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Redefinition in a 'New' Paradigm

by
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Redefinition in a 'New' Paradigm

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Abstract

This thesis considers the architectural implications of a perceived paradigm shift in science and scientific inquiry. This paradigm sees science not as separate from the world, from nature and society, but connected with it. As a result, the design of the science laboratory building must allow for the interaction of the scientific community with the object of study: the natural, the social, the human.

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Introduction

Since the dawn of the scientific revolution, the evolution of the laboratory has been driven by the scientist's desire for a productive environment that allows them to conduct experiments with rigor and control, to ensure the results are authentic, replicable, and long lasting. The particular requirements for rigor and control brought about the earliest manifestations of a laboratory, which over time, has evolved into the complex and sophisticated structure of today.¹

The last quarter of the nineteenth century introduced a "...growing interdependence of research and technology, which has turned the sciences into the leading productive force."² Research is now big business where scientific inquiry, technology, and industrial production are joined in a common enterprise.³ This enterprise models itself to be efficient, productive, and systematic in order to feed its capital necessity, but the scale of contemporary scientific research is such that it requires institutional support through corporate and public agencies.

With the growth of institutionalized scientific research, inextricable connections have developed between notions of science and varying standards of progress- especially as measured by the availability of new technologies,⁴. "Scientific progress has been closely associated with the development of instruments... The complexity and hence the cost required by scientists have been continuously increasing."⁵ This self-perpetuating loop, where research generates technology that requires more technology, is not sustainable and is contrary to the true spirit of scientific inquiry.

Science needs to be recognized not as a sterile and distant objectivity, but as a humanist strategy that mediates wonder, curiosity, nature and the unknown with the demands of contemporary economics. The design of the science laboratory must allow for the interaction of the scientific community with the object of study: the natural, the social, the human.

The thesis being put forward is that architecture can be a catalyst for the unfolding of the new scientific paradigm. In fact, architects have a responsibility to bring about a 're-viewing' of the world, to bring to a close the era of objective detachment and wake the world from its technological narcosis. The design for a sciences building on the campus of Georgetown University in Washington D.C., a program initiated by a 'sustainable' design competition⁶, is the vehicle for exploring this thesis.

Notes

- ¹ ACSA, 2003-2004 Laboratories of the 21st Century Student Design Competition, 1-17, 3 July 2003
<http://www.labs21century.gov/pdf/student_competition.pdf>, 3.
- ² Jurgen Habermas, Toward a Rational Society (Boston: Beacon P, 1971) 100.
- ³ Habermas, 104.
- ⁴ Thomas Kuhn, The Structure of Scientific Revolutions (Chicago: University of Chicago P, 1970) 161.
- ⁵ Russel L. Ackoff, Scientific Method (New York: John Wiley & Sons, 1962) 434.
- ⁶ ACSA, 2003-2004 Laboratories of the 21st Century Student Design Competition, 1-17, 3 July 2003
<http://www.labs21century.gov/pdf/student_competition.pdf>.

1

Science

Science is a quest for truth in a world of uncertainty and unknowns. It is a need to understand the world, to gain knowledge of the indefinite. In order to acquire such awareness, philosophers and scientists of the past developed methods of inquiry, observation, and experimentation. Science is a way of viewing and understanding the world, including the methods and processes of measurement.

For Aristotle (384-322 BCE)¹, the mode of inquiry was based on intuition, inspiration, and experience. It was a philosophy dealing with the embodiment of bodies and materials, and experience in connection with the physical. Observation, sensation, and experience were the methods through which discovery occurred. Aristotle saw ultimate reality in physical objects, knowable through experience. Objects, including organisms, were composed of a 'potential- matter', and of a 'reality- form', in opposition to Plato, his teacher, who located ultimate reality in Ideas or eternal forms, knowable only through reflection and reason.²

In the later Middle Ages, Aristotle's work was rediscovered and enthusiastically adopted by medieval scholars.³ Inspired by Aristotle's mode of inquiry, alchemy developed as a discipline to study the links between physical and metaphysical phenomena. This included the transmutation of base metals into noble metals such as gold and silver. It was a working of material and a connection with the spiritual and the unconscious. As a process of making and doing, the alchemist explored the world, the experience, and the spirit. [Appendix A]

The seventeenth century saw a rejection of Aristotelian philosophy for the Platonic. One dominant figure in this movement was Rene Descartes. Ideas derived from Descartes, whose preoccupation with the self as the singular knowable truth and

the primacy of individual experience, brought about a different mode of inquiry. This 'Cartesian' worldview has been dominant in science for over three hundred years. Perhaps the greatest impact of the Cartesian paradigm has been the "belief in the scientific method as the only valid approach to knowledge, [and] the view of the universe as a mechanical system composed of elementary material building blocks"^{4, *a} [Appendix C]

The systemization and objectification of nature and the fostering of a detached, subjective observer in the seventeenth century are the basis for modern scientific inquiry. In its search for the "Grand Narrative", science became withdrawn from the world,⁶ and abandoned physical/metaphysical link that alchemy had once offered to the world.

Since the last quarter of the nineteenth century, society has seen a "growing interdependence of research and technology, which has turned the sciences into the leading productive force."⁷ Research has become large-scale and industrial, governmental, or institutional, which caused science, technology, and industrial utilization to be fused into one system.⁸ It became important for science to be efficient, productive, and systematic to feed capital need.

With the growth of the 'system', inextricable connections could be seen between notions of science and of progress, especially in connection with technology⁹. "Scientific progress has been closely associated with the development of instruments... The complexity and hence the cost required by scientists have been continuously increasing."¹⁰ With the precision necessary in science, due to the need for accurate and objective conclusions, more and greater technical equipment is needed. A cycle is then produced, first created at the end of the nineteenth century, where "no technology without wealth, but no wealth without technology. It is this precise moment that science becomes a force of production, in other words, in the circulation of capital."¹¹ This creates what is called "big science", where research is restricted to large academic, governmental

and industrial organizations that can fund the projects, as research must be financed at a loss for a certain amount of time in order to increase the probability of the research producing a highly profitable innovation.¹² “This centralization of research has tended to divide academic institutions into those which concentrate on teaching and those which concentrate on learning (that is, those in which research plays an important role). Such a separation can have serious consequences to teaching...”¹³ Without the knowledge of both aspects, there cannot be a guide toward what is the future.

The need for instrumentation and equipment grew from the notion of progress, the values of modern science, and the birth of scientific method: the technique of acquiring proof. [Appendix B]

According to Thomas Kuhn, science progresses through a series of revolutions that occur when one ‘paradigm’ is replaced with a new paradigm by the scientific community. The paradigm, on the one hand, “stands for the entire constellation of beliefs, values, techniques, and so on shared by the members of a given community. On the other, it denotes one sort of element in that constellation, the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for the solution of the remaining puzzles of normal science.”¹⁴ They are important as they restrict the phenomenological field accessible for scientific investigation.¹⁵

The paradigm’s role is a vehicle for scientific theory. In that role it functions by telling the scientist about the entities that nature does and does not contain and about the ways in which those entities behave. “The information provides a map whose details are elucidated by mature scientific research. And since nature is too complex and varied to be explored at random, that map is as essential as observation and experiment to science’s continuing development.”¹⁶

A problem with or in the paradigm constitutes what Kuhn calls an anomaly, and discovery commences with the awareness of anomaly, “i.e. with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal

science.”¹⁷ In this sense, it is not what is known that becomes important, but what is not known.

In some instances, a piece of equipment, designed and constructed for the research, fails to perform in the anticipated manner, revealing an anomaly that cannot, despite repeated effort, be aligned with professional expectations. “In these and other ways besides, normal science repeatedly goes astray...the profession can no longer evade anomalies that subvert the existing tradition of scientific practice—then begin the extraordinary investigations that lead the profession at last to a new set of commitments, a new basis for the practice of science.”¹⁸ In other words, a new paradigm.

Each new paradigm “necessitated the community’s rejection of one time-honored scientific theory in favor of another incompatible with it. Each produced a consequent shift...And each transformed the scientific imagination...a transformation of the world within which scientific work was done.”¹⁹ This shift created a revolution, and a progression in the evolution of scientific theory. Also, this search for proof initiated and initiates the necessity for instruments, which, in turn, necessitates the need for capital, and drives the self-perpetuation loop.

According to Kuhn, there is an “image of science by which we are now possessed. That image has been drawn...from the study of finished scientific achievements as these are recorded in the classics and, more recently, in the textbooks from which each new scientific generation learns to practice its trade... we have been misled by them in fundamental ways.”²⁰ Science then, becomes a compilation of facts, theories and methods in current texts and scientists strive to contribute to such an assemblage. Science becomes seen, and taught, as one great mind or event after another.

However, the practice of science is not so clean cut. For example, the statement: ‘Oxygen was discovered’ misleads us by suggesting that discovering something is “a single simple act assimilable to our usual (and also questionable) concept of seeing. That is why we so readily assume that discovering, like seeing or touching, should be

unequivocally attributable to one individual and to a moment in time.”²¹ This can be seen in the recollection of Einstein and the theory of relativity, elevating Einstein to the status of genius.

Contemporary philosophers, historians, and scientists are beginning to note that “discovering a new sort of phenomenon is necessarily a complex event, one which involves recognizing both *that* something is and *what* it is. But if both observation and conceptualization, fact and assimilation to theory, are inseparably linked to discovery, then discovery is a process and must take time.”²² Therefore, again, the notion of the ‘hero scientist’ is a misconception.

In Kuhn’s terms, a change in theory or paradigm reflects upon much scientific work already successfully completed. The assimilation requires the reconstruction of prior theory and the re-evaluation of prior fact, a process that is seldom completed by a single man and never overnight.²³ In this, it can be seen that a change in theory necessitates a portion of the scientific community to agree to change the old theory for the new one, a complicated feat in itself.

A contributor to this concept of a stable, linear process to science is the science textbook, which aids the novice in understanding theories, and the laymen in grasping basic concepts.

Textbooks record the stable outcome of past revolutions and thus display the basis of the current tradition.²⁴ “Partially by selection and partially by distortion, the scientists of earlier ages are implicitly represented as having worked upon the same set of fixed canons that the most recent revolution in scientific theory and method has made seem scientific.”²⁵ A textbook presentation implies that scientists have striven for the particular objectives that are embodied in today’s paradigms, which is not so,²⁶ and also suggests that science has reached the present state by individual discoveries and inventions.

“Textbooks teach one thing now and something completely different 100 years ago.”²⁷ When a scientific community repudiates a past paradigm, it simultaneously

renounces most of the books and articles in which that paradigm had been embodied.

“The result is sometimes drastic distortion in the scientist’s perception of his discipline’s past...he comes to see it as leading in a straight line to the discipline’s present vantage.”²⁸

The textbook has the tendency to make the development of science linear and hides a process that lies at the heart of the most significant episodes of scientific development,²⁹ a process of inquiry and curiosity, accident and error, and a development that takes time and the consensus of many individuals.

However, contemporary science is now seen to be in crisis, a “crisis of perception...[whereby] we are trying to apply the concepts of an outdated world view—the mechanistic world view of Cartesian-Newtonian science—to a reality that can no longer be understood in terms of these concepts. We live today in a globally interconnected world, in which biological, psychological, social, and environmental phenomena are all interdependent. To describe this world appropriately we need an ecological perspective which the Cartesian world view does not offer.”³⁰

Scientific writers see this time as a new ‘paradigm shift’. Objectivity and rationality are not sole indicators of science, and research is not only confined to method. Subjectivity and intuition, experience and faith, chance and accident all play an important role in science education, practice, and research. What becomes interesting in modern science is the wide gap between nature and theory. An attempt at shrinking that gap is becoming predominant.³¹

Contemporary scientific historian Feyerabend “rejects philosophical discussions of ‘method’ as inadequate because they are mere verbal abstractions. What really happens in science, he believes, is a playful and quasi instinctive adaption to problems and circumstances that are not always fully understood.”³² Putnam points out that “physics itself could not proceed using only ‘scientific method’ and that some ‘non scientific knowledge’ is always presupposed by science.”³³ In the words of Galileo at the time Descartes was building his philosophy:

I am (indeed) unwilling to compress philosophical doctrines into the most narrow kind of space and to adopt that stiff, concise and graceless manner, that manner bare of any adornment which pure geometricians call their own, not uttering a single word that has not been given to them by strict necessity...I do not regard it as a fault to talk about many diverse things, even in those treatises which have only a single topic...for I believe that what gives grandeur, nobility, and excellence to our deeds and inventions does not lie in what is necessary—though the absence of it would be a great mistake—but in what is not...³⁴

Both the necessary and the unnecessary are needed for scientific action to occur and possibly evolve.

