Envisioning Creative Space

by

Mine Özkar

B.Arch.
Middle East Technical University, 1997

Submitted to the Department of Architecture
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Architecture Studies

at the

Massachusetts Institute of Technology

June 1999

Signature of Author — Department of Architecture
May 20, 1999

Certified by — William L. Porter
Norman B. and Muriel Leventhal Professor of Architecture and Planning
Thesis Supervisor

John Rajchman
Professor at the Collège Internationale de Philosophie, Paris
Thesis Supervisor

Accepted by — Roy Strickland
Associate Professor of Architecture
Chairman, Department Committee on Graduate Students

Thesis Reader

Sibel Bozdoğan
Associate Professor of Architecture

I would like to acknowledge

Sibel Bozdoğan, for her interest and encouragement,
Bill Porter, for his endless support at all times, and
John Rajchman, for his attention and valuable insights.

I am also grateful to many friends for their motivation.
Special thanks to Aslihan D., whose intuitive thinking and helping hand were essential for this thesis. Another set of special thanks to Axel K., my critical ally, Michael F., my "Karallen" reader, Heather C., for her sincere interest and excitement, Connie L., my company on the trajectory to the sciences, and Alkan K., for the physicist perspective as much as enthusiasm and patience.

The biggest thanks are to my parents and brother, who have been extremely generous in sharing good things. I am in debt to them for invaluable and continuous support.

Envisioning Creative Space

By
Mine Özkar

Submitted to the Department of Architecture
on May 20, 1999 in partial Fulfillment of the
Requirements for the Degree of Master of Science in
Architecture Studies

ABSTRACT

This thesis proposes a framework to articulate certain criteria in creative spatial productions such as architecture. I discuss that a conformist and unquestioning adaptation to conventional space conceptions limits enhancement of spatial sensibility, and consequently creativity. I connect such adaptations to linear progress of continuous and one directional accumulation. Specifically, I call attention to a non-linear progress that surpasses the limitations of these mental constructs and brings in creativity. My discussions are formed around how this non-linear progress might be conceived and sustained in dynamic systems of fragments. The thesis connects this inquiry to the historical and contemporary critique of positivism in the classical sciences, mainly due to the relation of origins of space conceptions to sciences.

Thesis Supervisor: William L. Porter
Title: Norman B. and Muriel Leventhal Professor of Architecture and Planning

Thesis Supervisor: John Rajchman
Title: Professor at the Collège Internationale de Philosophie, Paris

Contents

Creative Space 9 0

Envisioning creative space – an introduction. 9
The Aleph. 13
The Word Machine. 17
Defining creative space. 19

Making of Space 23 1

Producing and representing space. 23
Smooth and *Striated* spaces. 27

Striae in Space 31 2

Architecture and geometry. 31
Striae by Geometry 37
Restraints of Striae. 40

Critical Issues of Striation 47 3

Philosophy for the Striated Space. 47
Issue of becoming. 49
Conflict of subject and object- 49
Defining a becoming system- 51
Hegel- 54
Bergson- 55
Issue of progress. 57

Linear progress- 57
Propagation- 58
Invention versus Convention, and Creative progress 61

