On deciding the boundaries of architectural knowledge

Abstract

Architectural educators constantly struggle with the boundaries of architectural knowledge and the logistics of providing an education that prepares a student to become an architect. The constant struggle between the intellectual demands of the discipline of architecture and the practice of architecture is due to the vagueness in defining the boundaries of architectural knowledge. A new approach to structure architectural knowledge may provide the armature necessary to bridge the divide between the discipline of architecture and the practice of architecture, to redefine the architectural curriculum and allow us to map the territory of architectural knowledge.

Introduction

A major problem facing the field of architectural education is the lack of boundaries for architectural knowledge. The proverbial curriculum of 22 years suggested by Dean Hudnut, or pithy statements that point out that the pursuit of architectural knowledge is a lifelong endeavor, do not help the situation. Faced with a limited time frame in which to provide an architectural education in a university setting (which is constantly being questioned), deciding[1] the boundaries of architectural knowledge (thereby defining a discipline?) becomes a necessary task. Architects are perpetual transgressors when it comes to disciplinary knowledge. We appropriate from many different sources and pride ourselves on the fact that we are able to creatively synthesize an "architectural knowledge" from those sources. This raises a question. Is architectural knowledge one of a "discipline" or one of a "practice"? If there are no boundaries for architectural knowledge, and the pursuit of architectural knowledge is open-ended, should it not be required that we emphasize skills of practice like collaborative learning, negotiation, consensus building and integrative skills rather than disciplinary facts in schools of architecture? The 37 performance criteria that are required to be met by students in schools seeking accreditation from the National Architectural Accreditation Board (NAAB) are not classified to reflect the knowledge of a "discipline" or a "practice." The criteria are a bricolage of knowledge and skills that may be encountered in designing buildings pared down to reflect the time frame of a college education. These criteria reflect the unbounded nature of architectural knowledge. Deciding the boundaries of architectural knowledge will help solve the logistics of providing an architectural education and enable us to decide what it is that architects must know (and how) to be successful. This knowledge may very well combine the knowledge of a “discipline” and of a “practice,” crossing the divide between architectural education and practice.

In the current socio-technological context,[2] the value in expending a large share of the resources available to impart disciplinary facts in architectural education can be called into question. The development of the Internet and digital databases has now made it possible for one to have voluminous factual knowledge at hand. Accessing this knowledge is becoming increasingly easy. Soon, access to disciplinary facts will not be a problem, but the assimilation of these facts in practice will be the primary concern. We will soon be forced, if not already, to focus on the transformation of the “knowledge at hand”[3] to a “knowledge on hand”[4] in performing various tasks.

Problem setting: mapping the boundaries of architectural knowledge

Before we begin to tackle this problem, we need to situate ourselves, which interestingly is an architectural act. A problem setting,[5] if you will, is in order before we proceed. This will result in a disciplinary settling down within boundaries in a conciliatory act of dwelling. Rather than being intellectual nomads, as architects, we must come home. A fundamental task that one faces in this homecoming is demarcating the boundaries of architectural knowledge. This will enable us to understand the scope of architectural knowledge, a survey of the territory in which it operates, so to speak. Architectural knowledge draws from various sources in an unfettered way making the definition of its boundaries a complex task. Given a mandate for knowledge-based architectural education, it becomes imperative to identify the different knowledge bases that are required for architectural education. We can do this in an ad hoc manner or approach it in a systematic way. A systematic method to identify these knowledge bases, rather than being restrictive, will serve as an armature to give the field of architectural education its figural qualities. The development of a paradigm for design knowledge, thereby architectural knowledge, will provide this armature.

Seeking paradigms

A paradigm, as defined by Kuhn, is a "core cluster of concepts associated with a recognized scientific achievement or set of achievements."[6] Though Kuhn refers specifically to scientific achievement, his notion of a paradigm has come to refer to the core cluster of concepts in any field. A paradigm is an exemplary pattern of concepts that defines a field. A paradigm of design knowledge is an exemplary pattern of concepts that defines design. A paradigm of architectural knowledge is an exemplary pattern of concepts that defines architecture. To develop these paradigms, we have to first elucidate the scope of design epistemology.