P. B. Medawar, for his part, has stated that “*having ideas* is the scientist’s highest accomplishment,” that there is no “scientific method” and that a scientist is, before anything else, a person who “tells stories.” The only difference is that it is his duty to verify them.³⁵

It is not to go as far as stating that there is no method in science, but in the search for proof of a theory, through experimentation and observation, subjectivity is involved and certain assumptions are created. Feyerabend states that the scientist sometimes uses propaganda “...psychological tricks in addition to whatever intellectual reasons he has to offer that are the result of the scientist’s own fertile imagination, that it has been *invented*.”³⁶ In the scientific method, an argument is proposed and a search for proof occurs. “‘Irrational means’ are then needed in order to uphold what is nothing but a blind faith until we have found the auxiliary sciences, the facts, the arguments that turn the faith into sound ‘knowledge’... It will have to be brought about by *irrational means* such as propaganda, emotion, *ad hoc* hypotheses, and appeal to prejudices of all kinds.”³⁷

Science, then, is seen to be “much more ‘sloppy’ and ‘irrational’ than its methodological image...[and] the attempt to make science more ‘rational’ and more precise is bound to wipe it out, as we have seen....*these ‘deviations’, these ‘errors’, are preconditions of progress.*”³⁸

Notes

- ¹ Aristotle is seen as having a strong influence in the history of science and Western thought through his philosophies dealing with the the physical world, and thought by some as possibly being the first 'scientist' in Western society.
- ² Ben Waggoner, Aristotle (384-322 B.C.E.) UCMP, 1994-2002, 5 Dec. 2004 <<http://www.ucmp.berkeley.edu/history/aristotle.html>>.
- ³ Waggoner, <<http://www.ucmp.berkeley.edu/history/aristotle.html>>.
- ⁴ Fritjof Capra, The Turning Point: Science, Society, and the Rising Culture (Toronto: Bantam Books, 1983) 29-30.
- ⁵ The mention of Aristotle, Plato, and Descartes is for reference only, is not a description of the characters themselves. The philosophies are important in showing different world views and the development of modern science.
- ⁶ Nathan Schwartz-Salant, Jung on Alchemy (Princeton: Princeton UP, 1995) 4.
- ⁶ "This breaking up of the grand Narratives...leads to what some authors analyze in terms of the dissolution of the social bond and the disintegration of social aggregates into a mass of individual atoms thrown inot the absurdity of Brownian motion. Nothing of the kind is happening: this point of view, it seems to me, is haunted by the paradisaic representation of a lost 'organic' society. A *self* does not amount to much, but no self is an island, each exists in a fabric of relations that is now more complex and mobile than ever before. Young or old, man or woman, rich or poor is always located at "nodal points" of specific communication circuits, however tiny these may be." Jean-Francois Lyotard, The Postmodern Condition: A Report on Knowledge (Minneapolis: U of Minnesota P, 1979) 15.
- ⁷ Jurgen Habermas, Toward a Rational Society (Boston: Beacon Press, 1971) 100.
- ⁸ Habermas, 104.
- ⁹ Thomas Kuhn, The Structure of Scientific Revolutions (Chicago: U of Chicago P, 1970) 161.
- ¹⁰ Russel L. Ackoff, Scientific Method (New York: John Wiley & Sons, 1962) 434.
- ¹¹ Jean-Francois Lyotard, The Postmodern Condition: A Report on Knowledge (Minneapolis: U of Minnesota P, 1979) 45.
- ¹² Lyotard, 45.
- ¹³ Ackoff, 434.
- ¹⁴ Kuhn, 175.
- ¹⁵ Kuhn, 61.
- ¹⁶ Kuhn, 109.
- ¹⁷ Kuhn, 52-53.
- ¹⁸ Kuhn, 5-6.
- ¹⁹ Kuhn, 6.
- ²⁰ Kuhn, 1.
- ²¹ Kuhn, 55.
- ²² Kuhn, 55.
- ²³ Kuhn, 7.
- ²⁴ Kuhn, 137.
- ²⁵ Kuhn, 138.
- ²⁶ Kuhn, 140.
- ²⁷ Kuhn, 12.
- ²⁸ Kuhn, 167.
- ²⁹ Kuhn, 140.
- ³⁰ Fritjof, 15.
- ³¹ Kuhn, 27.
- ³² Joseph Grunfeld, Changing Rational Standards: A Survey of Modern Philosophy of Science (New York: UP of America, 1985) 41.
- ³³ Grunfeld, 122.
- ³⁴ Paul Feyerabend, Against Method (London: Verso, 1975, 1988, 1993) 54.
- ³⁵ Lyotard, 60.
- ³⁶ Feyerabend, 65.
- ³⁷ Feyerabend, 114.
- ³⁸ Feyerabend, 157.

2

The Student of Science

What a wonderful stimulant it would be for the beginner if his instructor, instead of amazing and dismaying him with the sublimity of great past achievements, would reveal instead the origin of each scientific discovery, the series of errors and missteps that preceded it—information that, from a human perspective, is essential to an accurate explanation of the discovery.¹

The study of theories and paradigms, through the classics and textbooks, is the main action to prepare the student for association in the particular scientific community with which he will later practice, composed of members who studied the same models, within the same paradigms. There becomes consensus as the theory is the same, allowing for the continuation of a particular research tradition by the community.² “The world that the student enters is not, however, fixed once and for all by the nature of the environment, on the one hand, and of science, on the other. Rather, it is determined jointly by the environment and the particular normal-science tradition that the student has been trained to pursue.”³ This then, allows for the ability of new theory to emerge, and the scientist’s perception of his environment must be re-educated.

In the initial stages of education, the student must acquire a thorough knowledge of the science intended to be explored. This knowledge should essentially come from “the descriptions in books and monographs, as well as from the direct study of nature itself. However, it is equally important that he acquire a general knowledge of all those branches of science that are directly or indirectly related to the one of choice because they contain guiding principles or general methods of attack.”⁴ The biologist then, should not be limited to studies of anatomy and physiology, but also must grasp the fundamentals of psychology, physics, and chemistry, and so forth. Therefore, there is not the strict boundaries between disciplines as was created in modern science and teaching, and science is the study of a broader context, as a problem “never exists in isolation; it is surrounded by other problems in space and time.”⁵ The chances of finding an

appropriate solution to the problem becomes that much greater when more of the problem is understood.

Notes

- ¹ Santiago Ramon y Cajal, Advice for a Young Investigator (Cambridge: MIT P, 2000) 10-11.
- ² Thomas Kuhn, The Structure of Scientific Revolutions (Chicago: U of Chicago P, 1970) 10.
- ³ Kuhn, 111-112.
- ⁴ Ramon y Cajal, 53.
- ⁵ Russel L. Ackoff, Scientific Method (New York: John Wiley & Sons, 1962) 429.

3

The Researcher

[Wolfgang Pauli] ... "At the moment physics is again terribly confused. In any case, it is too difficult for me, and I wish I had been a movie comedian or something of the sort and had never heard of physics." ... "Heisenberg's type of mechanics has again given me hope and joy in life. To be sure it does not supply the solution to the riddle, but I believe it is again possible to march forward."¹

"Like artists, creative scientists must occasionally be able to live in a world out of joint."² At times, a researcher has no basis or understanding in the process of discovery. It is not possible for the scientist to examine every problem in the theory, but there are times when blind faith has significance.³

Later, the answer does not always come through logic, and sometimes arrives "in the middle of the night, in the mind of a man deeply immersed in crisis... an individual invents (or finds he has invented) a new way of giving order to data now all assembled... Almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change,"⁴ This is often the case as these new researchers are not bound to tradition. These new understandings are "flashes of intuition through which a new paradigm is born. Though such intuitions depend upon the experience,"⁵ embodied in a way of viewing physical situations rather than sole conviction in rules or laws.⁶

Arriving at conclusions necessitates thought and concentration, based on observation and experience. As stated by Santiago, this "almost always requires severe abstention and renunciation. During the so-called intellectual incubation period, the investigator should ignore everything unrelated to the problem of interest...In the lecture room, on walks, in the theatre, in conversation, and even in reading for pleasure, seek opportunities for insight, comparisons, and hypotheses that add at least some clarity to the problem one is obsessed with."⁷

However, it is also stated that “of course we don’t recommend the elimination of all distractions...A stroll outside, contemplating works of art and photography, enjoying scenes such as monuments in different lands, the enchantment of music—and more than anything else the companionship of a person who understands us and carefully avoids all serious and reflective conversation—are the best ways for the laboratory worker to relax.”⁸

This relaxation is necessary as concentration can be physically and mentally draining, allowing for the freeing of the mind, rest, and regeneration. “This is the function of *recreation*. Complex social institutions exist in order to satisfy the recreational requirements of continuous progressive striving.”⁹ For to create, some reflection and relaxation must occur.

A second important aspect is stimulation. “Visions of as-yet-unattained...and must be inspired. Inspiration has long been recognized as a function of religion, philosophy, and art... Through art, religion, and philosophy, paint a picture of what man and his world might yet be. Thus recreation and inspiration are correlative activities which assure the dynamic properties of man’s pursuit of ideals.”¹⁰ Therefore, it is important to have places for such occurrences.

However, with the capitalist nature of science, the scientist can no longer afford to spend extended time on one idea. “Gone are the wonderful days of yore when those curious about nature were able to remain withdrawn in the silence of the study, confident that rivals would not disrupt their tranquil meditations. Research is now frantic.”¹¹ It is then, vital for the researcher to have places for the mind to foster and a quick escape from the work, for recreation and meditation, in the frenzied atmosphere created by capital. These places should be part of the everyday of the scientist, as it is the everyday that is science.

It is also important to note that the scientist is human. The observer may not follow the required operations either because of neglect or because it is not possible

practically to do so. In this way, observations may be biased by the researcher. Dials or meters may be read incorrectly, and the scientist may not accurately record a response to a subject questioned. "His senses as well as his powers of concentration are not perfect and hence lead to error."¹² However, as stated previously, error may lead on the path to discovery. For example, "the first, X-rays, is a classic case of discovery through accident, a type that occurs more frequently than the impersonal standards of scientific reporting allows us easily to realize."¹⁴ On the other hand, the scientist cannot, it is said, solve problems at all unless theory and some rules for applying it has first been learned.

The material which the scientist *actually* has at his disposal, his laws, his experimental results, his mathematical techniques, his epistemological prejudices, his attitude towards the absurd consequences of the theories which he accepts, is indeterminate in many ways ambiguous, *and never fully separated from the historical background*. It is contaminated by principles which he does not know and which, if known, would be extremely hard to test.¹³

The particular conclusions the scientist does arrive at are often determined by prior experience in other fields, by the accidents in his investigation, and by the scientist's own individual makeup.

Finally, it has been discovered that "*learning* does not go from observation to theory but always involves both elements. Experience arises *together* with theoretical assumptions not before them, and an experience without theory is just as incomprehensible as is (allegedly) a theory without experience."¹⁵ Therefore, it is not theory or experience, the material or the ideological, that presides, but both together in science and life.

'The scientist must not forget,' affirms Huxley, 'that hypotheses must be considered a means, never an end.' To observe without thinking is as dangerous as thinking without observing.¹⁶

Notes

- ¹ Thomas Kuhn, The Structure of Scientific Revolutions (Chicago: U of Chicago P, 1970) 84.
- ² Kuhn, 79.
- ³ Kuhn, 82.
- ⁴ Kuhn, 89-90.
- ⁵ Kuhn, 122.
- ⁶ Kuhn, 189.
- ⁷ Santiago Ramon y Cajal, Advice for a Young Investigator (Cambridge: MIT P, 2000) 34.
- ⁸ Ramon y Cajal, 38.
- ⁹ Russel L. Ackoff, Scientific Method (New York: John Wiley & Sons, 1962) 433.
- ¹⁰ Ackoff, 433.
- ¹¹ Ramon y Cajal, 35.
- ¹² Ackoff, 206.
- ¹³ Paul Feyerabend, Against Method (London: Verso, 1975, 1988, 1993) 51.
- ¹⁴ Kuhn, 57.
- ¹⁵ Feyerabend, 149.
- ¹⁶ Ramon y Cajal, 118.

4

University

As for geniuses, it is well-known that they have difficulty bowing to rules—they prefer to make them instead. Condorcet has noted that ‘The mediocre can be educated; geniuses educate themselves.’¹

In modern society, “universities and the institutions of higher learning are called upon to create skills, and no longer ideals...The transmission of knowledge is no longer designed to train an elite capable of guiding the nation towards its emancipation, but to supply the system with players capable of acceptably fulfilling their roles at the pragmatic posts required by its institutions...ends are functional.”² That is to say, universities are currently looked at in terms of teaching skill sets, which had been the role of colleges in the past, rather than a more philosophical and knowledge-based context.