4 **Making of Creative Space** 65

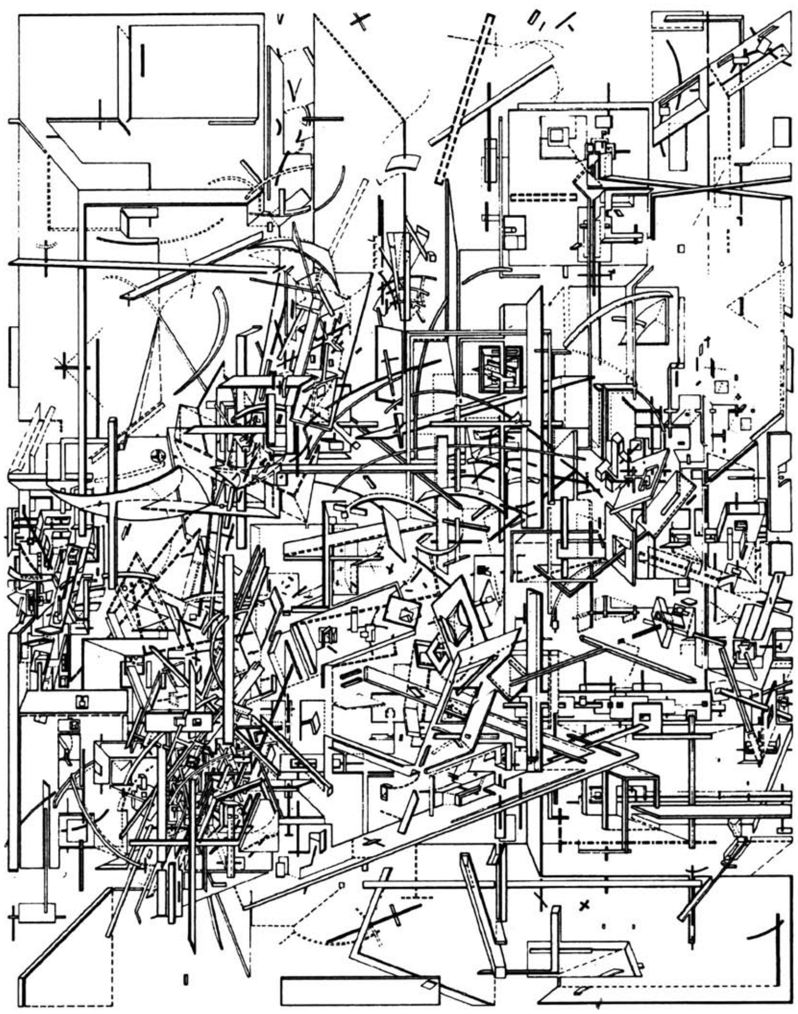
Striae by sciences. 65
On goals and methods in science. 67
Issues in a Constructive Critique of the Methods. 68
Falsificationism- 69
Emphasis put on subject- 73
A System of *different* fragments 79
legitimacy in anarchic pluralism – fragmentation through differentiation- 79
Multiplicities- 80
Progress in a becoming system of "different" fragments 82

Postscript 85

Appendix A 87

Appendix B 91

References 97



Little Universe.
From Daniel Libeskind, *End Space* [London: E. G. Bond Ltd., 1980], 25.

An architectural drawing is as much a prospective unfolding of future possibilities as it is a recovery of a particular history to whose intentions it testifies and whose limits it always challenges. (Libeskind 1980, 22)

0 Creative Space

In his End Space drawings, architect Daniel Libeskind (1980) attempts to transcend the established habits of thinking about the architectural drawings (i.e. pure and rigid formulations of architectural design cut off from external reference). In a quest for a creative usage for these drawings, he seeks to explore the indefinite potential of such formalization/visual representation in the abundant possibilities of architectural space representable through geometry.

Libeskind's drawings are not the initial source of inspiration for me in envisioning creative space. Nevertheless, they are among the first illustrations – suggestive of what I was envisioning, even if too figuratively – that I came across. The idea of a space that is abundant in possibilities of spatial relations among its elements comes forward in his explorations. This space, with numerous relations that are waiting to be discovered, revealed, interpreted, and constructed is anticipated to be the ultimate source for a creative production.

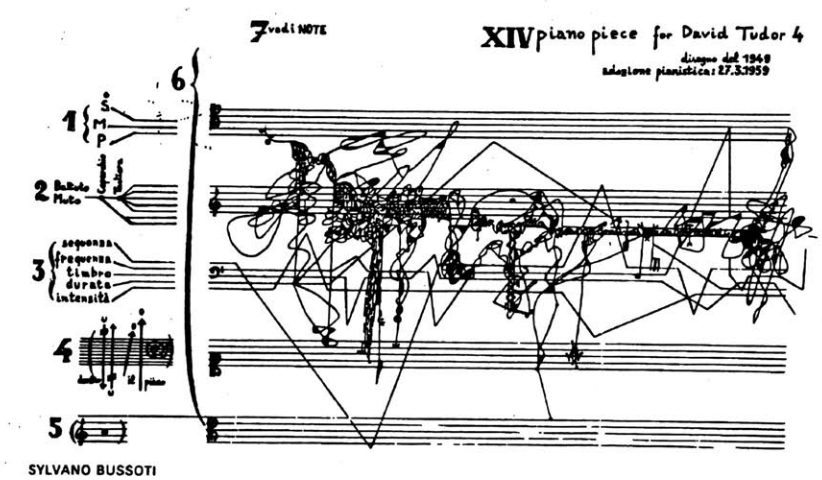
Envisioning creative space – an introduction.