Epistemology is the investigation of the origin, nature, methods and limits of human knowledge.[7] Design epistemology is the investigation of the origin, nature, methods and limits of design knowledge. Design is a complex process that relies on intuitive and rational thought processes. Design involves the application of different kinds of knowledge, e.g., scientific knowledge, technological knowledge and socio-cultural knowledge. Design knowledge is derived from all these different kinds of knowledge. This makes the epistemology of design a very intricate subject to pursue. The epistemology of design is almost equivalent to a general epistemology.

The four primary types of knowledge

The origins of design knowledge are manifold. Design knowledge can be mapped showing that it derives from four primary types of knowledge: empirical, rational, procedural and normative. Empirical knowledge is built from human perception. Rational knowledge is based on the human faculty of reason. Procedural knowledge is gained from human action, and normative knowledge arises from human belief.

Empirical knowledge is knowledge gained from sensory perception. It also includes knowledge gained from extensions to sensory perception, e.g., the telescope, the electron microscope, etc. Empirical knowledge is gained by observing the natural and human environment around us. Empirical knowledge is the basis of science. Empirical knowledge is not clearly bounded. The categorizing faculty of humans in processing empirical knowledge indicates that empirical knowledge is strongly related to rational knowledge. Concepts such as visual thinking[8] reflect this linkage. Rational knowledge is based on the human faculty of reason. It is an abstract kind of knowledge that is embedded in human thought processes. Deduction, induction and logic are examples of rational knowledge. Procedural knowledge is knowledge derived from doing things. It is what is referred to as "know-how."[9] It is the basis for the development of technology. It involves the application of empirical and rational knowledge. Normative knowledge consists of human values and beliefs. These values and beliefs guide human action. Normative knowledge combines with procedural knowledge to create theories of action. Normative knowledge is developed by a historical socio-cultural process that considers the values and beliefs held in the past by other human beings and adapts them according to the present. Philosophy and ethics are examples of normative knowledge.

The methods and limits of design knowledge are a subset of the methods and limits of its component parts. The method of empirical knowledge is observing. The method of rational knowledge is reasoning. The method of procedural knowledge is doing and the method of normative knowledge is judging. The design process uses all these methods.

Theories that arise from the primary types of knowledge

The interaction of the four primary types of knowledge gives rise to certain types of theories. Empirical knowledge and rational knowledge give rise to substantive theories. Procedural knowledge and normative knowledge give rise to procedural theories. Both these sets of theories combine to produce design theories.[10] Thus, if one were seek a pattern, the four types of knowledge resolve into two orthogonal axes which define loci for theory development. The vertical axis is the axis of substantive theory and the horizontal axis is the axis of procedural theory. Design theory which comprises both procedural and substantive theory is developed where the two axes intersect. Figure 1 illustrates this pattern.

