On Spatial Computations

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... I will always commend the time-honored custom, practiced by the best builders, of preparing not only drawings and sketches but also models of wood or any other material. These will enable us to weigh up repeatedly and examine, with the advice of the experts, the work as a whole and the individual dimensions of all the parts, and, before continuing any farther, to estimate the likely trouble of expense ....

There is !a particularly relevant consideration that I feel should be mentioned here: the presentation of models that have been colored and lewdly dressed with the allurement of painting is the mark of no architect intent on conveying the facts; rather it is that of a conceited one, striving to attract and seduce the eye of the beholder, and to divert his attention from a proper examination of the parts to be considered, toward admiration of himself. Better then that models are not accurately finished, refined, and highly decorated, but plain and simple, so that they demonstrate the ingenuity of him who conceived the idea, and not the skill of the one who fabricated the model. The difference between the drawings of the painter and those of the architect is this: the former takes pains to emphasize the relief of the objects in paintings with shading and diminishing lines and angles; the architect rejects shading, but takes his projections from the ground plan and, without altering the lines and by maintaining the true angles, reveals the extent and shape of each elevation and side - he is one who desires his work to be judged not by deceptive appearances but according to certain calculated standards. (Leon Battista Alberti, *On the Art of Building in Ten Books*, 1450, Cambridge: MIT Press, 1988, p.34).

The Rhetoric, of late, has become emphatic. There is an urgent and forceful tone to much of the current debate on the place and role of computers in architectural education. It is a rare discussion of the subject, where someone does not note, with an air of resignation or foresight, commonplace at the passing of an era, that architectural educators can no longer delay the integration of computers into the architecture curriculum. "Nowadays," it is often said, most offices will only interview recent graduates if they are proficient in computer-aided design. The industry demands the skill, in other words, and the educators must abide. The question, it is concluded, is no longer whether or even when, but rather how to best integrate computers into the curriculum. Answers to the latter question are, of course, virtually as diverse as there are providers, and points of overlap are often logistical, rather than pedagogical.

Behind the strong rhetoric and the perceived urgency of the matter, there are certain imperatives to the integration of computers into the architecture curriculum that I wish to explore in this paper. The purpose of this exploration is to assess the needs and formulate an effective strategy for the integration of the computer into the architecture curriculum.

It is important to note at the outset that the imperatives of integration far exceed the question of skill. They are directly related to the impact of the electronic media on architectural production, perception, and communication, as well as the far reach of this impact into the wider realm of cultural perception and production. Behind the rhetoric, there is more at stake than software proficiency and computer literacy.

The first imperative is related to the *long* standing question of the place and role of computers in architectural education? This is, in the least, a twofold question. At issue are the place and role of computers:

I. In the teaching of architecture as an educational and comrnunicational aid (Classroom condition).
II. In the making of architecture as a tool of implementation and realization (Studio condition).

The distinction is worthwhile because in each category the stresses on the two elemental functions of the computer are different. Assuming that the computer is fundamentally a tool for:

i. Access to and dissemination of information
ii. Manipulation and creation of new information

The stress in the first category (classroom) is on the effective re-presentation of an existing product, and in the second category (studio) on manipulation and production of a new product.

This is not to imply that the application of the computer in each category is limited to either the computer's potential as a device for passive representation and communication,or a tool for active manipulation and creation. The line separating these two potentials is extremely difficult, if not impossible, to pinpoint in this tool. In fact, what distinguishes the computer among other tools of the industrial and post-industrial age is precisely its overt overlapping of passive representation and active fabrication to the point of indistinctness.' The computer combines, patently and indiscriminately, what has been latent in other comparable tools of the industrial age, e.g., the camera. Its ability to create virtual realities, independent of the actual as the point of departure and return, radically disturbs the economy of representation, and further diminishes the aura of the *real* which begun, to a good measure, with the invention of the camera.[2]

The new tool's indiscriminate overlapping of representation and fabrication denies representation the innocence and the objectivity that comparable tools may have more readily afforded it in the past.[3] The Electronic re/production's dispensation with the referent as the point of origin - without the loss of pretense to objective representation - brings to surface a gap between form and substance, or else image and identity, that may be covered, but never bridged. The exposure of this gap offers a serious challenge to the privileged antecedence and alterity of reality as measured against representation. Electronic relproduction subjects the aura of humanist reality to radical query, insofar as the possibility of its fabrications and the proximity its representations strip reality of its endowed authority as the site of the transparency of form to substance, and image to identity. Subject as it is to the computer's manipulative interventions and virtual doubling, that forgo the possibility of a site for transparency, reality stands to disappear as a selfsame entity, only to surface as a suppressed virtuality and a purposed construction, "always already."[4]