These drawings by Libeskind are more relevant to a distinct problem of architectural representation.[1] Differently, I would like to think of a more general problem already hinted above in the way I approached his End Space. Similar to the creative potential I read in his drawing of abundant possibilities, is it conceivable for the space we inhabit to subsist, in an evolutionary character, a structure that is constantly supportive of creative production?

My objective is to encourage others as much as myself to think differently about space and the related concepts that comprise it. I am not suggesting that we discard our conventional ways of thinking about space. I believe that being involved in creative acts requires that the customary thinking is doubted in ways that open up and expand the breadth and critical

---

[1] Libeskind (1980) in the text that accompanies the drawings in the exhibition catalogue, writes of the dilemma of representation and buildable materiality in architecture. This issue is not within the scope of this thesis.



One of Sylvano Bussotti's Five Pieces for Piano.
From Gilles Deleuze and Félix Guattari, *A Thousand Plateaus* [Minneapolis: Univ. of Minnesota Press, 1987], 3

sensibility of established spatial acumen. I see this as a worthy challenge to be taken in disciplines such as architecture, which deal especially with production of quality space.

My discussions evolve around the issues and problems of production of both space and the conceptions of it. In this sense, what I call creative space is to be conceived both as a mental and as a physical model at the same time. This means to say that the space we inhabit physically, the architectural spaces we reside in, or see, can be conceived as creative space. In addition to such a conception, we also have our mental models, the totality of our conceptions of space. The physical model, with all the spatial constructions in it, is based on these mental conceptions of space, as much as the conceptions are triggered by the experiences we have in the physical one. As the two are interdependent, and a creative space displays different degrees of each at any given time, I certainly don't want to reduce my definition of creative space to either of them. Shortly, as I attempt to illustrate the creative space through visual and conceptual models, the content matter will always be the physical space and our conceptions of space.

Another question to be addressed before the full start is what kind of creative act is it that I am envisioning for this creative space. This might have been already partially answered in the previous paragraph. I am envisioning both the conceptions of space and the physical space that is dependent on these conceptions. But related to space, am I addressing architectural making, or artistic creation, or broadly knowledge production? I cannot just say "epistemology" and escape this question. My background allows me to discuss architectural space making, more than anything else does. However, I also acknowledge that architectural space making has always taken reference from other creative acts. And I can talk similarly for those "other" creative acts as well. Artistic creation for example, seems to be emerging from the interactions of artistic minds with other numerous types of creation.

Creative space has two very significant aspects intrinsic to its structure. One is its unascertained future and the other is its particular past. Creative space is an open system that is assumed to be forever-unfinished and unexpected. The unknown path of the future, constantly redefined at any moment, is due to a particular accumulation in the past that evolves at every present moment. In creative processes, the collective memory is always infinitely long-term, and the mind is open to every bit of available knowledge rather than

"The Aleph?" I repeated.
"Yes, the only place on earth where all places are – seen from every angle, each standing clear, without any confusion or blending."
...
I shut my eyes – I opened them. Then I saw the Aleph.
I arrive now at the ineffable core of my story. And here begins my despair as a writer. All language is a set of symbols whose use among its speakers assumes a shared past. How, then can I translate into words the limitless Aleph, which my floundering mind can scarcely encompass? Mystics, faced with the same problem, fall back on symbols: to signify the godhead, one Persian speaks of a bird that somehow is all birds [*Simurg*]; Alanus de Insulis, of a sphere whose center is everywhere and circumference is nowhere; Ezekiel, of a four-faced angel who at one and the same time moves east and west, north and south. (Not in vain do I recall these inconceivable analogies; they bear some relation to the Aleph.) Perhaps the gods might grant me a similar metaphor, but then this account would become contaminated by literature, by fiction. Really, what I want to do is impossible, for any listing of an endless series is doomed to be infinitesimal. In that single gigantic instant I saw millions of acts both delightful and awful; not one of them amazed me more than the fact that all of them occupied the same point in space, without overlapping or transparency. What my eyes beheld was simultaneous, but what I shall now write down will be successive, because language is successive.