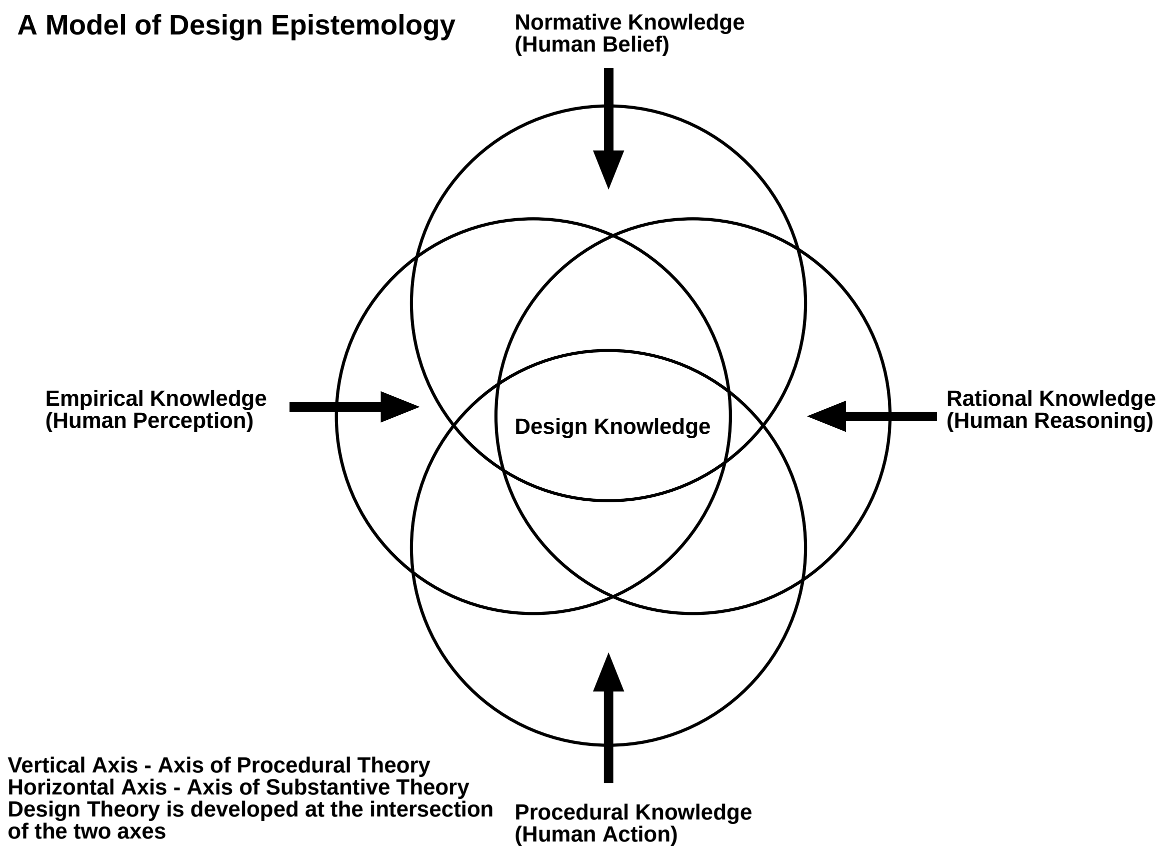

Figure 1. A model of design epistemology integrating the four primary types of knowledge and two locii for theory development

Substantive theories are concerned with the nature of phenomena which designers have to deal with in their work. These phenomena may be natural or human or a symbiosis of the two. Substantive theories are predominantly developed from empirical and rational knowledge. Substantive theories relevant to design are theories that explain the nature of materials, the interaction of natural forces such as wind, rain and sun with the artificial environment, etc. Substantive theories serve the scientific purposes of explanation and understanding of phenomena.

Procedural theories are concerned with praxis. In design, procedural theories inform the designer how to design, how to build, how to manage the construction process, etc. Procedural theories are predominantly developed from procedural and normative knowledge. Procedural theories serve the practical purposes of transformation and control of phenomena.

A model of design epistemology

The four primary types of knowledge and the two loci of theory development lend themselves directly to a model of design epistemology. The Venn diagram in Figure 1 illustrates this model of design epistemology. It shows the origins and nature of design knowledge. The diagram shows the four primary types of knowledge that intersect to define various subsets of knowledge. Groupings from the Venn diagram showing some of the subset patterns is illustrated in Figure 2. Empirical knowledge and rational knowledge combine to produce scientific knowledge. Scientific knowledge combines with procedural knowledge to produce technological knowledge. Empirical and procedural knowledge combine to produce behavioral knowledge. Normative knowledge, rational knowledge and procedural knowledge combine to produce social knowledge. All the four types of knowledge combine to form socio-cultural knowledge of which design knowledge is a subset.

