begins with a self view. Eugene Ferguson in his book *Engineering and the Mind's Eye*, discusses the nature of design, invention, and creation as primarily a technological endeavor.[9] Focusing on the discipline of engineering, the designer is referred to as a "technologist". A technologist "includes designers, inventors, engineers, mechanics, and users of technology - anyone who brings special skills or knowledge to technological endeavors."[10] This paper proposes that we assume the title of "technologist" (no offense intended to our engineering colleagues) in order to embrace the inventive and evolutionary possibilities of technology.

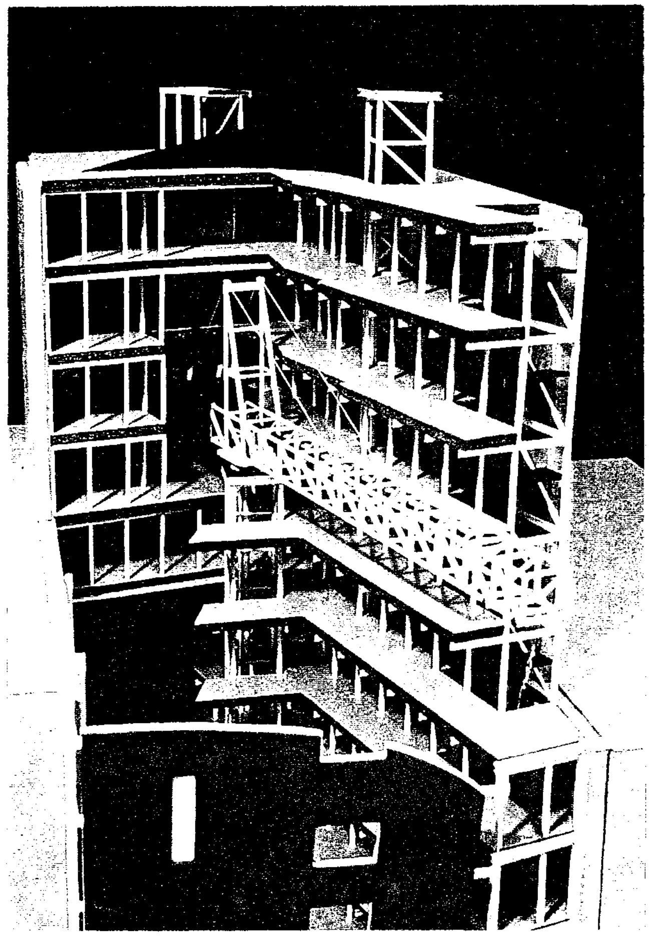
Relative to technology Steven Lubar, in his article "Representation and Power," describes two major themes in the recent historiography of technology: "technology as visual thinking" and "technology as social process".[11] For the visual thinking school, technology is knowledge which is pure thought. This knowledge exists "only in the inventors mind as he or she imagines the linkages and structures to use." Technological representations, both drawn and read, are seen as "a means of thinking out purely technological issues." The technology as social process school, on the other hand, "focuses on the social nature of technology, attempting to explain technological change in terms of social and cultural demands." Both of these historiographies are relevant and describe technology first and foremost as knowledge and dynamic processes of thinking. Central to a technological design process is the understanding that the definition of technology is not limited to the products and their processes of production, but must include the framework of thinking which is generated. This consideration of technology transcends specific technologies, classifications of modern and traditional technologies, and high and low technologies.

The design professions face, and will continue to be affected by, the evolution of technology. For George Basalla, in *The Evolution of Technology*, the most basis unit in consideration of evolution is the technological artifact. Artifacts can be read to reveal the technological knowledge of the designer and the maker. In construction of greater artifacts, the designer operates in a context filled with a "diversity" of artifacts. Diversity is "an acknowledgment of the vast number of different kinds of artifacts, or made things, that have long been available."[12] These artifacts include, as a by-product, the mental frameworks generated by their existence and use. It can be tedious to watch a black and white television with rabbit ears when one is accustomed to the preciseness of cable reception and a remote control. Mental frameworks of thinking are directly effected by the diversity of artifacts which develop an awareness of the possibilities and opportunities perceived in past and future artifacts.