The extemporaneous challenge of the computer to humanist presuppositions about the nature of reality and representation lies at the root of not only much of the ongoing and widespread resistance to computers, but also, and of greater interest, much of the perceived urgency to the integration of computers into academic curricula, in general, and architecture curriculum, in particular. The rejection of the computer and the conditional or regulated acceptance of it are two sides of the same coin.[5]

This is to say that if the various adopted policies on the integration of computers into academic curricula are not a conscious response to the ideational challenges of electronic relproduction, in the least, they have been well influenced by this challenge. In turn, no alternate policy can afford to assume itself immune to this influence without being patently or latently conditioned by it.

The initial and widely adopted policy of outfitted laboratories, coupled with a curricular emphasis on developing software proficiency is an institutional response to the ideational challenges of the computer, to the extent that it effectively segregates the computer from other spaces and other modes of representation and other modes of production within the university.

The segregation responds to the challenge by substituting the distinctness of spatial boundaries for the conceptual boundaries that the computer breaches in operation. The substitution allows us to conceptually reestablish the broached distance between the virtual and the actual, between representation and fabrication, with recourse to the literal boundaries that distance the computer from other spaces and other tools of production and representation that do not, in their operation, overtly challenge the presumed line between the actual and the virtual.

The spatial segregation of electronic relproduction attempts to delimit its conceptual impact, in a way that is perhaps best summed up by the peculiar, though widespread labeling of the institutional space of computing a *laboratory*. The term conjures up vivid images of separation and containment, and references distinct and specialized activities that are to be appropriately segregated and contained. However, what about the assumed nature of the tool qualifies the place of its presence as a laboratory, what distinct and specialized activity or experimentation is to be performed in this lab, or what aspect of electronic relproduction mandates containment, are questions to which answer is no mere matter of ease from a perspective that does not take the label for granted or assume it to be simply appropriate.

There is also a latent irony to the spatial segregation of the computer, considering that the computer radically disrupts and transforms the traditional synchronic experience of space and time. Allowing different spaces to occupy the same time (e.g., the internet), and different times to occupy the same space (e.g., multi-media), the computer hastens the collapse of traditional time and space, underway since the invention of the telegraph.[6] Within the spatial limits of the laboratory, however, the tampering with space and time and the breach of the established privileges of reality and representation have both the literal and the conceptual assurance of containment.

It is important to note that the initial policy of literal spatial segregation is slowly, but resolutely, giving way to a developing policy of spatial desegregation. This is in part due to the economic and the practical, to say nothing of pedagogical, infeasibility of the segregation policy. This slow change does not constitute, however, a fundamental shift in position, considering that it closely parallels the development of a more economical mode of spatial segregation, i.e., the institution of Cyber Space. Although this mythical parallel electronic universe is also conceived in distinct spatial terms, there is greater economy to this strategy of segregation. The boundaries of this space are at

once unbreachable and infinite. In this virtual scheme, electronic relproduction is not given to simply occupy a segregated literal space, but designated to a mythical parallel virtual space, where the rules of the game are not the same as Newtonian space. The laboratories of the immediate past have thus come to assume the added dimension of an evanescent universe where the ideational challenges of electronic re/production become the dismissable peculiarities of a Cyber Space that is safely locked away behind the looking glass of the monitor screen, both inside and outside of the literal bounds of the laboratory.'

As though the spatial - literal or conceptual - segregation of the computer was not sufficient, the systematic exclusion of the computer from the realm of production within the university is further augmented by the widespread curricular emphasis on the development of software proficiency. The segregated spaces of electronic relproduction have been instituted as places where one learns primarily what computers can do, as opposed to doing things with computers. The posed distinction here between operation and production may appear too fine. It is, however, an important and telling dissociation, particularly insofar as the integration of computers into the architecture curriculum is concerned.