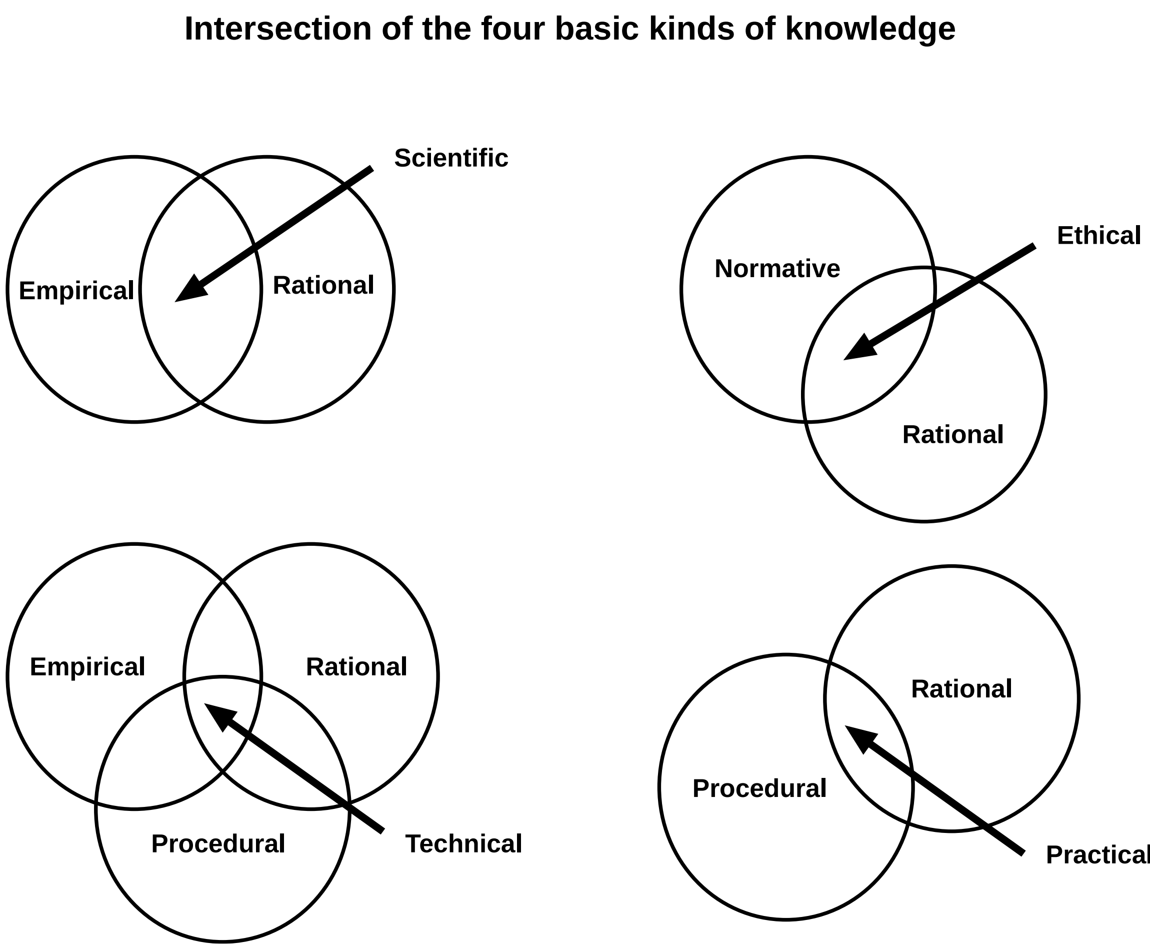

Figure 2. Subset patterns from the model of design epistemology

This model has to be related to the practice of architectural design to form a paradigm of architectural knowledge. Architects are involved in the task of designing the built environment from the scale of a single room to that of a city. When architects design, they make decisions about the shape, form, and the spatial arrangement of building materials and products, or their aggregates that define physical structures and spatial environments. The knowledge about the building materials comes from scientific knowledge (empirical+rational). The "know-how" to aggregate the building materials and products into physical structures comes form technological knowledge (empirical+rational+procedural). The decisions about shape, form and spatial arrangement are based on rational and normative knowledge, e.g., aesthetics and anthropometrics. Architectural design draws from intuition, experience, science, technology and creativity. Intuition springs from procedural knowledge, experience is based on empirical, rational and procedural knowledge, scientific principles are derived from empirical and rational knowledge, technical information is derived from technological knowledge and creativity springs from design knowledge.

Architecture is also defined as the art and science of building. The inclusion of both the terms "art" and "science" in the definition indicates that architecture is grounded in both these fields. Empirical knowledge and rational knowledge are subsumed under science. Procedural knowledge and normative knowledge are subsumed under art. Hence, a model developed for architectural design based on the four primary types of knowledge is consistent with the general definition of architecture. The analysis-synthesis-evaluation model of architectural design is also subsumed within the model presented. Analysis makes use of empirical and rational knowledge. Synthesis makes use of procedural knowledge and evaluation makes use of normative knowledge.