Technological imagination is founded in this awareness of artifactual diversity and holds a powerful place in our culture. "Machine Books" dating from the 1400's, are popular examples of the evocative power held by this imagination generally titled *Theatrum machinarum* (theater of machines). In discussion of "technological dreams," Basalla notes that the machine books "epitomize the technologist's propensity to go beyond what is technically feasible."[13] One of the best known of these imaginative treatises was written in 1588 by Agostino Ramelli, a French military engineer. Recently republished as *The Various and Ingenious Machines of Agostino Ramelli*, the book is a collection of plates and text which delightfully describe, in great detail, numerous machines.[14] In this, and other treatises, the inventive possibilities of technology are explored through the depiction of wondrous machines and the expansive delight found in human potential. As Basalla has noted, these volumes are "a celebration of technological possibility" that enlarge the design project and activate technology with fantasy and imagination. Science fiction is a continuation of this intoxication. The Star Trek television series activates the imagination of what can, and probably will, be possible. We should take note that architects do not exist in Star Trek except through the guise of archeology.

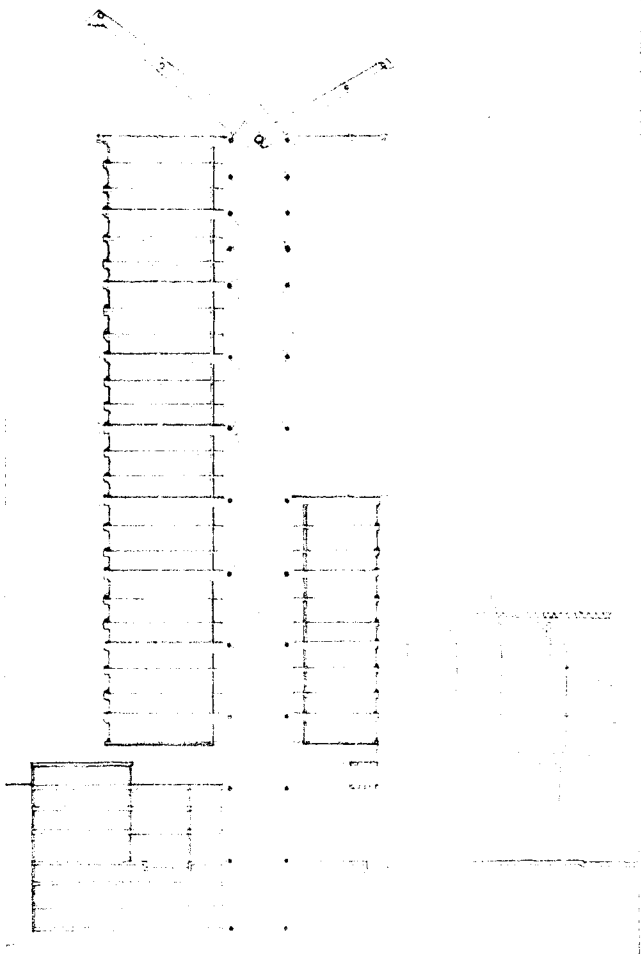
TECHNOLOGICAL INVENTION

You can't choreograph a dance until the dancers arrive. You can try on a piece of paper beforehand, but you're really not accomplishing much until the dancers work the piece and add their own special skills and magic. (paraphrased)
Director Stanley Donen[15]



Phase Two: Urban Institute, Infill Site. Darren Murrey, Washington State University. The crane as symbol.

It is commonly assumed, in a romantic way, that "inventors" are solitary geniuses who create new artifacts out of thin air, an image Basalla labels as "the myth of the heroic inventive genius."[16] He dispels this myth through a number of invention case studies including Eli Whitney's cotton gin, James Watt's steam engine, and Thomas Edison's electric lighting system. For Basalla, while each of these persons was a genius in some way, their genius was not based in the ability to invent an artifact from thin air, but rather in the transformation of existing technologies through progressive visions, visions based in the resolution of practical problems. This required a sensitivity and complex understanding of the technological diversity existing at the time and the vision to better it. Edison was able to generate the electric lighting system as a descendant from the gas lighting system through critical inquiry and a search for possibilities. More importantly though, in Edison's case, was his ability to devise and construct the marketing and large scale production strategies for the electric lighting system, and sell it to the general public. He developed one of the first private research laboratories at Menlo Park, New Jersey in 1876, and outfitted it with a team of researchers that complemented his strengths and weaknesses and "vindicated the concept that a team of researchers, each with different talents and specialties, could concentrate their efforts on a single problem." The nature of technological invention is not singular to one person, but begins with a vision executed through a team of professionals. The idea of the light



Phase Three: Urban Institute, High-Rise Site. Darren Murrey, Washington State University. The integration of the crane as integral tectonic apparatus to lift the high-rise above the existing urban fabric below.

and lighting system was truly Edison's, but his ability to build a diverse team to produce and promote the light brought it to reality.