However, the great function to be fulfilled by universities is to “lay open the whole body of learning and expound both the principles and the foundations of knowledge,”³ To learn is not solely the acquiring of skills and the role of university is not to output specialists.

In terms of science,

there is no creative scientific capacity without the speculative spirit. ‘Speculation’ is here the name given the discourse on the legitimation of scientific discourse. Schools are functional; the University is speculative, that is to say, philosophical. Philosophy must restore unity to learning, which has been scattered into separate sciences in laboratories and in pre-university education...links the sciences together as moments in the becoming of spirit, in other words, which link them in a rational narration, or rather metanarration.⁴

Therefore, it is important for there to be interdisciplinary learning within the sciences, but also within the university as a whole. The linking of the sciences and other schools of learning allows for a broader world-view and the ability to discover and accept other possibilities. As modern schooling has developed into specializations, society has developed a focused view of the world, which often leads to misunderstandings and

miscommunication. Interdisciplinary learning and relationships with scientific fields within the university would also allow the student of science a greater connection with the arts and other disciplines. This, in turn, would allow for a basic understanding of other modes of thought for the science student as well as a view of science by students of other majors, which currently occurs only in rare circumstances. As science has come to be seen as something removed from society, mixing disciplines has the ability to reconnect the two.

Notes

¹ Santiago Ramon y Cajal, Advice for a Young Investigator (Cambridge: MIT P, 2000) 6.

² Jean-Francois Lyotard, The Postmodern Condition: A Report on Knowledge (Minneapolis: U of Minnesota P, 1979) 48.

³ Lyotard, 33.

⁴ Lyotard, 33.

5

Communication, Debate, Consensus

Science will profit from everyone doing his own thing: a physicist might prefer a sloppy and partially incomprehensive paper full of mistakes to a crystal-clear exposition because it is a natural extension of his own, still rather disorganized, research and he might achieve success as well as clarity long before his rival who has vowed never to read a single wooly line...On other occasions he might look for the most perfect proof of a principle...Science needs people who are adaptable and inventive, not rigid imitators of 'established' behavioral patterns.¹

What becomes essential to research is not the mode in which the research is done, as the benefits come from the creativity of the work, but the need to communicate theories and results to three groups of individuals: fellow colleagues, the rest of the scientific community, and the general public.

One way of conveying knowledge and findings to fellow colleagues and members of the same scientific field is through journals, a characteristic evidenced by the presence of an estimated fifty thousand journals currently distributed around the world. "Journals of abstracts and reports are the first step in the direction of a process of translation that transforms and refines the raw material of original information."² It is also through this process that the scientific community can access information on what is being done around the world.

A number of journals serve the same purpose of communication between scientists of different disciplines who need an interpreter to be able to employ important information in neighboring fields for their own work... Physicists may even use *Time Magazine* to inform themselves about new development in technology and chemistry...interchange among scientists is already dependent on scientific journalism extending from elaborately written reports to the scientific columns of the daily press.³

The journals aid in reinterpreting the data into more accessible language and illustration, allowing for members of other sections of the scientific community to access the information. This allows for a greater form of communication within the community,

as well as some dissemination to interested parties in the general public, a necessity for the translation of scientific information, “which grows out of the needs of the research process itself, also benefits the endangered communication between scientists and the general public in the political sphere.”⁴ [Appendix D]

However, “making their availability known and providing means for acquiring them—is the problem of scientific communication....The volume of ‘material’ produced by science has been increasing at a much greater rate than the ability of the scientist to absorb it or even to obtain access to it...Even if a scientist were to devote himself exclusively to keeping up with his field, he could not do so.”⁵ In the past decade especially, this exchange of information through journals became vastly more accessible through the arrival of mass electronic communication. Cybernetics becomes essential in providing access to any journal from any location. Computers become crucial in the scientific process in action, research and exchange of ideas. However, rather than bringing about the extinction of localized communication, the excess amount of communication has instead boosted the importance of exchanges at the individual and local levels. Such discursion allows for the transmission and discussion of ideas, in conjunction with the availability of cybernetics.

In terms of research, “the scientist needs an addressee who can in turn become the sender; he needs a partner. Otherwise, the verification of his statements would be impossible, since the nonrenewal of the requisite skills would eventually bring to an end the necessary, contradictory debate,”⁶ for debate and consensus are the means of acceptance of paradigms and solutions. To progress in the world of science, the scientist must have the proposed statement seen and discussed by peers, as well as seen as worthy of such discussion. If this proves to be true, a process of argumentation and refutation occurs and the proposal enters the world of discourse.

Therefore, as discussion is a means of progression, a body of individuals must

be able to communicate and confer. For this to occur, the group must have similar basic understandings of various aspects of the topic, making teaching, research, and dissemination of knowledge essential elements in the process of scientific thought and research. This being said however, individuality and creativity in the group are also essential, as debate or open exchange becomes a mode of differentiation and aids in the development of new ideas because, as stated by Kuhn, for paradigm shifts to occur, the anomaly must be accepted. It is not to say that all members of such a group need to share identical ideologies, but that they all have equal capabilities.

According to Feyerabend, such open exchange is guided by a “pragmatic philosophy.”⁷ “The participants get immersed into each other’s ways of thinking, feeling, perceiving to such an extent that their ideas, perceptions, world-views may be entirely changed—they become different people participating in a new and different tradition.”⁸ Traditions and world-views then, are not absolute, and change based on many different factors and contexts. Individual make-up, group dynamics, experiences, past theories, and current societal views, to name a few, all affect the production of scientific theory and experimentation.

Dalton was neither a chemist nor interested in chemistry. Instead, he was a meteorologist investigating the, for him, physical problems of the absorption of gases by water and of water by the atmosphere. Partly because his training was in a different specialty and partly because of his own work in that specialty, he approached these problems with a paradigm different from that of contemporary chemists.⁹

Such ‘individuality’ shows that inter-community and inter-disciplinary discussion and views create a dynamic of disjunction that has the possibilities of discovery.

Adding to the discussion within the scientific community and individual specialities, the general public should not merely be the recipients of generalized dissemination concerning scientific theories, but an active participant in scientific thought and discovery. This interaction is important for two reasons. First, “because it is a concerned party (many scientific decisions affect public life); secondly, because

such participation is the best scientific education the public can get.”¹⁰ A dialogue with the public allows for general and specific social concerns to penetrate the scientific community as well as aids the general public in understanding science, something that was isolated and censored in the past.

“A full democratization of science...is not in conflict with science. It is in conflict with a philosophy, often called ‘Rationalism’¹¹, that uses a frozen image of science to terrorize people unfamiliar with its practice.”¹² Rather than science as a way of controlling society and supporting capitalism and commodity, science should be working in conjunction with the people and objects that are being studied. This ‘frozen image’ is instilled in the laboratory, offering a sterile and objective place, void of the everyday and often removed from public view, heightening the unfamiliarity of science from the general public.

In the end however, science can never be fully separate from society in any sense, and is always related to the public due to the structure of the system, as the non-scientific feeds the scientific in modern society, from the necessity of products to vaccinations, to the source of funding. As a result, scientists must find a way to speak of their actions and conclusions in layman terms. “What do scientists do when they appear on television or are interviewed in the newspapers after making a ‘discovery’? ...[O]n the users of the media, but also on the scientist’s sentiments...it concerns the relationship of scientific knowledge to “popular” knowledge.”¹³ Both types of knowledge need to nourish each other and therefore need the capacity for such interaction to occur and foster through dissemination, dialogue, and the physicality of proximity.

Aldous Huxley...*Literature and Science*...

The world with which literature deals is the world in which human beings are born and live and finally die; the world in which they love and hate, in which they experience triumph and humiliation, hope and despair; the world of sufferings and enjoyments, of madness and common sense, of silliness, cunning and wisdom; the world of social pressures and individual impulses, of reason against passion, of instincts and conventions, of shared language and unsharable feelings and sensations...

“In contrast, science does not concern itself with the contents of a life-world of this sort...Huxley juxtaposes the *social life-world* and the *worldless universe of facts*.”¹⁴
This distinction between ‘life’ and ‘science’, is being blurred in the contemporary world.

Notes

- ¹ Paul Feyerabend, Against Method (London: Verso, 1975, 1988, 1993) 159.
- ² Jurgen Habermas, Toward a Rational Society (Boston: Beacon P, 1971) 77.
- ³ Habermas, 77.
- ⁴ Habermas, 77.
- ⁵ Russel L. Ackoff, Scientific Method (New York: John Wiley & Sons, 1962) 435.
- ⁶ Ackoff, 435.
- ⁷ Feyerabend, 227.
- ⁸ Feyerabend, 228.
- ⁹ Thomas Kuhn, The Structure of Scientific Revolutions (Chicago: U of Chicago P, 1970) 133.
- ¹⁰ Feyerabend, 2.
- ¹¹ “**Rationalism**, also known as the **rationalist movement**, is a philosophical doctrine that asserts that the truth should be determined by reason and factual analysis rather than faith, dogma or religious teaching.”
Wikipedia: The Free Encyclopedia. 2004. Wikimedia Foundation Inc. Aug. 2004
<http://en.wikipedia.org/wiki/Scientific_method>.
- ¹² Feyerabend, 2.
- ¹³ Jean-Francois Lyotard, The Postmodern Condition: A Report on Knowledge (Minneapolis: U of Minnesota P, 1979) 27.
- ¹⁴ Habermas, 50-51.

6

Science and Society

This conflict has been most intensive, perhaps, in the increasing body of scientists working on the development of weapons. Ultimately this is a responsibility to act in the interests of mankind. The scientist cannot divest himself of this responsibility by claiming inability to judge what is or is not in the interest of mankind. As an intelligent member of society he is at least as well equipped to do so than is the nonscientist.¹

This connection of science with society creates a tension within the scientist as a member of the scientific community and the scientist as a member of society. A conflict occurs between scientific interests and broader social interests.

As a professional in society, members of the scientific community have an ethical and moral duty to work in the best interests of the larger society and to consider all consequences, whether or not that produces the 'best' results. Such an ethical standpoint has become a fragile issue in such a capitalist society, where research is driven by economical necessity and big business.

Since [the production of the atomic and hydrogen bombs] there have been discussions in which leading scientists have argued about the political ramifications of their research practice, such as the damages that radioactive fallout have caused to the present health of the population and to the genetic substance of the human species. But the examples are few and far between. They show at least that responsible scientists, disregarding their professional or official roles, cross the boundaries of their inner scientific world and address themselves directly to public opinion when they want either to avert practical consequences or to criticize specific research investments in terms of their social effects.²

However, there is such a responsibility which must be met, and it can be strengthened in the minds of the scientific community through dialogue and interaction with the general public. This interaction acts as a reminder of society's fragility and the scientific responsibility to it, and the fact that the scientist is a member of society, and not only of the scientific community, which is important both to the scientific community and

society as a whole.

As science is the attempt at creating dynamic models of the world, it becomes important to be connected with the world that is being studied, to discovery of the world *through* the world, rather than “be within the flux of phenomena in principle devoid of the world.”³ With a shift away from competition and capital (although never separate from them), in the attempt to help the world at large, science is to be a collaborative and social act. Power is then found in recognition, and has begun a change in the practice of science. It is about communication, between colleagues, within different fields, and with the public as a whole. Science is no longer solely a matter of demonstration but of consensus, as is, or should be, society.

Notes

¹ Russel L. Ackoff, Scientific Method (New York: John Wiley & Sons, 1962) 437.

² Jurgen Habermas, Toward a Rational Society (Boston: Beacon P, 1971) 78-79.

³ Jurgen Habermas, "Dogmatism, Reason, and Decision: On Theory and Praxis in our Scientific Civilization," Theory and Practice (Boston: Beacon P, 1973) 282.

7

Nature

Instead of treating nature as the object of possible technical control, we can encounter her as an opposing partner in a possible interaction. We can seek out a fraternal rather than an exploited nature... and try to communicate with nature instead of merely processing her under conditions of severed communication...¹

Habermas continues to state that if 'men' were to see themselves within the other, that is, to not distinguish differences but similarities, the world would be a better place. If this is possible, it could also be probable that humankind could see nature differently, not as an ideal object 'Other' but that humankind is in fact nature's 'Other.' In this sense, nature is not an object able to manipulate, but in fact humankind is the object with less authority.

From basic necessity to entertainment, the modern world is run by the 'advancements', through commercialization and commodity, of capitalism and economics. There is a drive to always create something better than the competitor, to sell the product, or produce the new substance. It is the drive of dominance and power over others, human and non.

"The modern age brings with it a tremendous assertion of man's autonomy and power. With the aid of science and technology, man sets out to realize the project of mastering nature..."² In this determination, mankind begins to "perceive himself as the genuine maker of his world."³

This drive to dominate, however, is not new to society and can be seen in the earliest writings of Western thought. Humankind was the actor, and nature the prey. This need to dominate nature, the elements, in understanding and in physicality, is seen as a quest for Order.