Excerpt from The Aleph
by Jorge Luis Borges, *The Aleph and Other Stories: 1933-1969*
[New York: E. P. Dutton & Co., Inc., 1970], 25-6

only the patterns. In this sense, the concept of continuity in creative space dissolves in a strange way. The accumulation continues and evolves, as its flow is disrupted by non-linear leaps.

The definitions of this process – the unfolding of creative space – constitute a significant part of the discussions of this paper and will be discussed in depth in the third and fourth chapters under the issues of becoming and progress. Initially I would like to call attention to some ideas that relate to this process through diagrams and abstract visual models.

The Aleph.

The subtitle to Edward Soja's 1996 book *Thirdspace,* is *Journeys to LA and Other* Real-and-Imagined *Places.* For this book, Soja was in part inspired by Henri Lefebvre's *The Production of Space.* [2] The term *Thirdspace* and the phrase "real-and-imagined" in the subtitle, both allude to the idealist vision of space that Lefebvre ([1991] 1997) describes as *representational space.* Soja associates this ideal space with a Borges story, *the Aleph.* Jorge Luis Borges (1970) tells of a point in the neighbor's basement, which contains all "points" in it.

Point, here, does not only have the direct geometric connotations. In fact, its geometric connotations have been expanded to fit a definition of an instant in space and time altogether. Rather, it refers to an "event-particle," an act.[3]

The Aleph is basically every place to be. Remarkably, the same concept of "a point of all points" is also what Michael Benedikt attributes to "digital space" at *First Steps* Symposium

---

[2] Soja (1996) in the Introduction part of his book explains his own idealist vision. It includes an endeavor, in line with my direction, for questioning the conventional ways of thinking about space and spatiality in ways that enhance the perceptive sensibility of our "instituted spatial or geographical imaginations."

[3] What Whitehead ([1920] 1964) describes as event-particles comply with both this conception of point and the significance of this conception in a creative space. In The Concept of Nature, Whitehead simply names "the point of the instantaneous space which we conceive as apparent to us in an almost instantaneous glance" an event-particle. (p. 86-89) Its *extrinsic* character is its relation to the smaller and smaller set of events which approximate to it. Points [of timeless space] should not be confused with those of instantaneous spaces. Therefore the name "event-particles" is appropriate for the ideal minimum limits to events.

Whitehead's conception of event-particles on infinitely many time-lines actually belongs to a broader interesting scheme. It suggests that any cross-section of time, is a collapse of many different time-lines into one. This aspect of his philosophy is of interest to me in terms of the upcoming discussions in chapter three. The attribute of "many" is important in the fragmentative logic behind creative space. With issues such as qualitative multiplication, the number of possibilities of choice transcends the mere combinatorial options and move to more progressive spaces.

(1990, 1-25). Benedikt, like Soja, engages in this analogy, on account of that it reflects a creative character of space. He intends to praise the digital space for being creative.

Both of these visions are significant to us as they connote to architectural spaces in one way or another.

Soja refers to the "chaotic city" as a creative space, a space that is yet allowing for various interventions and interpretations.[4] In the sense that Soja reflects, especially the medieval city, as opposed to rationally planned meta-narratives, seems to be the ultimate source for variety of spatial relations. Soja suggests that the city offers a space where one is able to deconstruct and create. Such a premise, that of the city being a creative space, might indeed be appropriate if we accept that "creation" is acquired out of interaction with an infinite number of possibilities, rather than only within the rigid and conventional structures. A point of all points is significant as a collapse of infinite possibilities. It is precisely what one wants and has to have primarily for creative act, to be able to see and access the dynamically infinite all. The city, the point of all points, in many ways – even if not geometrically – holds such dynamics. It is pregnant for creativity, or a *line of flight*. In the rich chaos of the city, events are accidental, coincidental, indeterminate, *rhizomatic*.[5] How does the same analogy of "a point of all points," as Benedikt suggests, suit the digital space? The coding, the connection, digital technology in general constantly speed up our ways of access to information. The collapse of space and time (in terms of this speed), and consequently of infinite possibilities is a significant characteristic of the way we experience the digital space

---

[4] He actually refers to it as "representational space" in the Lefebvrean terminology. I want to introduce these concepts only in the next chapter.