In comparison to architecture and architectural education the role of invention is not a new topic. Designers often romantically consider themselves inventors. The larger question, though, is do we invent artifacts or do we invent strategies for others to make artifacts? Do we understand enough about technology and construction to enable the strategies to find their intended manifestation? Edison certainly designed the concept of the light and the strategy for implementing its design. But could he have made it into a reality if he did not first understand the existing technological context through the experience of actually constructing artifacts? Can architects be technologically inventive if they do not explore, and understand, technology and construction even at the most basic of empirical levels?

INVENTION PEDAGOGY SKETCH

We must recognize that training in design is not a form of teaching, but something quite different. Teaching involves facts and knowledge which are imparted to the student by a teacher. There are no facts about design.
Llewelyn Davies[17]

It is commonly accepted that our culture is becoming increasingly scientific in nature.[18] The academic institution relies on a quantitative scientific method of instruction whereby awareness is associated with theories and teaching involves the communication of fact as knowledge. While science originated in the activities of experimentation and observation which led to the formulation of theories, it is now fairly common to accept scientific axioms without question or even a concern for their origins. This leads to an elevated expectation of technology. We watch the weather report to anticipate the weather for the next day, and later become agitated when the forecast is faulty. It is comfortable to believe what we are told, and our culture has become quite trusting. The predominance of theoretical knowledge over empirical discovery predetermines our understanding of the world. This has led Thomas Kuhn, in *The Structure of Scientific Revolutions* to proclaim that research in the professional world is a "strenuous and devoted attempt to force nature into the conceptual boxes supplied by professional education."[19] Scientific based knowledge, by its very nature, overlays a system of limits upon our experience. Technology and construction for most architectural institutions have become viewed as scientific and quantifiable, resulting in the predominance of an applied science pedagogy presented by engineers. Structures is understood not through empirical activities such as making, breaking and reflecting, but through component analysis and behavioral formulas. Existing outside of the design studio in lecture course formats, technology and construction are considered, by students and design faculty alike, to be of secondary importance and likened to chores.

The design studio, rightly the central core of educational activity, is intended to be the synthetic apparatus of learning through emphasis on the process of "making," the creative act of design. Given the ancillary attitudes towards technology and construction combined with the increasingly scientific leanings of our society, however, the design studio has become associational and predominately mimetic. Models of artifacts are made in lieu of constructing actual artifacts. We expend our energies in making things look tectonic rather than being naturally technological through the resolution of identified problems. Strategies for making tend to be more interesting than actual making, and are emphasized. The design concept holds a prized position whereby, somehow, students are expected to understand and defend their intentions for architectural design that are, for all intents and purposes, simply plots for an eventual story. If we are to believe John Steinbeck, then plots are irrelevant. The mark of a true writer is in the skill of the storytelling and a good writer can create a compelling story from any plot. I can better learn how to use a computer program by being forced to solve immediate problems. *How do I change this text or alter this image? Why won't it print at the proper dpi?* Following are some naively stated conclusions I have arrived at in search of a technological design pedagogy. They can form a sketch of a basic design teaching paradigm.

The beginnings of the technological pedagogy reside in the realization that "the concept," and the requirement to justify the concept, can be detrimental to imagination and specifically technological imagination. It becomes important, and surprisingly successful, to initially eliminate the need for a justifiable concept. Students have a fairly clear intuitive understanding of what they do. The studio begins with the generation of constructions which focus on the development of a tectonic language. No program, site, or other quantitative requirements

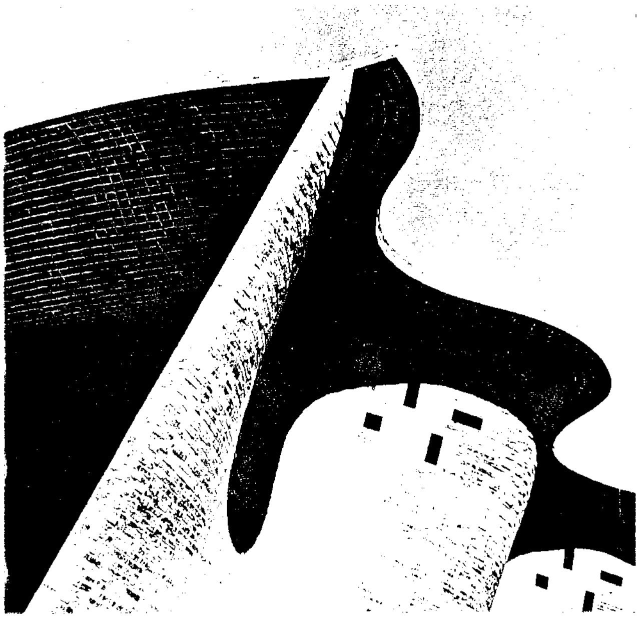


Figure 5: Iglesia de Atlántida. Eladio Dieste, 1959.[20]