What is most striking in conceptions of nature, ... is the yearning for purpose and order; perhaps these notions of order are, basically, analogies derived from the orderliness and purposiveness in many outward manifestations of human activity: order and purpose in the roads, in the grid of village streets and even winding lanes, in a garden or a pasture, in the plan of a dwelling and its relation to another.⁴

Humans became the instillers of order and modifiers of nature, and therefore creators of a new environment, as human intelligence and physicality gave an advantage over plants and animals and was noted by many as being 'God's will'. It became the creation of a 'second nature' to adapt the environment as was needed.⁵

As the dominance over nature escalated, 'second nature' grew with innovations. Cities ordered nature into the background and society looked upon itself. Economy grew, driving society. With financial growth, one could now apply control within the designed environment. This factor created the field for domination of man over nature (natural) and man over man (social).

However, the effects of this have begun to emerge in contemporary society and environmental issues have become a growing concern. With this, sustainability in the environment, both built and non, has started to be an active characteristic in design and action, as well as issues of natural, emotional, and physical qualities rather than solely economical variables.

From this perspective, humanity's relationship to nature becomes a relationship between factors, rather than a dominance of the man-made and the individual over the natural and the other.

Notes

- ¹ Jurgen Habermas, Toward a Rational Society (Boston: Beacon P, 1971) 88.
- ² Piotr Hoffman, The Quest for Power: Hobbes, Descartes, and the Emergence of Modernity (New Jersey: Humanities Press, 1996) vii.
- ³ Hoffman, vii.
- ⁴ Clarence J. Glacken, Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century (Berkeley: U of California Press, 1973) 3.
- ⁵ Glacken 117.

8

The Laboratory

According to John Weeks, “The history of the laboratory as a specialized building type begins with the alchemist’s cell...a room in picturesque gloom with a furnace, giant alembics, flasks and crucibles on the floor, while the ceiling and walls are hung with mysterious clutter giving an impression somewhere between magic and madness.”¹ It was the time of experiment and the unknown, where the alchemist would hide in the darkness with his ‘magic’. [III. 8.1]

As experimentation with materials took place, the alchemist believed that the divine was present. It was an attempt to ‘change base metal into gold’ and connect with the spiritual in the material. In other words, in the alchemist’s attempt to change one material into another, there was not a separation between the world of the physical and the world of the spiritual. Both were involved in the magic of science and the alchemists believed that truth could be found in matter. Alchemy was looking at the whole, not the parts in a causal. [Appendix A]

The laboratory of the alchemist was a setting of clutter and disorder. There was not an overt concern with sanitation or factors that would disrupt the experiment, as the presence, or possible presence, of something unknown was a vital part of the occurrence or the magic. [III. 8.2-8.4] The tools used in alchemy were basic, often just clay pots or dishes used to melt or alter the substances with fire or steam. [III. 8.5-8.6] Little was created in terms of transcription, as it was the physical that was the product. Scientific objectivity in any experimental sense did not exist.²

However, a shift occurred when chemistry and other sciences began to be viewed as scientific practices rather than ‘magical’ disciplines. This shift occurred in the seventeenth century and was caused by a change in scientific thought. There was a rejection of Aristotelian physics, the natural philosophy dealing with the embodiment of bodies and

the tendencies of objects to act in a certain natural way. “Some bodies naturally fall, and others naturally rise; some are naturally cold, and others are naturally hot...”³ and so forth.

A noteworthy proponent of this rejection was Descartes, a worker of science and philosophy. He replaced the ‘old’ physics with one grounded in a “mechanistic conception of nature,”⁴ seeing the world as a machine. He was noted to be interested in mathematical and scientific questions, ones based on fact and reason, and was classed among the rationalists.⁵ [Appendix C]

It was notions of this separation of mind and body, spirit and material, thought and experience, subjectivity and objectivity, and reason over the senses, which changed the ideology, tools and method of science. With these ideas came the attitude of “separating processes into distinct parts and focusing attention on the parts even to smaller and smaller units.”⁹ It was a shift in scientific ideology and is crucial as it changed the conception of the laboratory, causing the rooms for experimentation to be distinguished in an objective way, rather than the disarrangement of the alchemist’s cell. Objects were organized and ordered, while shelves categorized equipment and materials as seen in the images of *Lavoisier’s Laboratory*.¹⁰ [III.8.7, 8.8]

A change in the scientific method, as well as the laboratory organization also occurred. In both images, the scientist Lavoisier can be seen dictating the progress of the experiment to the woman at the table, and “mystery has wholly given way to careful observation and exact recording.”¹¹ It was not about the experiment or the physical anymore, but about the careful and rational recording of the experiment. Method as a rational system became inherent.

The instruments used in experimentation became more complex and mechanic, making way for accuracy and precision of experiment, observation and the recording of the observation. [III. 8.9, 8.10] The tools became a manner of inscription devices¹² whose job it was to record the occurrences and to create exactness in method, rather than

to act as objects of manipulation and creators of the unexplained. 'Truth' was found in accuracy and method rather than in matter.

This change in materials, method and idea had an influence on the laboratory as objective reasoning created an objectified layout. This objectification of space continued as science evolved. Changes in methodology in turn affected the space and use of the laboratory.

By the nineteenth century, as gas became a heat source, pipes began to be serviced to benches. However, as new technologies developed, the laboratory layout remained relatively the same, as seen from the illustration entitled *Liebig's teaching laboratory at Giessen* from 1842. [III. 8.7] Fixed benches line the walls, complete with cupboards, the space between the benches and the benches themselves are similar today, responding to "clear ergonomic necessity."¹³ [III. 8.12, 8.13]

Sinks were added and by the twentieth century, the laboratory bench developed complete with electricity, air, steam, water, and suction services.¹⁴ The bench itself evolved into a fixed module which continues to remain the standard. [III. 8.14]

Analysis occurred on a micro and macro scale, and with the emphasis on the instruments and data produced for publication, quality and matter became less significant. The laboratory became a room for the instrument, a place of sterility and data collection, removing all emphasis on the material save for the tools of observation. As the separation between matter and idea emerged as the focus, the laboratory as a physical place ceased to change or develop. The laboratory became a place of objectivity and sterility constructed as such so as to produce data for publication.

It can be said that the "motive force" for the scientific revolution of the seventeenth century, "at least for a while, was man's increase of self-knowledge, rather than his increasing knowledge of the external world. This increase in man's self-confidence led to the discoveries of science, not the other way around."¹⁵ The individual as authority and the laboratory evolved more and more into a specific, objectified design

due to the method and new ideology, but also because of the want and need for the field to remain as is. As science was to be a rational view of nature, so the laboratory had to carry a certain design.

Due to changes in scientific ideology, development of the laboratory as a physical space has not evolved drastically since the seventeen century or at all in the last fifty years as the focus has been on theory, method and data collection rather than the actual. However, as described, the practice of science is not as it may seem, and there is much more to science than rational objectivity. New equipment and ways of working have emerged, and yet the laboratory has not changed. It is a place of wonder and experience, debate and discussion, error and accident, and it necessitates a connection with nature and society: The need to communicate with others is also necessary to strengthen the opportunities of discovery, and an understanding of for whom and why the research is being done is of paramount importance.

Therefore, the laboratory, based on an obsolete system, needs to change along with the progression of science and society, in terms of ideology and physicality, to be neither the alchemist's cell nor Lavoisier's Laboratory, but to encompass science and the world as it is today. The laboratory as the place of discovery needs to adapt, and be open to discovery, discussion, connection and communication.

8.1 Adrian van Ostade
The Alchemists
1757

**8.2 Pieter Brueghel the Elder
(1525-1569)
An Alchemist at work,
mid 16th cent.**

**8.3 David Teniers
(1610-1690)
The Alchemist,
c.1645**

**8.4 Hans Weiditz
(fl. early 16th cent.)
An Alchemist,
c. 1520.**

8.5 Clay Tools of Alchemy

8.6 Alchemy Apparatus

**8.7 Lavoisier's Laboratory,
From Grimaux, Lavoisier (1888).**

**8.8 Lavoisier's Laboratory
Dwg by Madam Lavoisier showing herself taking notes**

8.9 17th-18th century apparatus

8.10 17th-18th century apparatus

8.11 Liebig's teaching laboratory at Giessen,
circa 1842

8.12 Replication of Liebig's
laboratory

8.13 Current laboratory

8.14 Current laboratory bench

8.15 Current laboratory equipment

Notes

- ¹ John Weeks, "A Design Approach," Design for Research: Principles of Laboratory Architecture, ed. Susan Braybrooke (York: Wiley & Sons, 1985) 2.
- ² Nathan Schwartz-Salant, Jung on Alchemy (Princeton: Princeton UP, 1995) 4.
- ³ Daniel Garber, Descartes Embodied: Reading Cartesian Philosophy Through Cartesian Science (Cambridge: Cambridge UP, 2001) 2.
- ⁴ Garber, 2.
- ⁵ Garber, 2, 111.
- ⁹ Schwartz-Salant, 4.
- ¹⁰ Weeks, 2.
- ¹¹ Weeks, 2.
- ¹² Bruno Latour, and Steve Woolgar, Laboratory Life: The Social Construction of a Scientific Fact (Princeton: Princeton UP, 1986) 15-103.
- ¹³ Weeks, 2.
- ¹⁴ Weeks, 2.
- ¹⁵ Joseph Wood Krutch, Human Nature and the Human Condition (New York: Random House, 1959) 146.

9

Georgetown

Georgetown, named after King George II, originally donned the name George, Maryland, in 1751 and it stood as a station point for the inspection and shipping of tobacco, the most important crop of Maryland.¹ In 1791, Washington City was formed and Georgetown provided housing, supplies and services to the growing city. A college was also formed to satisfy the intellect and educate the members of its society.

However, with the growth of Washington, bridge construction rendered the waterway unusable, and soil depletion destroyed the tobacco crops of Maryland, causing the town to struggle in existence until the construction of the 'C & O Canal' in 1828, providing access from Georgetown to Cumberland. This waterway was to transport coal, limestone, lumber and flour and helped sustain the town.² [Ill. 9.1]

By the 1870's Georgetown struggled no longer, living on profits made from products produced by mills, factories, foundries and blacksmith shops which transformed the materials brought through the canal and shipped around the world. In 1871, Georgetown became part of the city of Washington.³

Once a town before the creation of Washington, Georgetown is now a section of Washington, DC. Today, with the lack of a Metro station (as per the wishes of the community) and the preservation of old houses and "small town charm," Georgetown retains its distinct character.⁴ [Ill. 9.2]

9.1 Georgetown Waterfront, c. 1864

9.2 Georgetown, Oct. 2003

Notes

¹ Stephen J. Ackerman, "Georgetown," Washington D.C. Visitor's Guide, (Washington: , 1990) 96.

² Ackerman, 96.

³ Ackerman, 96.

⁴ Ackerman, 96.

Currently a prominent political university, known for graduates such as former president Bill Clinton, as a place of speech from President George Washington and as having received an honouring from President Johnson, Georgetown University's history is charged with religion and politics. It began with a struggle to start a Catholic school in America when the Jesuits order was being suppressed, but in the long run owed much of its growth to the birth of the United States as a nation. Founded by Bishop Carroll, objections (for developing a school) from the clergy ceased once Carroll reminded the members that the main purpose of the Catholic Society was to teach. The construction of the first building began mid-April 1788 and the college opened to students November, 1791.¹ Often laden with financial difficulties, frequently short staffed, and replete with multiple riots throughout the years, the university held on.

In 1841, Father Curley, a professor at the school, decided to plan construction of an astronomical observatory at a time when there were only two in the country. He drew the plans, supervised the construction, and directed the purchase of required equipment from Europe; Father Curley had no scientific training, but seemed to have an intuition for it.²

During the Civil War in 1861, the school became quarters for military regiments, and despite the problems in the country, the school benefited from the war with the opening of the Medial School, and by 1864 was the only medical school operating in the district. By the 1880's, it was decided to make the school a full university, which was nearly shut down in the 1890's with orders from Rome due to its competition with The Catholic University. However, this did not occur and the university grew with the addition of the Law School and the Georgetown University hospital. By 1925, the university was advancing in fields of research and later in 1949, opened a Language school, followed by

the School of Business in 1955.³

Throughout this time, many recreation activities occurred, including ice skating on the canal, dances, and sports. Basketball, football, handball, baseball: all sports became strong in the university and helped in keeping the school from termination.⁴

Situated atop a hill overlooking Georgetown and Washington and next to a river, Georgetown University is a location of natural beauty and grounded in its site. Restricted to one hundred and four acres and with strict zoning, the campus buildings are multi-use and cluster together.⁵ Architecturally, the campus has a wide range of buildings, some dating back to 1790 and others constructed only recently, such as the new student residence (2004), a sign that the university continues to grow. Rumor has it that the administration is looking at building new facilities for the English department and the Science department in the near future. The wide range of styles on campus much debated by the university and the students alike⁶, ranges from the old stone buildings dating back to the beginning of the university which promote permanence and power, to the cheap constructions of the 50's, to the sustainable attempt of the 80's and the modern concrete building from the 90's. Some prefer one over the other, some like the mix of material and style, others dislike the lack of homogeneity, while some university officials suggest hiring Frank Gehry to design the next new building.⁷

The university, historically driven architecturally throughout the early years by adding to the campus (sometimes changing the orientation), progresses in function and action, and often the architecture represents the times (powerful and permanent in the 1800's, economically conscious in the 50's, modern in the 70's, and sustainable in the 80's). In the 1970's a design for the Master Plan of the university was begun, looking at long-term planning and the inclusion of the human scale.⁸ Soon, the university expanded beyond the stone walls and into the Georgetown neighbourhood to include more student housing and subsequent additional programming.