The model of design epistemology and the model of architectural design that is based on it depict architecture in its multi-dimensional aspect. All other definitions and models are subsumed within these two models. Hence, these models can together be said to constitute a paradigm for architectural knowledge.

Architectural design as procedural knowledge

Architectural design involves the application of design knowledge to transform the natural environment based on the intentional direction of human activities. The architectural design process can be modeled as a transformational activity. This activity brings to bear empirical and rational knowledge to understand the environment, procedural knowledge to develop methods to transform it, and normative knowledge and rational knowledge to guide the intentional direction of the transformation. Because it is a transformational activity, architectural design is a form of procedural knowledge.[11] A diagram depicting architectural design as a transformational activity is presented in Figure 3. This transformation of the natural environment is effected through the process of building.

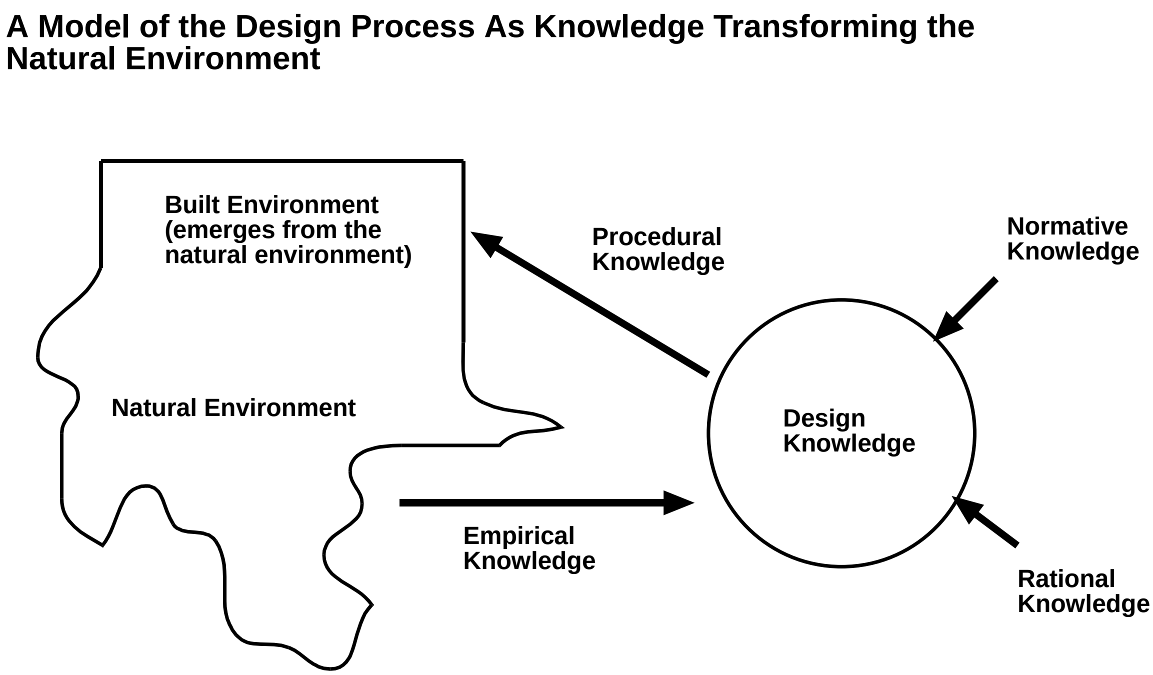

Figure 3. A model of architectural design as a transformational activity

The goal of architects should be to create interesting, useful, and safe environments (the qualities of *venustas*, *utilitas* and *firmitas* of Vitruvius) to facilitate a wide range of positive human experiences. These experiential environments should be transformable without being degraded. This aspect is taken into consideration in the diagram. The natural environment is shown as an amorphous shape. The built environment which is a part of the natural environment is a rationalized artificial part of the total environment and is depicted by the emergent orthogonal form. If the transformational design process persists without a lack of balance in preserving the natural environment, then the image of the natural environment in the diagram would become a square representing total artificiality. The quality of feedback from such an environment would transform design knowledge which in turn would affect the procedural knowledge at work transforming the environment. Limits to the transformational capacities of the design process begin to emerge as a result of this condition.