[5] Deleuze and Guattari (1987) are to be credited for the word *rhizome*. The first chapter of A Thousand Plateaus, titled Rhizome, is reserved for descriptions, in their own cynical manners, the root structures of plants. They draw analogies to numerous unrelated topics. These analogies are never too direct. They rather speculate on what the concepts inspire:

> Rhizome includes the best and the worst: potato and couchgrass or the weed…
> Any point of a rhizome can be connected to anything other, and must be. It ceaselessly establishes coneections between semiotic chains, organizations of power, and circumstances relative to the arts, sciences, and social struggles…
> A rhizome may be broken, shattered at a given spot, but it will start up again on one of its old lines, or on new lines…
> Transversal communications between different lines scramble the genealogical trees. Always look for the molecular, or even submolecular, particle with which we are allied…
> A rhizome has no beginning or end; it is always in the middle, between things, interbeing, *intermezzo*. The tree is a fliation, but the rhizome is alliance, unique alliance. The tree imposes the verb 'to be,' but

today. "The point of all points" analogy actually fits this conception of space in a more appropriate way. This representation of space is particularly about points: momentous exposures of a particular bit of information, which is amputated out of all others due to a particularity. The "spatio-temporally physical" relations between points are subject to change dependent on external forces such as who is accessing them.

In correspondence to these views, one can talk about a distinct perception of space. This new geometry of points is the second concept I want to emphasize alongside with multiplicity. It is not representative of the content at all, but the space that it takes. It lacks form. Its formal representation could be of points; yet, these points are not to form lines as in the Cartesian system. Their status is different. They are not building blocks but collapse, bifurcation, and inflection nodes i.e. transition nodes. [6] Lines of transfer, which are not even known to be straight, intersect in them; they are amidst of flow; each of their phases is a single autonomous moment. The customary geometric definition of the line being constituted of points does not help to conceptualize about the point itself. The point, alone, stands for a more complex conceptual frame where it can be envisioned as the intersection of infinite number of lines. Thinking of the point as intersection of lines, of which the origins and directions are unknown to us, is more inspirational, than thinking it simply a part of *a* line.

> [Extrinsic singularity refers to extrema in a delimited or coordinate space, whereas] the intrinsic singularity involves an unlimited space, "prior to coordinates, without up or down, right or left, regression or progression." The inflection point belongs to a topography where a line is not what goes between two points, but a point is the intersection of many lines. Thus it involves a flexible kind of continuity that is not totalized, finalized, or closed. (Boyman 1995, x)

---

the fabric of the rhizome is the conjunction, 'and, and, and…' (7-25)

[6] By *collapse*, I am referring to Quantum Mechanics terminology in which a use for the word would be "at a random instant in time, the existent possible states collapse into one and are perceived by the observer as that particular state."
By inflection node I am referring to where the direction of a curve changes as in graph terminology.

We crossed a walk to the other part of the Academy, where, as I have already said, the projectors in speculative learning resided.
The first professor I saw was in a very large room, with forty pupils about him. After salutation, observing me to look earnestly upon a frame, which took up the greatest part of both the length and breadth of the room, he said perhaps I might wonder to see him employed in a project for improving speculative knowledge by practical and mechanical operations. But the world would soon be sensible of its usefulness, and he flattered himself that a more noble exalted thought never sprang in any other man's head. Everyone knew how laborious the usual method is of attaining to arts and sciences; whereas by his contrivance, the most ignorant person at a reasonable charge, and with a little bodily labour, may write books in philosophy, poetry, politics, law, mathematics and theology, without the least assistance from genius or study. He then led me to the frame, about the sides whereof all his pupils stood in ranks. It was twenty foot square, placed in the middle of the room. The superficies was composed of several bits of wood, about the bigness of a die (singular of dice), but some larger than others. They were all linked together by slender wires. These bits of wood were covered on every square with papers pasted on them, and on these papers were written all the words of their language in their several moods, tenses and declensions, but without any order. The professor then desired me to observe, for he was going to set his engine at work. The pupils at his command took each of them hold of an iron handle, whereof there were forty fixed round the edges of the frame, and giving them a sudden turn, the whole disposition of the words was entirely changed. He then commanded six and thirty of the lads to read the several lines softly as they appeared upon the frame; where they found three or four words together that might make part of a sentence, they dictated to the four remaining boys who were scribes. This work was repeated three of four times, and at every turn the engine was so contrived, that the words shifted into new places, as the square bits of wood moved upside down.