Much debate has occurred as to whether or not buildings fit in with the campus or do what they were designed for. Some residential buildings act like mini villages; the ICC building symbolizes intercultural education and communication, whereas the scale of the Leavey center which houses student services is said to be too grand, making intimacy difficult, yet ties into the 'character' of the university.⁹ A remarkable feature of the university over the years has been the ability to adapt to the needs of a changing society through the principle of mixed uses, which also created a sense of community, something that was important to Healy, the president of the university in the 1870's.¹⁰

The architectural vision of the university however, is not yet clearly defined and the Master Plan is not set in stone, "but is rather a 'living, daily effort'."¹¹ This 'living plan' would be built on the context and sense of place.¹² As stated by Joseph Hudnut,

Every attempt to bind [universities] to a pattern laid out in advance has failed and ought to have failed...We must set them free to develop...The task to be performed in university buildings and the methods by which they are built constantly change ...Let's imagine the university...as a growing organism whose form lies partly in the past, partly in the future.¹³

As the university has demonstrated, through development, "a desire to adapt to dynamic needs of a changing environment, it has also displayed a concomitant penchant for perpetuating a spirit of history and culture...[representing] a coalescence of architectural innovation and preservation, of modernity and antiquity, of pragmatism and aesthetics."¹⁴

10.1 Georgetown University, c. 1842

10.2 Healy Hall

GEORGETOWN UNIVERSITY

1 Laurier Library	14 Biol Sciences Building	27 The Research Building
2 Village A	15 Health Village	28 Building D
3 New South	16 Leroy Center	29 Robert Hall
4 Carver/Hubberty-Ryan	17 Kober-Cogan Hall	30 Albert House
5 Old Road Halls	18 Pascher-Ha Healthcare Center	31 Xavier/Lowder/Pycke Hall
6 Maguire Hall	19 Donald Hall	32 Walsh Building
7 Old Math	20 St. Mary's Hall	33 North Building
8 Dabiggen Chapel	21 Georgetown Hospital	34 Alumni Square
9 New North	22 Quackenbush Case Center	35 Village C
10 Ryan Administration Building	23 Lombardi Science Center	36 Harbin Hall
11 Corby Hall	24 Delaplan Medical Library	37 Mc Donough/Egyptianum
12 White-Dravner	25 Medical and Dental Building (Med/Dent)	38 Yates Fell House
13 Intertribal Center (ICC)	26 Basic Science Building	39 German Building
		40 Blue Building
		41 Car Barn

The Graduate School of Arts and Sciences is located in Suite 502 of the Intertribal Center.

10.1 Georgetown University Campus Map

Healy Building (6)

Lauinger Library (1)

Healy --mixed materials

Old Ryan (4)

Dahlgren Chapel (8)

ICC (13)

Village A (2)

Village C (above) &
Dahlgren Medical Library (24)

Reiss Science Building (14)

10.4 Campus Buildings

Notes

- ¹ Bob Echele, ed., "175 Years of Georgetown," Ye Domesday Book, (Washington, n.d.) 4-5.
- ² Echele, 7.
- ³ Frank Buono, "Georgetown's Edifice Complex," The Georgetown Voice, 23 Sept. 1986: 8.
- ⁴ Echele, 4-11.
- ⁵ Elizabeth Prelinger, "'From her Spires and Steeples Beaming': Mission and Image in Bricks and Stone," Georgetown at Two Hundred: Faculty Reflections on the University's Future (Washington: Georgetown UP, 1990) 336.
- ⁶ Prelinger, 335, 340.
- ⁷ Scott Redford, "Finding method in campus madness," The Georgetown Voice, 21 Feb. 1991: 8.
- ⁸ Prelinger, 346.
- ⁹ Prelinger, 349.
- ¹⁰ Buono, 8.
- ¹¹ Prelinger, 350.
- ¹² Redford, 9.
- ¹³ Prelinger, 351.
- ¹⁴ Buono, 8.

11 Site

The proposed site for my project is located outside of the main gates of the university. Still university property, it is located in a primarily residential area, the closest of which provides student housing. On the same block as the site, sits a university building (Poulton Hall) containing continuing education programs, a post office, the theatre group 'M & B', and a daycare facility. The surrounding streets are tree-lined and stone finished, with parking on the streets and housing of a colourful 'Georgetown character'.

The site proper accomidates student rowhousing is located as well as two children's playgrounds for the daycare and a small parking lot. To the north of the site is a stone wall enclosing a private highschool while rowhouses and student residences face the east and south ends.

The neighbourhood surrounding the site is mainly residential, with student housing in the blocks closest to the university, and general housing throughout the rest of the area. Buildings are two to three storeys in height. Few commercial merchants are situated in the twenty blocks closest to the university. One bar, a small grocer and pizza parlour are located one block south of the site and a university cafe is situated two blocks east. Near the cafe, a few small shops sell their goods.

Access to the area is by bus, car, streetcar, bicycle and on foot for local residents. Students travelling to the university are not permitted to drive, and are required to park their vehicles across the river and take an alternate mode of transportation to the campus proper as per university restrictions.

Association of Collegiate Schools of Architecture

11.1 Site Map

11.2 Site

11.3 Site Photos Site

11.4 Site Photos Across From Site

Scientific thinking, a thinking which looks in from above, and thinks of the object-in-general, must return to the “there is” which underlies it; to the site, the soil of the sensible and opened world such as it is in our life and for our body—not that possible body which we may legitimately think of as an information machine but that actual body I call mine...Further, associated bodies must be brought forward along with my body—the “others.”¹

¹ Merleau-Ponty “Eye and Mind.” *Primacy of Perception* (Chicago: Northwestern University P, 1997) 160,161.

12 Project

The following is a brief description of some design moves in relation to the site and surrounding context, environment, and culture. Sustainability was a starting point for the project, as the program basics and site derived from the ACSA Student Design Competition: Labs for the Twenty-First Century, which focused on sustainable issues. As stated, sustainability encompasses more than technical requirements and sun angles. However, some moves are in relation to such issues (though not always a priority) and therefore influenced the design, as sustainability incorporates these issues along with the cultural, social, and contextual.

Urban

The site is part of the university complex, yet is situated outside of the campus walls, segregated from the rest of campus programming. Therefore, it became important to draw people to and through the site, to create the density that would be characteristic and important for a university (and to improve the quality of life). One primary decision was to create a strong path through the site, a 'short cut' through the block to the university main gates. Therefore, it is not necessarily only people using the facilities flow through the site but also people on their way to and from the main campus. This increases interaction and communication between scientists, the scientific community, the university community, and the neighbourhood.

It became important to program the site with multiple functions to aid with this density increase as well as to connect it with the rest of the neighbourhood. On a neighbourhood scale, the area is almost completely residential, with a few small food and coffee outlets such as a pizza parlour, a small convenience store, one bar and a student café. Commercial and retail outlets, coffee shops, and restaurants would bring more students and the public to the site—creating density and promoting business economics.

Residential accommodation also became an issue. The university is currently short on student housing and the area is expensive making additional housing extremely useful. The proposed site for the science facility contains student row housing. To remove existing residences when housing is already an issue is a problem (social obligations) and so some existing buildings are to remain, the removed housing is replaced and more is added to the site. The playgrounds on site were also another important space to reinstate for the daycare and to encourage interaction between the different age groups.

In terms of university programs, mixed programs within disciplines (i.e. biology and chemistry), mixed disciplines (i.e. humanities and sciences), and multiple levels within the disciplines (i.e. undergraduate and graduate) were created.

Environment

The building faces south, benefiting from sun/solar capabilities while the labs face other directions with controlled natural lighting. The outdoor plaza is also open to the south, offering possible winter use. The theatre is underground with a green roof, being a large building that is mostly used in the dark, allowing for more green space, adding to the natural environment, social interaction and well-being. All rooms have natural ventilation capabilities and wind stacks for labs and the lobby are designed with the stack effect. Some materials, are reused, such as brick and other materials from the demolished row houses, for environmental and also historical/contextual purposes. Water also became a design component, moving and collecting rainwater run-off which also acts as a water element in public places.

Culture

Science is the study of the natural, the social, and the human. This project considers science and scientific practice in relation to the 'new' paradigm and proposes an architectural response. The laboratory is transformed into a place for discovery and curiosity. It is a locus for communication and consensus and a vessel for possibilities. My design acknowledges the 'sloppy and irrational', the errors that lead to scientific discovery. The building opens the laboratory to the world, encouraging the scientific community to embrace other disciplines, other paradigms and to remain connected to the tactile, the visceral, the social. It is a place to live, to contemplate, and to inspire.

PATH

PILOTES

COURTYARD

12.1 Design process included 1:500 massing models. The first 3 iterations looked at various spacial urban strategies.

LAYERING The layering of the three strategies

12.2 Combining the three strategies at 1:500.

12.3 Midterm design model -ground level 1:200
 Programming and spacial design

12.4 Arial Midterm Model 1:200

12.5 Final 1:500 massing model

12.6 Axonometric

12.7 Basement plan

The underground theatre is accessed from the main lobby of the building as well as via a secondary entrance for night-time use with a coat check area. Both entrances lead to the theatre lobby which is also accessible from Poulton Hall, a convenience for the theatre group that is located there. The theatre can be used for lectures by any university program (science and non), small and large with the use of an operable separating wall. Also, the site includes a stage and change rooms for performances, separated by another operable system.

The space below the main path is a museum/gallery space showing innovative research projects and experiments in the past and present, offering sources of inspiration.

Maintenance offices light by natural lighting from clerestory windows.
Mechanical and Electrical rooms.

12.8 Ground plan

The main path as a through-way to campus, drawing people to and through the site, passing by sunken chemistry laboratories, research and teaching. Green space separates existing rowhouses from the labs, offering a view while separating. Retail for students and surrounding neighbourhood, restaurant/ bar along path and street with interior/exterior stage and outdoor plaza. Centralized cafe accessible from path overlooking water element and playground. Light into theatre space. Walkway from main lobby/path from other entrance overlooking playground. Seminar rooms for all programs. Small meeting/discussion spaces.

12.9 Second Plan

Research and teaching biology laboratories with offices accessible yet separated by lightwells c/w operable windows. Laboratories also overlooking green space separating rowhousing. Lightwells over labs creating an interaction with the residence above and allowing for ventilation. Labs on two facades overlooking neighbourhood. Green space for products on south side. Access to roof-top deck above offices from cafe. Common space over-looking and accessible to green space. Green space for relaxation and interaction with small exterior theatre also accessible from ground level. Offices/ lounge space overlooking green space and plaza. Research lab separated from residence tower by open court.

12. 10 Third Plan

Residences with lightwells to labs below. Suite-style. Green space with access to lower terrace accessible from cafe. Lightwells to lower first-level laboratories. Sloping roof for rain-water run-off and water element for play area.

12.11 East Elevation

East-west facing laboratories. Indirect natural sunlight, view to neighbourhood and neighbourhood viewing of lab. Residential units. Existing rowhouses.

12.12 South Elevation

Southern exposure sun shading and overhangs. Path through site. Re-use of brick from demolished rowhouses (environmental and contextual) Stone wall to tie in with university walls. Tower to link to main campus buildings. Bus stop and bicycle parking.

12.13 South Elevation Photomontage

12.14 Final Model 1;100

12.15 Detail Section Path

Relationship of lobby-path-lab and offices-labs next to and below as well as roof-top terrace.

Book wall in main lobby for 'expired' textbooks.

Distinguishing materials and structure yet also continuation for interconnectivity. (and possible future adaptation).

Gallery/museum below with continuation of book wall. Light as continuation.

Relationship between residential
and laboratories through green
space and lightwells.

12.16 Detail Section

Lab/Residential

12.17 Detail Section Theatre/Green space

Green roof above theatre with secondary exterior theatre. Covered space beyond.