to be met by the design are offered. Evaluation criteria is limited to the craftsmanship and skill exhibited in the constructions, and the students' process of inquiry in developing the systems and artifacts. Through focus on structure as a reaction to forces, materials and the tectonic joints which develop the grammar of the language, the student develops a proposition that can lead to an architectural eventuality. As the language incrementally matures, the specific problem topic is introduced, the site condition presented, the site condition changed, the program added, the program changed, an idea of high/low budget is presented and changed, etc., etc. The goal is to place the student in a dynamic context of continual change. The only common condition throughout the process are the constructions, the hope of which being, to breed in the student an understanding that architectural form results from tectonic responses to the conditions at hand. Central to this pedagogical sketch, is the fact that the student is always faced with an artifact they have constructed. The design process is primarily a transformation of the artifact through critical thinking, interpretation, subsequent action and reaction. This attitude is intended to foster design invention that is technological in nature. Interestingly enough, the concept notion of strategies begin to re-emerge, and students have little difficulty offering numerous interpretations, most having been discovered through the making process rather than predetermined and premeditated prior to the making. The design process, if defined by a premeditated concept, becomes a search for the appropriate form to match the concept. If the work conflicts with the initial concept then it is discarded in favor of a differing formal approach. If we consider the design process to be a continual transformation of artifacts, however, the concepts are discovered through the work.

Of a side note, but none the less important, is the realization that while the design studio is the central component of the design curriculum, it can convey a mixed message to students. Design studios tend to be individually based whereby the student acts alone, in the starving artist model, to analyze, and act upon criteria through a complex design project. As a working model it is far from the condition that awaits one upon graduation regardless of which profession the student chooses to enter. In fact, any creative project will involve many persons who will have an impact on the project. It becomes critical to develop in students a social method of working and an understanding of the opportunities available through teamwork, especially from teams made up of persons from differing disciplines. The interdisciplinary design studio, a nationwide interest of late, is a more dynamic working model that can be introduced, in conjunction with the archetypal studio, into curriculums to expand the understanding of the design process. The notion of an architect working with a interior designer, landscape architect, environmental scientist, etc., in the pursuit of, and response to, the larger problems of our present and future culture is paramount to an understanding of the future professional project.

CONCLUSION

...architecture is also construction. A work has not been well-conceived unless thought has been given to how it will be constructed. The methods of construction have in themselves extraordinary inspirational and expressive value. Every type of structure is intimately linked to certain building methods, and these methods can be read in the finished product. It is not enough to resolve functional problems and give them form. We must also build those spaces so that their expression will be conditioned by the methods and materials that we use to construct them. ...Construction will always be indiscernible from architecture. It is its flesh and bones.
Eladio Dieste[21]

The work of Eladio Dieste exhibits an advanced condition of technological invention and imagination. Trained as an engineer and practicing in Uruguay, Dieste exhibits a keen understanding of the construction practices, technology and possibilities of the culture within which he builds. The work exhibits the ability to understand, accept and further his specific context in the creation of works that transcend mere building into architecture. Utilizing primarily a local low compressive brick, his means and methods are challenging for the local trades, but are in keeping with their specific abilities and levels of craft. His work is founded in a transformation of the diversity and context of his cultural condition.

The computer, it can be argued, is a specific technology which thinks. Aside from the obvious arguments that a computer will only spit out what is programmed in, and that it is still up to the professional to correctly interpret the responses, the computer can analyze information, identify problems and propose solutions to given problems. The information upon which the computer operates is quantifiable in nature and more akin to scientific knowledge. More importantly to this discussion, though, is the mental framework of thinking which has been generated by this technology. The computer has activated a self empowerment quality of our society which is forcing a reevaluation of most professional disciplines. When home desktop publishing became possible through the acquisition of computer tools, the discipline of graphic design was challenged. Accountants have had to struggle with the fact that I can process my own tax return at home through a purchased program. There will undoubtedly be, in the very near future, computer programs which will provide solutions for the quantifiable aspects of the architectural discipline: The health safety and welfare of the public, sustainability, behavioral and environmental sciences, etc., etc. Obviously, the computer has not eliminated the needs for any of these professions, but technology has forced a continual reexamination of their means of working and professional status. If anyone can design a building with the aid of a computer, how will the architect fare? The future direction of the architectural discipline does not lie within the *quantifiable* aspects of our society, which the computer and other technologies will cover adequately, it resides in the *qualitative* needs of our culture. The role of the architect, in purposely residing between the contractor and the engineer, is to defend the imaginative and qualitative aspects of our culture through the creation of works that challenge and impart a future of possibilities. This is to be discovered in the capacity for technological imagination founded in the empirically inventive act of construction.