The focus in the segregated space of computing is on the computer, and not on production. Here the computer is the end and not the overt means to an end; much less is it a participatory means among others to a wider end. The curricular emphasis on the development of software proficiency, coupled as it is with spatial segregation, forestall the integration of the computer into any productive process other than the computer's own internal process of production. Furthermore, the policy assumes and instills, implicitly or explicitly, the prevalent conception of the computer as a productive Cyber organism that an ***operator*** - a term as widespread and telling as laboratory - prompts to the performance of specific preordained tasks. The software proficiency approach, in effect, alienates the operator from the mechanism, insofar as it treats both as such. It also relieves the operator from creative participation in the process of production, and in the end, the product itself, insofar as the policy emphasizes learning and performing preordained tasks.[8]

The alienation of the operator from the computer is, of course, as purposed as their mutual spatial segregation. Both dissociations are essential to what ultimately is only a deferral of the computer's ideational challenges. Divorced from both the potential producer and other modes of production and creation, the computer is given to assume the guise of a self-referential entity whose peculiarities and breaches in relproduction are endemic to it and not reflective of a general state of relproduction. It is needless, perhaps, to point out that the policy of double segregation - spatial and conceptual - is a problematic one in any curriculum where the emphasis is on creation and relproduction. It is, however, precisely in such curricula that the ideational challenge of the computer is most acutely felt.

If academia has thus far managed to neither wholly reject, nor afford to unconditionally embrace the computer, this is partly because the fit between academia and the computer is all too close. Both traverse analogous routes to the same end, inasmuch as education, for which academia is a conduit, is fundamentally about acquisition, manipulation, and application of knowledge. Given academia's elemental mission, it is all too apparent why the question of the computer's integration into any academic curriculum is only a question of time. As a tool for acquisition and effective manipulation of information, the computer is too powerful and tailor-made to be ignored, and yet too revealing to be left unregulated and controlled.

Like the computer, academia is a tool for the construction of virtual realities. Since every cultural reality is de facto a virtual reality, and education is a primary vehicle of culture's self-perpetuation, academia is the effective arm of a culture industry that is actively and ceaselessly engaged in the construction of a virtual or cultural reality that is wrapped in such an aura of factuality that its virtuality ceases to appear on the surface altogether. This latter is a virtual difference between the computer and academia.

Whereas the computer ceaselessly exposes the suppressed virtuality of the real, academia constantly validates its activity, and disguises its active participation in the fabrication of our virtual or cultural reality, with recourse to an actual and objective reality that it helps construct and purport to exist, independent of its gaze, outside the self-imposed boundaries of the university (the campus). Whereas academia constantly distances itself from the cultural reality it helps to fabricate, by assuming the voyeuristic role of a detached observer with respect to it, the computer ceaselessly breaches the distance that academia so carefully constructs between itself and the subject of its representations, reflections, and contemplations. The computer disturbs the distance that academia tries hard to maintain between itself as a virtual reflection and the outside as the actual referent to the stable representations within the university.

If, therefore, there is a tone of urgency to every discussion of the place and role of computers in academia, if we are eager to define, regulate and control the limits of its place and role within the university, it is, to a measure, because the fit is too close, the similarities are too great, the dependence is unavoidable, and consequently at stake are the lines and boundaries that academia has tried hard to maintain between, among others, the virtual and the actual, reality and representation.

Also, if the preoccupation with the place and the role of the computer in the architecture curriculum is particularly acute, this is in part because of all the branches of academia, architecture is the field that, among a handful of others, is literally and overtly engaged in the fabrication of our cultural or virtual reality.

It is a field where our cultural beliefs, ideas and values assume spatial and formal dimensions, by way of allowing subjectivity to assume the guise of objectivity, and the virtual

the aura of the actual.[9] It is the field or the place of passage where the line between the virtual and the actual is most volatile and the distance most acute. Traditionally, the field has maintained the distance between its virtual productions and its actual products — between what it does and what it produces — with recourse to various modes of representation, whose abstraction did not cross or shed doubt on the presence of the line between the actual and the virtual, or reality and representation. The opening passage from Alberti's Ten Books is a vivid testimony.[10]

The distance that drawings and models, in their abstraction, had carefully maintained, are now threatened with collapse by electronic re/production. The field's available modes of representation - indissociable from its modes of conception and creation - are subject to radical transformation by the computer.

This transformation is unavoidable, because even if we choose not to engage the tool, we must nevertheless contend with its products, which have us see in ways that we had not, and could not have envisioned before. Insofar as computers constitute a particular way of looking at and manipulating the world, their impact on our perceptions and conceptions are as unavoidable, as they are problematic.