12.18 'Lab Space' 1:100 Model

12.19 VIEW FROM LAB TO CHILDREN
SCHOOL

12.20 BOOK WALL -outdated sciencetific textbooks

12.21 PATH
-lobby and laboratories

**12.22 SECONDARY PATH
OUTDOOR
THEATRE/STAGE**

**12.23 MAIN PATH MEETS
SECONDARY PATH**

12.24 PARK & PLAYGROUND and water element

Cafe overlooking park

**12.26 GREEN ROOF &
OUTDOOR SEATING** above theatre

12.28 1:20 MODEL
'SEATING' ALONG PATH

place of observation, chance encounters

12.29 1:20 MODEL
CONTEMPLATION
place of contemplation, observation, and discussion

12.30 CONTEMPLATION
place of contemplation,
observation, and discussion

**12.31 1:20 MODEL
RESIDENCE ABOVE LAB**

interaction and integration of spaces

**12.32 LIGHT-
WELL SECTION
1:50**

12.33 SUBTLE DETAILS OF USE AND OBSERVATION

Viewing to laboratories below and across to offices. Place for writing. Safety fire doors to close off labs when necessary.

12.34 THE LABORATORY

Teaching

Typical Research
Lab Layout

- place of learning, replicating experiments
- learning standards
- authority
- ordered
- different actions in different areas (separation)
- standardized
- equipment as priority
- discussion separate from experiment

Research

Typical Teaching Lab Layout

- elements separated by function
- organization to promote order and precision
- instrumentation as experiment
- linear layout and separation
- experimentation
- creative liberty?

[Appendix E]

Research

-idea of integration of elements, materials and equipment

-inter-relationship
-interaction with fellow researchers

COMMUNALITABILITY

-transformation/adaptability
-connectivity of process, individuals, actions

Teaching

The re-evaluation of the teaching laboratory looks at the interaction of the units.

Interaction:

-4 people sharing one bench
-shared tables between others
-room works together and learns together
-material and equipment integration
-writing and experiment close together

-discussion and interaction

-core service columns, moveable tables, adaptable space depending on experiment and needed use

12.35 REDEFINING THE LAB BENCH

The Lab Bench

Current lab benches are available in three sizes: 1000mm, 1500mm, 2000mm and various heights

Modular

Modularization of the bench allows for the adaptation of the bench as needed in the lab. Units of 500 x 500 allow for various sizes, layouts, and colours

The bench as a shell allows for elements to be removed and re-arranged depending on project and user. (i.e. more drawers vs more shelving, etc.)

12.36 REDEFINING THE LAB BENCH

ADAPTABLE TOPS

ADDITION OF SHELVING

FRAME

REMOVABLE PANELS

North Side

12.37 1:100 Model -Sectional

North East Corner

East and Above

Residence Access

Green Terrace

East 'Elevation'

Stage

South and Above

12.38 1:100 Model

Conclusion

This research observes a shift in paradigm in (and which *is*) science, scientific inquiry and modes of working, researching and experimenting. This shift, though arguably not new in theory, moves away from the objective and sterile view of science and its grasp on the world, to a more interconnected and integrated world view as science interacts with that which is being studied: the natural, the social, and the human. It is a world view of consensus, of tactility, of communication and interaction. As a result, science is no longer framed as a separate practice from everyday life and objectivity in science becomes, rightly so, an unattainable goal. Scientific practice is a human social practice.

In light of these considerations, it becomes clear that the laboratory building needs to reflect and incorporate such a paradigm in its creation and inhabitation. Gone would be the days of hidden and structured research, replaced by a more accessible and dynamic workplace, an environment designed with the everyday in mind and as part of its very purpose.

Inherent in the thesis in conjunction with the specifics of science and the laboratory, is the issue of sustainability and its role as an elastic framework for Architecture, in the sense that this structure is free-flowing, not fixed in the technological, but open and moldable to the layers of context that compose it. It is a system of interconnected elements of environment, of culture, of the specific site, and of the user, all of which are informed by the ideologies of a society at a particular time.

To demonstrate this understanding of sustainability, my design acknowledges and augments context, human performance and well-being, and the collaborative spirit of scientific inquiry. Day-lighting and operable windows are integrated into all areas in

an effort to limit systems overload and to establish a relationship with diurnal and seasonal cycles. The inter-relationships between programs creates a community of individuals and disciplines: research laboratories, access for the theatre to the theater group in Poulton Hall, computer laboratories, and classrooms to be shared by other programs all reconnect this site with the university proper. Green space is developed to enhance the ecological contribution of the project while drawing in the surrounding neighbourhood and providing a place for students and researchers to relax and interact.

This research sees sustainability as a framework that is not different from the paradigm in science, but *as* it, in the interconnectivity of things. This project began with sustainability, and although its focus shifted, it never quite left sustainability behind.

A second inherent aspect in this work is ethics--the ethics of science, and of the design of a laboratory building, and the need to change the view of laboratory design once the paradigmic shift has been recognized. As the view of science has changed, the need for a more interconnected place of communication and thought has emerged and therefore must be re-examined in the context of design. This however, is beginning to happen.

[Appendix E, Appendix F]

In a broader architectural context, the concept of interconnectivity and interaction as a system is hardly a new one, and has been expressed many times before:

The parts should be integrated in the structure, and the building itself integrated into the environment. "The first thing he [the architect] is to consider is the outline of the edifice; he is to study what figure will best lie upon the spot, will best fill it, or best become it."¹

(Alberti)

Beauty will result from the form and correspondence of the whole, with respect to the several parts, of the parts with regard to each other, and of then again to the whole...²

(Palladio)

There must be Order and just Proportion, Intricacy with Simplicity in the component Parts, Variety in the mass, and Light and Shadow in the whole, so as to

produce the varied sensations of gaiety and melancholy, of wildness, and even surprise and wonder.³

(Soane)

Often reinterpreted formalistically, however, these conceptions can instead be seen in a way of working and also reveals itself in the connections and relationships of all contexts, including form. The 'parts' and 'structure' can refer to the physical components of the building, but can also refer to the contextual framework.

As stated by Kaufmann, it is the interrelation of parts, the 'system', or elastic framework of Architectural imperatives:

There is another, deeper-rooted and deeper-going, change besides the periodic appearance and disappearance of form, namely, the change in the interrelation of the parts—or, in what I propose to term the system... There are profounder reasons for a change of system than for a change in forms, or even in characteristics. Systems depend wholly upon, or, better, derive directly from, the general mental attitude of a particular era. Since attitudes change unceasingly, the architectural systems also are in a state of unceasing flux.⁴

This system is constantly fluctuating, dependent on the state of society, which itself is continuously changing. Therefore, to find the place of architecture in society, it is important to be designing in relation to it. Like science, which needs to interact with that which is being studied: *the natural, the social, the human*, and as it is a human and social practice, so too does, and is, Architecture.

Notes

¹ Emil Kaufmann, Architecture in the Age of Reason (New York: Dover, 1955) 9.

² Kaufmann, 11.

³ Kaufmann, 60.

⁴ Kaufmann, 76.

Appendices

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A Alchemy

al- and the Greek word *chymeia* meaning “cast together”¹

Not solely vanity in the search for precious metals and wealth, alchemy had the ‘wider and truer significance’ of being the chemistry of the middle ages. Dating back to the third century, many theories as to the true origin of alchemy, from Egypt to Greece, have been debated, but the principle of transmutation is thought to have been influenced by Eastern conceptions of magic and astrology.² The ‘philosopher’s egg’, or stone, symbolizes creation, and is the symbol of the art and of the universe, as it is enclosed and composed of the four elements; earth, air, fire, water. [III. A.1] In this sense, man, *microcosm*, contains within himself all parts of the universe, *macrocosm*, and earth metals are seen to be linked with the planets.³ Like magic and astronomy, alchemy became concerned about the universe and the connection of all things, the physical, the intellectual, the spiritual.

In the process of transmutation, the alchemists saw all substances as being composed of the ‘prima materia’ and searched to strip materials of all other qualities to grasp the ‘prima materia’ itself. [III. A.2] Identified with the essence of mercury, the ‘mercury of the philosophers’ (spirit), sulphur was the philosopher’s stone (soul)⁴, and the path to transmutation.⁵ This transmutation was a connection to nature and the universe, as the alchemist strived to reproduce the methods employed by nature in the creation of such metals. Alchemists were attempting to investigate and explore nature prior to basic scientific tools and practices, “relying on rules of thumb, traditions, basic observations, and mysticism to fill in the gaps.”⁶

In many instances, the alchemical process was described and seen in terms of the processes of life, such as “pairing, production of offspring, pregnancy, birth, and

so on”⁷; the agricultural cycle as alchemy strove for growth, improvement, ennoblement and perfection. It was also the union of principles (such as two seeds combined to create one entity) which was the foundation of alchemical doctrine.⁸ [III. A.3]

As well, alchemists believed that the universe was tending towards a state of perfection, and by transmuting base into gold (a metal that was immune to decay), alchemists were taking an active role in helping the universe attain such perfection. In addition, the alchemists believed that the attempt to capture the immutability of gold had the ability to reveal the keys to the elimination of disease and ill-health.⁹

Come the sixteenth century, alchemy saw a new direction, as it was declared to be the act of producing medicines, rather than gold, and substances were examined in relation to the human body. In this view, health relied on the harmony of man (microcosm) and Nature (macrocosm). The body was seen as needing a certain balance of minerals, and it was thought that certain chemicals and substances had the ability to remedy certain illnesses.¹⁰ Transmutation was still a process of enormous appeal however, and great scientific discoverers such as Boyle and Newton retained an interest in alchemy throughout their respective careers.¹¹

From this era through the Renaissance, and as alchemy spread through the Western world, it functioned on the mundane and the spiritual levels. Due to its metaphysical beliefs and the fact that it never separated itself from the supernatural and magical, alchemy never developed modern scientific methods,¹² and hence was not seen by those who embraced those methods to fit into modern scientific practices. Along with transmutation and medical purposes, alchemy was a “path of spiritual purification and transformation; the expansion of the consciousness and the development of insight and intuition through images.”¹³ Both mystic and mystery, the symbolism is said to have had the ability to alter consciousness and connect the soul to the divine. The alchemist used dreams, inspirations, and visions for guidance in their art.

Transmutation then, can be understood in three ways: the chemical changes of

substances, physiological changes in the human body and psyche (such as sickness to health, and the hoped-for aged to youth), and the passing between the earthly and the spiritual or divine. Always positive, alchemy strived for “the great human ‘goods’: wealth, longevity, and immortality,”¹⁴ as did religion, medicine, and metallurgy.

By the eighteenth century, alchemy became distinct from science and took on a more religious aim, as modern science became more objectified. The successors of Newton and Lavoisier limited their objectives, and renounced what had previously been an important question of science: man in relation to the cosmos.¹⁵ With the specialization of science and the emphasis on rigorous quantitative experimentation, alchemy, or “ancient wisdom”, was placed outside the boundaries of modern scientific inquiry.

Alchemy is an universal art of vital chemistry which by fermenting the human spirit purifies and finally dissolves it...Alchemy is philosophy; it is the philosophy, the finding of the Sophia in the mind.

Mary Anne Atwood¹⁶

What was forgotten, however, was that to the alchemist, “there was no compelling reason to separate the chemical (material) dimension from the interpretive, symbolic or philosophical one. In these times, a physics devoid of metaphysical insight would have been as partial and incomplete as a metaphysics devoid of physical manifestation.”¹⁷ Therefore, the writings and symbols of the alchemist had multiple meanings, those connected to the physical transformation of the material and an inner meaning connected to the spiritual development of the alchemist.

With the development of modern science then, alchemy was seen as mystical and not connected to the objectivity and quality of the new mode of contemplation and experimentation. New science displaced alchemy from medical roles, interpretive and prescriptive, and from the discipline of science in practice and in teaching. Viewed in terms of charlatanism and superstition, reduced to an arcane philosophy, and disconnected from the material world as modern science became the mode of action, alchemy became ostracized and shunned as a practice.¹⁸

From the alchemist's point of view, chemistry represented a "Fall" because it meant the secularization of a sacred science.¹⁹

A.1 The elements as four women
earth, water, air and fire
Herbrandt Jamstahler
1625

A.2 The unfettered opposites in
chaos. 'Chaos' is one of the
names for the *prima materia*.