In the model of architectural design as a transformational activity, the subjective dimension is not emphasized strongly enough except as design knowledge. It must be noted that by transforming the environment, the architectural design process alters the basis of design knowledge. This is an important feedback that has to be considered. The architectural design process then becomes instrumental in a transformation and restructuring of experience. The physical structures and spatial environments that architects design, create a complex synthesis of visual, aural and kinesthetic experiences that is constantly being transformed.

<u>Redesigning the education of an architect: from Vitruvius to the NAAB and beyond</u>

Given the model of design epistemology that has been presented in this paper, a redesigning of the education of the architect is possible. Grounding architectural education firmly on the four primary types of knowledge bases will provide the necessary armature for architectural education to finally acquire figural qualities. The goal of this redesigning is to cross the divide between architectural education and practice. The reorganization of the knowledge bases required in architectural education can possibly eliminate this divide. Historically, this divide has not always existed.

Current concerns related to the divide between architectural education and practice are based on the dichotomous division of architecture into a “discipline,” and a “practice.” This division has its roots in the model of Technical Rationality.[12] Models for professional knowledge such as the model of Technical Rationality have a long evolutionary history. Originating in the tenets of Positivism which posited that the only true knowledge is scientific, the model of Technical Rationality gradually evolved and firmly took ground. In this model, professional activity is considered “problem solving made rigorous by the application of scientific theory and technique.”[13] This notion of professional practice as the application of science to solve human problems has taken strong root in our institutions of learning. As long as we accept this model of professional practice the divide between a “discipline” and “practice” will remain.

Others have attempted to create models to redesign education, specifically professional education. In their book on increasing professional effectiveness, Argyris and Schon examine the redesigning of professional education and point out that the different professions have different configurations of technical and interpersonal theory, the two kinds of theories that constitute a theory of practice and are needed for professional competence.[14] Technical theory is related to the disciplinary aspect of a profession and interpersonal theory is related to the aspect of practice. This separation of technical and interpersonal theory seems to have the vestiges of the dichotomous division of "discipline" and "practice."

In his suggestions for redesigning an educational curriculum to foster collaborative learning, Bruffee talks about "foundational" and "nonfoundational" ways of thinking about knowledge.[15] In the foundational approach, knowledge is said to have a foundation - a ground, a base, an idea, a theory, a structure or a framework. All knowledge in the foundational view is built on such a foundation. Bruffee suggests that, in the traditional view of knowledge, this foundation is the Cartesian binary structure of the subjective *(res cogitans*) and the objective (*res extensa*) worlds. In this scenario, learning happens through cognition when the subjective and objective worlds interact. In the nonfoundational approach, knowledge has no base and is constructed through a social process by a community of people who share a common language. The creation of knowledge is a community project and seemingly independent entities such as objective reality and subjective selves are social constructs as well. Learning happens in a sociological process of reacculturation from one "knowledge community" to another.[16] The benefit of this model is that it allows us to explore nonfoundational strategies in redesigning education if we find that the foundational approach to knowledge is not serving us well.

The challenge now is to take these recommendations for the reform of education and see where they fit in terms of the heritage of the community of architects. Recommendations for the education of an architect have evolved from the classic prescriptions of Vitruvius[17] to their current incarnation in the form of the NAAB criteria. It is very interesting to observe how these recommendations have evolved, what has endured, and what has changed. In the first of his ten books on architecture, Vitruvius makes the following prescription for the education of an architect:

> "Let him be educated, skilful with the pencil, instructed in geometry, know much history, have followed the philosophers with attention, understand music, have some knowledge of medicine, know the opinions of the jurists, and be acquainted with astronomy and the theory of the heavens."

Besides noting the range of subjects identified, it is interesting to note all the nuances in the level of accomplishment for each of the subjects mentioned. It ranges from being skillful and knowing to having some knowledge, having followed with attention, or being acquainted. A mastery of all these subjects is not intended by Vitruvius.[18] However, Vitruvius is clear on the need to integrate practice and theory[19]. Vitruvius also stresses applied knowledge[20] and carefully explains why the architect must be well versed in the different fields of study prescribed. Contrastingly, the NAAB criteria do not specifically address why its different performance criteria need to be met. In doing so, it may very well be possible to identify what is vital and what is not, or if any essentials are being left out.