From 'A voyage to Laputa,' Gulliver's Travels, by Jonathan Swift, 1726. This extract is taken from Isaac Asimov, *The Annotated Gulliver's Travels* [New York: Clarkson N. Potter, Inc./Publishers, 1980], 173.

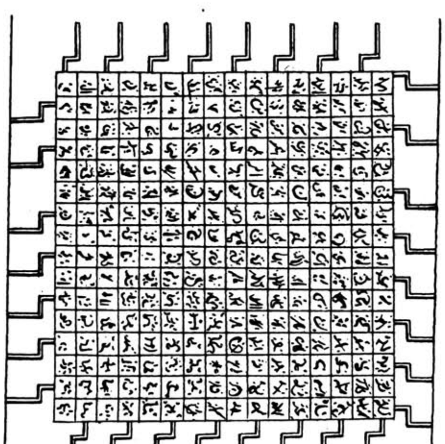
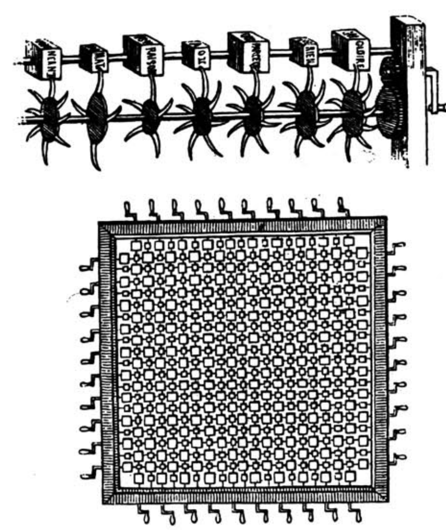


Illustration from the first edition. London. 1726. From Isaac Asimov, *The Annotated Gulliver's Travels* [New York: Clarkson N. Potter, Inc./Publishers, 1980], 173.



The Word Machine by Grandville, 1838 from the first French integral edition of 1838, in Jasia Reichardt, *Cybernetics, Art and Ideas* [Greenwich, Connecticut: New York Graphic Society Ltd.], 8)

Such a diagramming of [digital] space is promising and stimulating, mainly due to its allusion to the ideal space in Lefebvre's and Soja's writings. This space envisioned by all the figures mentioned above, is recognized as a representational space that permits creativity.

The space of points then, represents the spatio-temporal relations among "acts." This configuration is compliant to the vision of a creative space of progress mentioned earlier. The successive acts on a line indicate linear advance, whereas in this diagramming, acts appear as individual points in a non-linear space and time. Their physical relations are not bounded by time and vice versa [temporal relations are not bounded by space]. Precisely what gives it this creative character will be the subject of discussion throughout the whole thesis.

The Word Machine.

Another model for illustrating creative space is a little different than the creative space of points. However, it does comply, to a certain extent, with the notion of "accumulations of the past" that I have initially emphasized as an intrinsic aspect of creative space. It is representative of the production of the richness and variety existent as accumulated knowledge.

Jonathan Swift has devised what he calls 'the machine for speculative learning,' in one of the chapters of his famous Gulliver's Travels. (Asimov 1980, 173) This machine, its products and its production procedures are not as endless and indefinable as the Aleph. It simply works on the basic idea of combinatorial possibilities. Being a closed and deterministic system, it does not resemble the creative space at all. However, it does point out to certain interesting issues relevant to – productions in – creative space. Rather than the machine itself, which is more reminiscent of randomized processes and computers, the appealing concept is that of a knowledge-space.

The machine works on the basic understanding that words are the primitives of language. Despite this naïve conception, the fact that words are said in many different moods is "carefully thought of" and numerous instances of the same words have been entered in the device. As the machine works, different combinations for any set of words of any mood are sought. When it is stopped at an arbitrary point in time, the combinations that have 'meaning' are recorded down. The machine is a continuous source of 'possible' combinations – to the point where the possible combinations come to an end. The professor boasts about it because in this sense, the machine is more powerful than the human mind. It can produce, in arbitrary order, a combination that would not cross the minds of a human being who thinks in a frame of reference of his own little history. This dilemma still exists today with the computational models.