A.3 Two stages of the alchemical
operation as conception and
pregnancy
Johann Daniel Mylius

A.4 Following Nature's footsteps. *'May Nature, reason, experience and books be guide, staff, spectacles and lamp for the chemical practitioner'. Michael Maier*

Notes

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- ² The 1911 Edition Encyclopedia, 2002-2003. LoveToKnow Corp. Aug. 2004 <<http://74.1911encyclopedia.org/A/AL/ALCHEMY.htm>>.
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- ⁶ <<http://en.wikipedia.org/wiki/Alchemy#Overview>>.
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- ⁹ <<http://en.wikipedia.org/wiki/Alchemy#Overview>>.
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- ¹¹ Nathan Schwartz-Salant, Jung on Alchemy (Princeton: Princeton UP, 1995) 3.
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- ¹⁴ <<http://www.crystalinks.com/alchemy.html>>.
- ¹⁵ <<http://www.crystalinks.com/alchemy1.html>>.
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- ¹⁷ <<http://en.wikipedia.org/wiki/Alchemy#Overview>>.
- ¹⁸ <<http://en.wikipedia.org/wiki/Alchemy#Overview>>.
- ¹⁹ Schwartz-Salant, 2.

B Scientific Method

The **scientific method** is a sequence or collection of processes that are considered characteristic of scientific investigation and the acquisition of new scientific knowledge based upon physical evidence.¹

In the seventeenth century, the description of a rational procedure for “establishing causation between phenomena”² was attempted by Francis Bacon, and a procedure enhanced by the work of Galileo and Newton. The essential elements were “iterations and recursions” of four steps:

Characterization
Hypothesis
Prediction
Experiment

which is called the ‘hypothetico-deductive’ method, a formula still often used in education.³

Characterization

Characterization of the subject being investigated relies on **observation**, which, in turn, demands “careful *measurement* and the use of *Operational definitions* of relevant concepts.”⁴ These definitions acquire exact meanings as assigned by the scientific community which may not correspond to the language of everyday life. With such precision, new theories may arise with the definition of words that may not have been clearly outlined, allowing for the adaptation and discarding of previously accepted ideas.⁵

However, observation relies on perception, and therefore the scientists themselves, given that it is a cognitive process. It relies on some previous understanding of how the world works, and such understanding is not passive, affecting what is noticed and considered. As stated by Kuhn, observations rely on a specific paradigm, that which the theory is being tested on, and within the “logically consistent ‘portrait’ of the world” derived by the consensus of the scientific community, so that justification can occur. Kuhn argues then, that the rejection or acceptance of a paradigm is a social process more so than it is a

logical one.⁶

Hypothesis (theoretical, hypothetical explanation)

The development of a hypothesis is generally a causal explanation or else a proposed correlation between ideas or outcomes. It is a suggested explanation, in the form of “universal statements” rather than observation, which is generally expressed in the form of “existential statements;” Every instance is in opposition to some particular instance. However, in such a case, there is no validity to the statements, as all of the variables cannot be known, and hence it must rely on “subjective degrees of belief.”⁷ Therefore, the scientists’ “own creativity, ideas from other fields, induction, or even systematic guessing, or any other methods available” are used to create explanations for what is being studied. Such a hypothesis can emerge from a ‘hunch’ or ‘flash of inspiration.’⁸

Prediction (logical deduction from hypothesis)

Predictions are made by deductive reasoning; If the predictions do not match the results of the experiment, then the hypothesis proves to be incorrect or incomplete, and the hypothesis must be discarded or re-evaluated and edited. If the hypothesis proves to be correct, further testing with alternate variables must be conducted.⁹

Experiment (test of above)

With the creation of a prediction, an experiment is designed to test it, to either confirm or falsify the hypothesis. With the multiplicity of variables, a control can be augmented, testing the integrity of that variable and the experiment. This isolation of criteria and phenomenon intensifies the degree of validity.¹⁰ However, the scientist must have accountability in the experiment, keeping records, reports and evidence, ‘proving’ validity and assisting in reproducing the experiment to re-test, as the scientific process is iterative.¹¹ Also, as science is social and will only be accepted (by the scientific community) if it can be verified, such recording is essential to the process, and to the later descriptions that are published in scientific journals for peer evaluation.

All scientific knowledge is in a state of flux, for at any time new evidence could be presented that contradicts a long-held hypothesis.¹² 104

Notes

- ¹ Wikipedia: The Free Encyclopedia. 2004. Wikimedia Foundation Inc. Aug. 2004
<http://en.wikipedia.org/wiki/Scientific_method>.
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- ⁷ <<http://en.wikipedia.org/wiki/Hypothesis>>.
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- ¹¹ <<http://en.wikipedia.org/wiki/Experiment>>.
- ¹² <http://en.wikipedia.org/wiki/Scientific_method>

C Descartes

Some key points of Descartes' doctrines which are relevant to the ideas explored in this thesis are summarized below:

1- The division of mind and body.

Descartes divided the world into "two kinds of stuff...mental substance whose essence is thought and material substance whose essence is extension."¹ This division of mind and body included the separation of the material and mental; the physical and the spiritual. It is the division of that which enquires and that which is enquired.

2- The emphasis of reason over the senses.

Whereas the Aristotelians believed that all cognition began in sensation, Descartes' judgment was that the senses could not tell us the way things really are, nor are they reliable in practical situations. This led Descartes to reject the senses in favour of pure thought and reason. This mind-over-body philosophy included the rejection of tradition and authority, and held the view that knowledge must be grounded in the individual and in the individual alone. This argument can be best illustrated in the *cogito*, "I think therefore I exist," where the world is built out of the self, not out of anything outside the self.²

3- The importance of methodology in science.

Descartes wrote the *Discourse on the Method*, emphasizing method and the importance of method in making the discoveries. The influence and prominence of this work unscours the influence that Descartes' method would have on the progress of science as a whole.³ Based on these writings, method as an objective process was born.

...On the banks of the Seine River in Paris, [Descartes' followers] would nail dogs to wooden boards, cut them open, and watch them bark and writhe. They would exclaim: Isn't this wonderful? What marvellous machines! You do something to them. And they start barking and writhing, almost on cue!...This treatment of dogs on the part of Descartes' followers is paradigmatic of our rape of the non-human natural world. If the non-human natural world is an inert, lifeless machine, it is of instrumental value only...⁴

Notes

¹ Daniel Garber, Descartes Embodied: Reading Cartesian Philosophy Through Cartesian Science (Cambridge: Cambridge UP, 2001) 133.

² Garber, 4.

³ Garber, 33.

⁴ Leslie A. Muray, An Introduction to the Process Understanding of Science, Society and the Self: A Philosophy for Modern Humanity. (Lewiston: Edwin Mellen P, 1988) 3.

D The Science Image

The role of the scientific image becomes more than a documentation of the process and results of the experiment for the researcher. The need for the report, article, or documentation to communicate to other members of the scientific community is important and the image becomes a vital mode in that exchange.

Apart from communicating to fellow colleagues, those who understand the research and the relevant processes, the work needs to convey the intent and results to other science disciplines and researchers. As such, the images used need to be represented in a way which allows for these members to comprehend the work being accomplished. The inclusion of equipment, of elements to denote scale, the choosing of specific points of view, and the combining of images all aid in explaining the project.

The other group of intended viewers is the general public, both a source of funding and part of the research itself. "Using compelling and accessible pictures is a powerful way to draw the public's interest to the world of research. When the public develops a more intimate association with science the results will be both a richer society and one supporting the important efforts in scientific investigation."¹ The image then, needs to be evocative, intriguing, and enticing so as to engage the public. The image is more than exclusive documentation; it includes "the marvel" of the phenomena. Light, shadow, space, composition, colour, depth of field, exposure, camera angle, background, magnification, and scale all play an important role in the creation of the image.

In the process,

As you spend more time making these new images of your research to communicate to a larger community, you will see your work differently; you will expand the way you think about your work and therefore the way you envision it.²

In this sense, the researcher has the ability to both see and project the work in a new light and possibly discover something new through the image.

**D.1 Galileo
Moon Drawings**

**D.2 Bubble Chamber
Pair Formation**

D.3 Field Ion

D.4 'Crystal'

D.5 'Water jet'

D.6 'Calcite'

D.7 'Petri'

D.8 'Ferrofluid'

Notes

¹ Felice Frankel, Envisioning Science: The Design and Craft of the Science Image (Cambridge: MIT P, 2002) 1.

² Frankel, 1.

E Laboratories

E.1

Chemistry
Carleton
University

E.2

Biology
Ottawa
University
Downtown
Campus

E.3 Ottawa University
Smyth Road

E.4

White-
Gravenor
Georgetown
University

E.5 Abbot Laboratories
Noth Chicago, Ill., USA
1960

Source: W.R. Ferguson, Practical Laboratory Planning (New York: Wiley, 1973).

E. 6 Homer Research Laboratories
Bethlehem, Penn., USA
1970

Source: W.R. Ferguson, Practical Laboratory Planning (New York: Wiley, 1973).

F Redefinition

Russell, James S. "In the Clark Center, the task for Foster and Partners and MBT was no less than to redefine the way interdisciplinary research is done."
Architectural Record Feb. 2004: 94-99.

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Director of Special Projects
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The following article is an example of the changing conception of laboratory design. It is not to say that it is what will be the definition of lab design in the near future, but only to demonstrate that there is a current **redefinition** of the laboratory and its use based on contemporary social, communal, and scientific paradigms.

In the **CLARK CENTER**, the task for **Foster and Partners** and **MBT** was no less than to redefine the way interdisciplinary research is done

By James S. Russell, AIA

DNA may have been sequenced and the human genome decoded, but turning these scientific advances into products and therapies people can use is today's great research challenge. Researchers themselves recognize that a linear approach within one's own discipline is no longer enough. "I'm a physicist, but most physicists don't look on what I do as physics," says Steven Chu, a member of a faculty group that spearheaded the formation of Stanford University's Bio-X program, adding, "I don't either."

As traditional disciplinary boundaries dissolve and information explodes, Chu and many of his colleagues began to feel a whole new way of working was needed. "We keep to ourselves, to the groups, the fields, and the students we know," he says, which is fine when the research path is clear. "When you don't know where you are going, in my experience, is when chance encounters are very important." Chu joined a team that won a Nobel Prize in 1997 because of a casual conversation. The Stanford faculty steering committee, of which Chu was a member, convinced the university to form Bio-X, comprising 23 scientific disciplines brought together from the Medical School, the School of Engineering, and the School of Humanities and Sciences.

"Interact here!"

Facilities intended to foster cross-disciplinary collaboration in the life sciences are in construction or on the boards at universities across the country; Stanford, however, may be unique in the degree to which architecture is used to make the chance encounters Chu and his colleagues envisaged actually happen. For the scientists involved, the great ideas hatched in a cafeteria at Bell Laboratories or at a famous dining hall atop a lab building at Oxford University had already taken on a mythic quality.

Creating opportunities for researchers to interact is hardly new in science buildings. And yet architects' best social intentions frequently go awry. "We have toured lots of labs, and you would often come across a corner of the building laid out with Italian furniture and what might as well have been a sign that said 'Interact here!'" said David Nelson, the partner in charge at Foster and Partners, one of the Clark Center's two architects. No one, it seemed, ever did.

Foster was brought into the project because the Medical School liked the firm's Center for Clinical Sciences Research (CCSR) at

Stanford. It had created a pleasing social hub with simply a courtyard roofed by attractive sunshades. Its scientists enjoyed getting to know each other over a sandwich or a cup of coffee next to a lush stand of bamboo (see story, June 2001, page 139). David Neuman, FAIA, Stanford's campus architect, united Foster with MBT, a firm with laboratory expertise that had enjoyed success with the Engineering School.

A single criterion ruled the selection of the site: "To pull people together," says Neuman. The location selected offered an ideal proximity to the schools feeding the project (site plan, opposite). Setting the build-

Project: James H. Clark Center, Palo Alto, California

Owner: Stanford University

Architects: Foster and Partners—Norman Foster, David Nelson, Nigel Dauncey, Chris West, Ross Palmer; MBT Architecture—H. Russell Drinker, AIA, Tolly Shelley III, AIA.

Seth Meisler, AIA, Karen Grubbs-Kuklin, Stan Vistica, Carol Struckmann, Harriet Chang

Consultants: Middlebrook & Loane (structural engineer); Alpha Tech (plumbing and mechanical)

Construction manager: Hutchinson Dinwiddie

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PROJECTS

ing at a crossroads caused Foster to reverse the normal lab layout in which a core of technology-intensive functions is surrounded by dry labs and offices at the exterior. Instead, Nelson's team hollowed out the center, devoting it to a shaded courtyard surrounding an auditorium. They carved gaps in the sides to draw in existing pedestrian paths. "It was sited so you would go through, not around," explains Chu.

A lab layout game board

In the meantime, MBT worked closely to identify the needs of research teams. "We knew what the disciplines would be, but we did not know who would go into the building when we were designing," says Tully Shetley, AIA, MBT principal in charge. The MBT team did know they were dealing with diverse research cultures, with needs ranging from traditional wet-bench sinks and fume hoods to accommodations for specialized equipment—some of it in open labs and some in special rooms requiring close control of access, temperature, light, noise, contamination, and vibration. MBT looked for common ground among the disciplines as they tabulated equipment and linear feet of benches.