This brings us back to our point of departure, i.e., to the emphatic and urgent tone of much of the current debate on the place and role of computers in architectural education, as well as the lingering question of policy. The urgency, I have tried to point out, is a voiceful recognition of displaced boundaries and changing percepts. The question of policy reflects institutional consternation and the need for a measured response. The trajectory of the response will depend on the ideational posture of the respondents. The options, however, are not obscure.

We can readily pursue the existing policy of segregation and emphasis on software proficiency development. Alternatively, we can resist the change and guard our beliefs and presuppositions by raising the barriers higher, or what is not fundamentally different, seek a more effective solution to the ideational challenges of the computer with recourse to, for instance, the economy of Cyber Space. However, what I have tried to point out thus far is that the motivation for the adoption of either of these or similar policies is to a great extent ideological, and not necessarily pedagogical. The policy of literal or conceptual segregation and alienation are, in fact, pedagogically counter productive as applied to architecture curriculum, insofar as the emphasis in this curriculum is on creation and effective production. It is as pedagogically feasible to have a computer lab in this field, as it is to have a pencil lab. The segregation of the various tools of production has no greater purpose and speaks of no greater cause than an ideological apprehension.

We could also embark on a journey that follows a different path, one whose destination is not yet known. This is a journey that recognizes the change and tries to focus on the pedagogical imperatives of the integration, all too aware of the ideological challenges and dilemmas of the tool. It is a journey, at the outset of which, there is no assumption of an answer at hand. There is, however, the presumption of the computer being a powerful pedagogical tool for access, manipulation, and creation of data in all its various guises. At the outset of this journey, there is also the recognition of a potential for the hegemony of the electronic media in the absence of a clear pedagogical mandate guiding our steps on an untrodden path.

There is no pretense to pragmatism in this approach. There is even less of a pretense to ideational immunity. There is only the recognition of being caught in between conflicting modes of conceiving, organizing, and representing the world, and the imperative of being blinded by neither, at the risk of the hegemony of one.

Should we choose to let the pedagogical benefits of the computer point the way to the determination of its place and role in the architecture curriculum, then we may begin to chart a course of integration by noting that pedagogy in architecture, unlike most other fields of study, relies on two interrelated, though distinct strategies. Given the unique mix of information and skills needed to practice architecture, architectural education has traditionally divided its focus between the familiar classroom condition and the lesser known format of the design studio.

In elemental terms, classroom instruction in architecture does not differ greatly from classroom instructions in most fields. However, insofar as the question and the impact of the integration of computers are concerned, there is a substantial difference between the two. Unlike most, classroom instruction in architecture has been, traditionally and essentially, a multi-media event - be the subject at hand technical, theoretical or formal in focus. Trusted with the mission of imparting a body of knowledge to which forms and images are integral, as well as the distinct and various modes of analyzing architecture, formally and otherwise, classroom instruction in the field has had to rely heavily on the graphic presentation and manipulation of images and forms as an indispensable part of its pedagogic strategy. The computer's potential as a tool for access to large bodies of information, coupled with ease of manipulation and mixed media presentation, is likely to impact classroom instruction in architecture at a level of increased proficiency and effectiveness that is not likely to be felt in most fields of instruction.

The benefits of integration not withstanding, classroom instruction as a mode of representation within the university has remained virtually unaffected by the computer's potential, due largely to the prevalent policy of segregation. This is a lost opportunity that is keenly felt in the field of architecture. Any policy that seeks to gamer the benefits of the tool must assume a strategy that overcomes the dichotomy of computer labs and classrooms as segregated modes of re/production within the university.

As dramatic as the impact of the computer on classroom instruction in architecture can be - to the point of potentially supplanting the classroom, by allowing its mode of instruction to forego its dependence on classroom space - it is likely

that the impact of the computer will be felt most dramatically in studio.

Whereas the pedagogical focus of the classroom in architecture is information and analysis, the pedagogical focus of the studio is application and production. The studio is a unique pedagogical environment, where the knowledge and the analytical skills acquired in the classroom is brought to bear on the translation and transformation of ideas, values, and beliefs into form. Studio's pedagogy is focused on the development of creative solutions to specific design problems. The process entails persistent experimentation, simulation, and critical analysis in search of an appropriate formal solution. It requires the employment of a host of tools and a combination of *technologies* whose diversity is not likely to be matched even by the allied art studios, and much less a typical classroom.