If you study the NAAB criteria they are telling in terms of what is required in the education of an architect. The strongest requirements where the level of accomplishment is an "ability" to do something are referred to as skills. Ability is defined as the skill in relating specific information to the accomplishments of tasks. A person with ability can correctly select the information that is appropriate to a situation and apply it to the solution of specific problems. The skills explicitly identified include verbal and writing skills, graphic skills, research skills, critical thinking skills, fundamental design skills and collaborative skills. These skills can be classified as skills that provide the basic competence to practice architecture. Grouped with these are the ability to use precedents, the ability to address accessibility, the ability to address site conditions, the ability to integrate building systems, the ability to develop design details, the ability to create technical documents, the ability to prepare architectural programs and the ability to design comprehensively. These abilities are related to basic professional competence.

The next level of accomplishment is an "understanding." A person with understanding is defined as one who can correctly paraphrase or summarize information without necessarily being able to relate it to other material or see its full implications. The recommendations include an understanding of western traditions, national and regional traditions, environmental conservation, formal ordering systems, structural systems, environmental systems, life safety systems, building envelope systems, building service systems, legal responsibilities, building code compliance, building materials and assemblies, the context of architecture and professional internship. All these areas of study form a disciplinary knowledge base. What is needed in practice is the ability to integrate all these areas of study. This level of accomplishment is very disturbing. Not being required to relate material to other relevant material and not being required to understand full implications is antithetical to the integrative skills required for practice.

The next level of accomplishment is "awareness." A person with awareness is defined as one who can correctly recall information without necessarily being able to paraphrase or summarize it. A student of architecture is expected to be aware of human behavior, human diversity, non western traditions, building economics and cost control, the legal context of architectural practice, practice organization management, contracts and documentation, architect's leadership roles, ethics and professional judgment. It is difficult to see how this level of accomplishment can inform practice. This level of accomplishment results in merely "know-that" instead of "know-how."

Taking all the recommendations from Vitruvius to the NAAB criteria and integrating the model of design epistemology, the following knowledge bases for the education of an architect emerge based on broad categories:

Normative Knowledge: This is gained from the study of philosophy (the forming of worldviews), the study of ethics (what is right and wrong and how to choose right action), the study of law (the social contract, building codes, liability and arbitration), the study of politics (governance, democratic processes) and the study of aesthetics.

Rational Knowledge: This is gained from the study of rational thinking (deduction, induction and logic) and the study of critical thinking (deconstruction).

Empirical Knowledge: This is gained from the study of the natural environment (climate, ecology), the study of the social environment (human behavior, human institutions and how they work) and the study of the built environment (buildings and landscapes - local, regional and global).

Procedural Knowledge: This is the knowledge of how to create representations (including representational thought), how to synthesize designs (integration of the different building systems - structural systems, environmental control systems, life safety systems, ordering systems, etc.), how to manage the construction process, how to evaluate designs and how to collaborate (negotiation, consensus building).

This knowledge-based curriculum has both foundational and nonfoundational aspects. Empirical and rational knowledge are foundational in nature. Normative and procedural knowledge are nonfoundational in nature. Empirical and rational knowledge form the axis of substantive theory which is foundational. Normative and procedural knowledge form the axis of procedural theory which is nonfoundational. This knowledge-based curriculum integrates substantive and procedural theory, foundational and nonfoundational creation of knowledge, and the concept of a “discipline” and a “practice.” It also provides clear locii for theory development. As such it forms an interesting framework with which to redesign the education of an architect. If the divisive forces that separate architectural education and practice need to be reined in, a curricular model such as this that integrates these divisive forces may provide the solution.

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[1] The establishment of boundaries for architectural knowledge may very well be an act of deciding rather than act of defining.