The architects invited researchers to a series of workshops, for which they had prepared little cardboard models of furniture and equipment. They urged scientists to arrange them to suit the work they intended to do, on boards printed with a schematic floor plan. The scientists began to realize that a bench needn't be in one part of a building, separated from a desk or from a specialized piece of equipment. "They discovered the immediacy of performing one operation, writing it up right there, then going on to the next piece of equipment," says Nelson. "That was the breakthrough."

Out of these exercises emerged a new lab-layout concept. The architects placed enclosed spaces that would require specialized light and environmental conditions (many of which could be shared by teams from different disciplines) against one exterior wall. As the plan developed, the enclosed labs were accessed with corridors opening to daylight, interlaced with cores containing shafts, exit stairs, and bathrooms. The rest of the floor would be open, like a loft, permitting research teams to arrange their areas freely and change them easily. The open floor would also make each team's work visible. Everyone hopes that scientific investigators will frequently ask each other "how did you do that?" In this way, Chu explains, "you trade technologies and dreams."

The building section echoes the loft notion. Building utilities run through gaps in the massive steel sections of the 4-foot-deep floors above a fixed acoustic ceiling (page 98). Water, medical gasses, power, and

PHOTOGRAPHY: NIGEL YOUNG (LEFT); ROBERT CAMFIELD (RIGHT) (THIS PAGE)

The extensive glass (protected by a horizontal roof projection) brings light deep into the loftlike labs. The glazing also intentionally exposes work to passersby. Neatness does not count.

1. Open lab
2. Enclosed lab
3. Computer science
4. Meeting
5. Demountable office
6. View/exit corridor
7. Laser lab

Standard benches, tables, and other fixtures have been customized so that they can be mixed to suit the task at hand.

Daylight filters through the ceiling-mounted Unistrut grid that supports neatly arranged utility wires.

telecommunications intended for use by investigators run under the fixed ceiling along with a Unistrut grid that supports utility drops.

"The rawness of all this is part of how it 'says' it can be changed," comments Nelson. The benches, tables, shelves, and other components are based on standard fixtures but have been customized to be easily mixed. Casters were added to ease change, but special restraints were included because of the area's high seismic risk. Demountable offices with translucent glazing give privacy to principal investigators.

"When you stop for coffee, you don't switch off"

There is little about the building that does not in some way serve the informal-collaboration agenda. It was cheaper to use open exterior balconies, stairs, and bridges for circulation, but they are also more appealing places to stop and chat. To emulate the eateries that had inspired so many collaborations elsewhere, an attractive food-service area was built into the ground floor. It includes refectory-style seating to invite conversations. "Just sitting next to someone who doesn't do what you do forces you to describe what's on your mind," observes Chu. "And you learn about what they want to do." A coffee shop has opened on the third floor. "When you stop for a coffee, you don't actually switch off," explains Nelson. "What you were doing is still in your head even if you are talking to someone else in just a social way."

It was clear on a recent visit that the research teams have taken to heart the idea of arranging their own space. The tidiness visible in the early photographs accompanying this article has already vanished. Webs of pipes, cables, and Unistrut already hang in nearly impenetrable thickets from the ceiling above bubbling flasks and humming equipment.

Yellow-painted benches contrast with the prevailing black ones to denote teams housed in the center short-term. Some teams align their benches for easy access to enclosed labs; others place them at 90 degrees to keep a daylight vista open or for easy observation of a fume hood. While some people seem to enjoy the daylight pouring in through the floor-to-ceiling glass, others obscure the windows to avoid the distractions of passersby.

The Clark Center culture doesn't work for everyone. Indeed, some desirable teams preferred to stick with their departments. Bio-X does not supplant the departments, it "stretches them," according to Neuman, because the careers of investigators and postgraduate researchers are still defined by their disciplines even though they spend much of their time working outside them. "We're concerned for junior faculty, because they need ties to their field's senior people," says Chu.

"This was a great opportunity to explore the idea of how people sensibly relate to each other," says Nelson. "Great places usually evolve over a long period. The challenge today is to make a great place that works instantly. It's tremendously difficult." The scramble to build versions of Bio-X elsewhere, however, suggests just how high the rewards may be. ■

Sources

Curtain wall and metal cladding: Polih USA

Glazing: Viracon (exterior); Etnaline (interior)

Stone cladding: Rocamat France

Seismic joints: COS Group

Ceiling panels: Armstrong (lab)

Support, acoustical: Unistrut (open lab perforated metal)

Lab casework/furnishings: Fisher Hamilton/ISAC, Weindl, Stechere

For more information on this project, go to Projects at www.architecturalrecord.com.

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G Redefinition2

Russell, James S. "A San Gimignano for science, Gehry Partners' Stata Center nurtures a research culture ready to cross the fast-dissolving boundaries of knowledge."
Architectural Record Sept. 2004: 98-111.

Only pages 98,99, 102, 105-110 are reprinted for thesis purposes.

A San Gimignano for science, **Gehry Partners'**
STATA CENTER nurtures a research culture ready
to cross the fast-dissolving boundaries of knowledge

Two 12-story towers
 make glassy Kohnse
 stand out in a terrace
 filled with colorful
 sculptural meeting
 places. Below, the
 choice of trees
 and plant diversity
 makes Kohnse right
 place for people
 close to the
 historic Park Street.

When word got out that Frank Gehry was proposing to model the 720,000-square-foot State Center at MIT on an orangutan village, there were those who thought the architect had finally lost it. A primate palace as the crown jewel of the campus's \$1 billion building program? Imagine the teeth-grinding in high places.

The building started out as a way to bring together several related programs in the computer sciences. It evolved, according to MIT provost Robert Brown (who joined the project when he was dean of the school of engineering), because the researchers wanted more openness, community, and easier ways to collaborate. Everyone's heard this before: Making idea sharing possible is part of the program of virtually every research building. At MIT, this desire got elevated to an obsession. Why?

Two trends drove this \$300 million commitment by MIT, according to William Mitchell, who was involved very early as dean of the architecture school and now runs its legendary Media Lab. "Most significant research gets done by research groups and research teams; it's very much a social process," he said, noting, "a huge amount of what's important happens where fields intersect and cross over." Scientists have had to declare ivory-tower solitude all but dead, he explained. Competition for grants, students, and discoveries requires researchers to draw together fields that 10 years ago would have seemed to have nothing in common.

The focus on easy interaction and collaboration emerged early in the programming process, but deciding how these goals would be realized took years to figure out. "These guys are iconoclasts," said Gehry. "They hide out in their offices. They're loners and don't want to talk to each other. But they're also univalent. They want to talk to each other." It was one of the most in-depth—and contentious—program processes the firm was ever involved in, according to Craig Webb, the project designer at Gehry Partners.

"I predicted that people would tell us what they wanted without realizing that what they described was what they already had," said Gehry. That's

an architectural prairie-dog town. With private spaces below, "you would 'pop your head up' to see what others are doing in the communal space," explained Webb.

Then came the orangutans. Since family groups spend their days together on the ground but sleep in separate nests in trees, the firm made a model that placed spaces for quiet, private work a level above areas for meeting, relaxing, and conversation. They hated that, too, said Gehry: "They thought we were calling them orangutans. But it started the conversation, and made what we've built possible."

Out of these intense discussions came a building that makes, as Mitchell calls it, "a broth of people to enable new intersections of thought and ideas to happen." The most public realm is the ground-floor Student Street. According to Provost Brown, the university "needed a space that was open and accessible to the whole MIT community." A report commissioned by the institute had underlined an imperative to make student life more amenable, not just to attract the best (though this was certainly an important reason), but because students have too often found high-pressure technology environments socially isolating, and too many suffered for it—a few even taking their own lives.

So MIT added to the academic program a fitness center, day-care center, classrooms, and food service to the street. Festooned with intertwining overhead stairways and shapes from the floors above plunging through the ceiling, it urges students to slow down by offering eddies of space fitted out with benches, computer terminals, and blackboards.

As John Guttag, head of the department of electrical engineer-

The hive-like intricacy of the design opens up offices, lounges, and labs to view. There's always the possibility of finding the person who has the answer to the question you have not yet thought to ask.

Tighe, David Rodriguez
Associate architect: Cannon Design
Engineers: John A. Martin &
Associates, Martin/Martin & ABS,
CBI Consulting (structural);
Vanderweil Engineers (mep)
Construction manager: Beacon
Skanska

Skylights and jets
through the fourth
floor (opposite page)
spread daylight into
the Warehouse-style
labs (this page).
Conference rooms,
bright painted tower
opposite left, offices,
corridors, and stairs
look in on the action.

PHOTOGRAPHY BY RENE SPAN

SIXTH FLOOR

NINTH FLOOR

The intricately choreographed gradations between private and shared space (drawings, left) could not have come about without color-coded models (above), which helped researchers understand possible social arrangements. Lounges that look down through skylights to lower-level labs were studied in models (left).

SECTION 6-6

ing and computer science, explained. "One of the things it took us a while to understand is that there were layers of community. Faculty members had their students, and worked with slightly larger groups of faculty and their students. So the idea of a neighborhood emerged, where the people you expected to see every day would be."

Labs open to the light

What's called the Warehouse, which stretches over more than 40,000 square feet on both the second and third floors, is separated from the Student Street by vestibules (see plans, pages 106-107), so that, says Gattag, "this community of researchers is able to circulate freely." Within it, the building cracks itself open: Private offices and open work spaces surround two large laboratory spaces at the east and west ends, which rise to enormous sloping skylights framed over the fourth floor. "They needed these high-bay areas for heavy equipment, for graphics, visualization, and robotics," said Webb. (Some labs are fully segregated.)

A similar but finer-grained graduation of privacy occurs in the two towers that rise from the fifth floor upward. They both curve in a C-shape to focus the action on double-height lounges, each with its own spiral connecting stair, that serve the neighborhoods of researchers. The towers and the warehouse come together at the fourth-floor faculty dining space and pub, which spill onto a piazzalike outdoor terrace. Seminar rooms that might have been placed within departments were consciously

grouped on this floor, poking through the terrace in a riot of brick, yellow-painted metal, and polished steel. Everyone mixes while they're getting their cookies between presentations, explained Gattag.

Real, not virtual community

The spatial intricacy and labyrinthine circulation bear no resemblance to the typical rectangular research structure—rigidly modular and zoned by mechanical services. The specificity of the State Center's form serves the collaborative and interactive agenda generally, rather than wrapping itself around specific functions. The dead ends and eddies of space are ideal for a quick sit-down, noted Gattag. One of the reasons the building became so

WHY SO MANY PLACES TO GATHER? "LOUNGES ARE WORKPLACES; SOCIAL EVENTS ARE TECHNICAL DISCUSSIONS."

large (420,000 square feet on top of a 300,000-square-foot garage) is that so many research groups wanted to be near each other. "The lab groups in computer science wanted to be near the groups in the Artificial Intelligence Laboratory," said Webb. "They all wanted to be on the other's boundaries. Finally, they decided they didn't need the boundaries. So the two groups combined in the middle of design." (The interdepartmental facility is called the Computer Science and Artificial Intelligence Laboratory, or CSAAIL.)

"Web technology con-
nects in lots of ways,
not on lots of levels,"
says Tim Berners-Lee, a
pioneer of the Internet.
He saw an analogy in
the way "the circulation
stairs that appear here
and there make net-

works," like the stair
winding over the
Student Store (oppo-
site, left). Research
"neighborhoods" share
lounges (opposite,
right), which look into
and through offices
and labs (this page).

You would think that this obsession with proximity wouldn't matter anymore. After all, the building is chock full of people who have invented many of the technologies that are supposed to keep us connected without the inconveniences of personal contact. So where are the gee-whiz interactive gizmos, the virtual communities? "They believe that the old-fashioned ways are the right ways," explained Alec Marante, a linguistics professor and the head of the school of humanities and social sciences. "Including face-to-face and casual, spontaneous interactions that involve places where you can talk together and write on something."

Whether the devotion of such a variety of spaces to collaboration will pay off is the long-term question. "We didn't measure efficiency in dollars per square foot," explained Gutting. "Lounges are workplaces. Social meetings are technical discussions. That's why we wanted a lot of gathering spaces. Though it's hard to measure, we think it's efficient." ■

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Brick: *Grande*
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Skylights, curtain wall: *Zahner/Karas*
Roofing: *Zahner/Karas (metal); Sarnafil (PVC); Grace (elastomeric)*

Wood doors, woodworking: *North American Woodworking*
Ceilings: *Baumgarten Ecophon*

For more information on this project, go to Projects at www.architecturalrecord.com

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