The traditional method of science is deductive and thus involves value judgments. The standard of measure are axioms. due to this deductive method scientific findings are frequently mingled with ethical postulates. That is the root of our expecting from science ethical and aesthetic decisions which it cannot supply.
Stefan Polónyi[22]

NOTES

1. Question was posed to a third grade class at Concord Elementary School, Concordville, Pennsylvania, in October 1991
2. Ivan Illich; *Celebration of Awareness.* (Berkeley: Heyday Books. 1970): 11
3. Peter McCleary; "An Interpretation of Technology." *Journal of Architectural Education.* (Winter, 1983) See also Steven Lubar's discussion on the visual thinking historiography of technology in "Representation and Power."
4. Kenneth Frampton; "Rappel a l'ordre: The Case for the Techtonic." *Architectural Design.* 60/ 3-4. (New York: St. Martin's Press, 1990): 19
5. The American Institute of Architects; *AIA Document A201, General Conditions of the Contract for Construction.* Fourteenth Edition. (Washington: AIA. 1987): 8 & 10
6. Crinson and Lubbock; *Architecture—Art or Profession? Three Hundred Years of Architectural Education in Britain.* (New York: Manchester University Press. 1994): 182
7. Eladio Dieste; "Some Reflections on Architecture and Construction." *Perspecta 21.* The Yale Journal of Architecture. (New York: Rizzoli. 1984): 14
8. Giuseppe Zambonini; "Notes for a Theory of Making," *Perspecta 24.* The Yale Journal of Architecture. (New York: Rizzoli. 1988): 3
9. Eugene S. Ferguson; *Engineering and the Mind's Eye.* (Cambridge: The MIT Press. 1992)
10. Steven Lubar; "Representation and Power." *Technology and Culture. Supplement to April 1995.* Volume 36, Number 2. (Chicago: The University of Chicago Press. 1995): S57, note 5. Lubar elaborates upon Ferguson's definition for a technologist.
11. Ibid., S55-S60
12. George Basalla; *The Evolution of Technology.* (Cambridge: Cambridge University Press. 1988): vii-25
13. Ibid., 64-80
14. Agostino Ramelli; [Le diverse et artificiose machine. 1588] *The Various and Ingenius Machines of Agostino Ramelli.* Translated by Martha Teach Gnudi; technical annotations and pictoral glossary by Eugene S. Ferguson. (New York: Dover Publications, Inc. 1976)
15. *The Moviemakers, Stanley Donen.* A profile of the life and work of director Stanley Donen; *Singing in the Rain.* Aired on PBS.
16. Basalla; 21. Discussion of inventions and the invention process, 26-63
17. Crinson and Lubbock; 164
18. See C.P. Snow; *Two Cultures.* (New York: Cambridge University Press. 1987). Snow proposes that our culture has splintered itself into two factions, one scientifically based and the other non-scientific. For the effect that science has had on engineering and design, see Eugene Ferguson, *Engineering and the Mind's Eye*, and Stefan Polónyi, "The Concept of Science, Structural Design, Architecture". Alberto Perez-Gomez, in *Architecture and the Crisis of Modern Science* (Cambridge: The MIT Press. 1983): 3-14, concludes that "scientific thought", through the fanatical determination in the seeking of axiomatical truth, has replaced "metaphoric thought" as a basis of perception and creative action.
19. Thomas S. Kuhn; *The Structure of Scientific Revolutions.* (Chicago: University of Chicago Press. 1970): 5
20. Facultad de Arquitectura, Universidad de Los Andes—Columbia; *Eladio Dieste, La Estructura Ceramica.* (Bogatá: Colección Somosur. 1987): 117-135
21. Eladio Dieste; 14
22. Stefan Polónyi, "The Concept of Science, Structural Design, Architecture." *Daidalos.* (Vol. 18, 15 December 1985): 45