Inasmuch as classroom instruction in architecture is a multi-media event, the studio is a multi-medium event. Here, the exigencies of formal realization and relproduction demand and guide the mixed use of a variety of tools and technologies. Of these the computer can be the most powerful and persuasive medium yet. However, it is important to note that the focus of the studio is never on any given medium. Rather, it is on arriving at a formal solution, for the realization of which no medium is by itself sufficient. The studio is not a single medium environment. This is for the simple reason that every medium has its unique limitations as well as contributions, and a mix of medium is required to compensate for the limitations of individual media.

The pencil, the cardboard, and ultimately the computer - or else two and three dimensional drawings and models, whether manual, mechanical, or electronic - are not different mediums of choice for accomplishing the same task in the studio. Rather, they are complementary and supplementary means of finding an effective solution to the problem at hand. This is precisely why the computer lab policy is pedagogically counter productive for architecture. The studio pedagogy can only benefit from the computer's immense potential, if it is effectively integrated with other tools and technologies that mutually compensate for each other's limitations, in a multi-medium environment. The spatial and conceptual segregation of the computer can at best render it an ineffectual pedagogical tool for architecture, or worse lead to the hegemony of the electronic media with all the entailed limitations and pedagogical shortcomings.

The solution to the problem is as obvious as it is elusive. To be effective, the computer must be integrated into the studio space and used in conjunction with other complementary tools and technologies. This entails universal access, on call, within the space of relproduction for all students. Whether this is accomplished by providing each studio work space with a computer, or by requiring students to purchase their own CPU is not only a question of economic and administrative feasibility, but also, I have tried to point out, a question of posture and outlook.

NOTES

[1] The computers potential for representation and fabrication are in inverse ratio. The more active the computer's fabrication, and the more forceful its intervention, the closer is the appearance to passive representation.

[2] For a comprehensive discussion of the impact of mechanical reproduction, in general, and the camera, in particular, please see: Roland Barthes, *Camera Lucida* (New York: Hill & Wang, 1981), and Walter Benjamin, *Illuminations* (New York: Schocken Books, 1978), pp.217-251. For a discussion of the impact of duplication on the economy of representation please see: Jacques Derrida, "Economimesis," *Diacritics* 11 (1981): 3-25

[3] The computer, it is important to note, is not unique in its overlapping of representation and fabrication. There is, for instance, the pencil, among other comparable tools. The computer is unique, however, in the manner in which it overlaps the tasks of representation and fabrication. The computer's representations come too close to the "real," in a manner that pencil's representations never can and in this respect the computer is similar to the camera. Whereas the pencil maintains a safe distance and the camera's representations can readily be referenced to reality, the computer actively creates a representation that is neither sufficiently distant nor can it be readily reduced to an existing referent, outside it.

[4] I have outlined the problematic challenges of representation and mechanical duplication to humanist assumptions about the nature of reality, and their bearing on architectural discourse, elsewhere. To avoid repetition, I refer the reader to "On Truth, in Theory: Representation and the Crisis of Signification in Theoretical Discourse on Architecture," *The American Journal of Semiotics* 10 (1993):155-76, and "On Life, By Analogy: Architecture and the Critical Discourse on Extrinsic Constraints," *Poetics Today* 16 (1995).

[5] The rampant fear of falling behind in the employment of the new technology that often accompanies the urgent call for the integration of the computer into academic curricula without a clear, articulated pedagogical mandate, may well be an alternate expression of the fear of not having control over the new technology and the parameters of its influence and reach, i.e., the fear of the displacement of the real and the loss of its humanist privileges.

[6] For a comprehensivediscussion of changes in the experience of space and time since the end of 19th century, please see: Stephen Kern, *The Culture of Time and Space: 1880-1918,* (Cambridge: Harvard University Press, 1983).

[7] The invention of Cyber Space is analogous to the invention of the decimal system in that both have made their respective subjects mobile. Whereas the decimal system facilitated the free circulation of the book, hitherto chained in place within the bounds of the library, Cyber Space has allowed the computer greater conceptual mobility in that the computer can now be conceived as a moveable window into Cyber Space.

[8] There is, peculiar as it is, such a thing as a computer-generated drawing, though no equivalent recognition exists with respect to, for instance, a pencil, or a water color generated drawing. The distinction speaks vividly of an imposed difference between the pencil, conceived as a tool, and the computer, conceived as a machine, the one used and the other put to its use.

[9] The spatial configuration and segregation of the computer is a case in point.

[10] For a comprehensive discussion of this passage please see *Alberti, Laugier, Ruskin: On Natural Architecture* (Ann Arbor: U.M.I., 1989), pp.19-33.