[2] The technological development of the Internet and the social interaction patterns that have emerged due to the Internet create this socio-technological context.
[3] Knowledge at hand is the factual knowledge that one can access from information sources such as books and databases.
[4] Knowledge on hand is the tacit knowledge that is embedded in action. It is the knowledge that one brings to bear in action.
[5] "When we set the problem, we select what we will treat as "things" of the situation, we set the boundaries of our attention to it, and we impose upon it a coherence which allows us to say what is wrong and in what directions the situation needs to be changed. Problem setting is a process in which, interactively, we *name* the things to which we will attend and *frame* the context in which we will attend to them." D. A. Schon,, *The Reflective Practitioner: how professionals think in action* (New York: Basic Books), 40.
[6] One of the multitude of definitions that Thomas Kuhn uses in *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962)
[7] Dictionary definition of epistemology in *Webster's New Universal Unabridged Dictionary* (New York: Barnes and Noble, 1994)
[8] Rudolph Arnheim has made an eloquent case for visual thinking in his book *Visual Thinking* (Berkeley: University of California Press, 1969)
[9] Know-how is a kind of procedural knowledge, a knowledge of how to do something.
[10] Though the terms "substantive theories" and "procedural theories" are used by Jon Lang in *Creating Architectural Theory* (New York: Van Nostrand Reinhold, 1987), the interpretive nuances are different in this article.
[11] "Homo sapiens became Homo faber not by virtue of his familiarity with nature's laws-though this helped-nor his adroitness in the manipulation of abstract symbol structures-which also helped-but by way of his intimacy with the artifactual form itself, its variety of features and properties, and by knowing or having the capacity to hypothesize how forms with such desired properties or characteristics can be achieved. It is such knowledge which, following Michael Polanyi's suggestion, we are calling operational principles." Subrata Dasgupta, *Technology and Creativity* (New York: Oxford University Press, 1996), 167.
[12] The model of Technical Rationality is discussed by D. A. Schon in *The Reflective Practitioner: how professionals think in action* (New York: Basic Books, 1983), Chapter 2
[13] See D. A. Schon, *The Reflective Practitioner: how professionals think in action* (New York: Basic Books, 1983), 21.
[14] See Chris Argyris and D. A. Schon, *Theory in practice: increasing professional effectiveness* (San Francisco, Josey-Bass Publishers, 1974)
[15] See Kenneth Bruffee, *Collaborative Learning* (Baltimore: The Johns Hopkins University Press, 1993)
[16] Reacculturation into a knowledge community is a sociological process whereby an individual becomes familiar with a knowledge community, e.g, architects, gains membership in that community and becomes an active participant in that community.
[17] In the first of his ten books on architecture, Vitruvius discusses the education of the architect and provides his classic prescriptions. Vitruvius, *The Ten Books on Architecture*, Translated by Morris Hicky Morgan (New York: Dover, 1960)
[18] "For, in the midst of all this great variety of subjects, an individual cannot attain to perfection in each, because it is scarcely in his power to take in and comprehend the general theories of them. Still, it is not architects alone that cannot in all matters reach perfection, but even men who individually practise specialties in the arts do not all attain to the highest point of merit. Therefore, if among artists working each in a single field, not all, but only a few in an entire generation acquire fame, and that with difficulty, how can an architect, who has to be skilful in many arts, accomplish not merely the feat -- in itself a great marvel -- of being deficient in none of them, but also that of surpassing all those artists who have devoted themselves with unremitting industry to single fields?" Vitruvius, *The Ten Books on Architecture*, Translated by Morris Hicky Morgan (New York: Dover, 1960), 11.
[19] "The architect should be equipped with knowledge of many branches of study and varied kinds of learning, for it is by his judgement that all work done by the other arts is put to test. This knowledge is the child of practice and theory." Vitruvius, *The Ten Books on Architecture*, Translated by Morris Hicky Morgan (New York: Dover, 1960), 5.

[20] "An architect ought to be an educated man so as to leave a more lasting remembrance in his treatises. Secondly, he must have a knowledge of drawing so that he can readily make sketches to show the appearance of the work which he proposes. Geometry, also, is of much assistance in architecture, and in particular it teaches us the use of the rule and compasses, by which especially we acquire readiness in making plans for buildings in their grounds, and rightly apply the square, the level, and the plummet. By means of optics, again, the light in buildings can be drawn from fixed quarters of the sky. It is true that it is by arithmetic that the total cost of buildings is calculated and measurements are computed, but difficult questions involving symmetry are solved by means of geometrical theories and methods." Vitruvius, *The Ten Books on Architecture*, Translated by Morris Hicky Morgan (New York: Dover, 1960), 6.