The issue relevant to definitions of creative space here is that the – combinatorial – potentials are explored. The professor is seeking other possible books that could be or could have been written. His best attempt is to check, one by one, all the possible combinations. The idea is very evocative. I had mentioned an infinitely long-term memory earlier. In the case of the machine, that memory is formed as these combinations are recorded down. These combinations of words are not exactly creations in our sense of the term. But, it brings to mind a further point of interest. If these recorded phrases or sentences – of meaning – start to enter the list of primitives and become effective in the production procedure through having been written on the boxes themselves, then the repertoire is getting richer and richer. Then, the machine can actually be of interest to us in terms of creative space definitions.

The basic concept in the argument of the above paragraph can be explained in a simpler way. Suppose we produce a concept 'c' out of 'a' and 'b', such that c is a totally different entity. 'a' and 'b' are both inherent in 'c' but 'c' cannot be decomposed. 'c' is not any of 'a/b' or 'b/a' or something similar to these, nor does it symbolize expressions like these. We have founded 'c' out of 'a' and 'b'. Once we have 'c', we do not necessarily erase 'a' and 'b'. We might always have a preference towards c, for futuristic projections, but we have a memory of all a, b, and c. Creative space allows existence for all three.

One might suggest that creative space is like an antique-collection in this sense. However, it does not hold useless matter. Rather, it holds the primitives of the used matter. It holds the origins of whatever knowledge we have. Each newly created concept is added onto an already existent set of concepts. This is not to suggest an endless and non-hierarchical pluralism![7] It is an awareness towards the existence of alternatives as well as the hierarchical relation in between them in terms of their places in memory.

Defining creative space.

The examples above have been articulated to instantiate a definition of creative space. From what has been delivered so far, I want to bring forward not one but three definitions: one of multiplicities, one of a geometry of points, and one of a particular way of accumulation of constituents. Each corresponds to an aspect I want to relate to in my envisioning of creative space.

End Space Drawings: Multiplicity – Libeskind's drawings illustrate the first concept I want to point out in defining what creative space is. Creative space is constituted of multiple parts/elements. The multiplicity brings a richness in terms of the possible relations in between the constituents.[8]

The Aleph: (geometry of) Points[9] – The Aleph and the discussion attached to it, display the second concept I want to emphasize alongside of multiplicity: a geometry of points. The parts/elements of creative space are multiple and simultaneously existent. Each is envisioned as points to reflect the notion of distinct event-particles. Points stand for particular spatial characteristics – i.e. all attributes of existence – at a particular time instant. The temporal quality offers a subjective unfolding for each. They also converge; they unfold in relation to each other. Each then becomes a point of intersection – or inflection – as it links to another or many others. This suggests possibility for a non-linear continuity in relations.

The Word Machine: Accumulation of content – The third and the last of the concepts of emphasis is the idea of a concrescent library. This library works as a dynamic system. It

---

[7] The pluralism-like multiplicity will be subject of discussion in further chapters in greater detail.

[8] I will develop it fully into extents of defining qualitative and quantitative multiplicities through an analysis of Bergson's ideas as well as Riemann's geometries in the final chapter where I will call back these three concepts. They will then be outlined as the criteria for creative production

[9] The geometry of points does not only accord with the methodology of creative space, but the concept of it, the different conceptions of the adjacencies, actually stands as an alternative conception of space. Similar to the non-Euclidean multiple dimensional spaces, it might be perceived as a different configuration that does not allow

renews itself as a whole each time a new component is added. Each component is regarded based on its relation to the whole rather than a small predetermined group. New formulae of relations among the components take place in the library as new components themselves. None of the components get erased unless it slowly diffuses or is replaced by an equivalent or more.

These concepts are not sufficient separately to define what I envision as creative space. They are rather simple models that I gather as bits of reference in my envisioning. In each, I find a very basic idea that eventually extends to support an argument on creative production.

I gather these concepts in what I call creative space due to two reasons: Firstly, they already belong to visions of creativity in each of the contexts given. Secondly, through these concepts I want to reconstruct some criteria and promote a production of an environment that is continuously not limiting but creative.

I can delineate what I mean by creative space, through these emphasis points, as the following: It is a conceptual space – that does not detach too much from the means and ways of physical space – of multiple constituents. These constituents exist simultaneously and continuously. They are open to multiple variety of relations amongst each other. This possibility of all points, despite different degrees of relatedness, should not be mistaken as to be promoting random productions. The faculty of meaning is always involved in the rationale of the process of creating the relations. This vision however is to illustrate an environment that is not limited by mental or physical constructs. This is based on assumptions that constructs are *complete* objects or conceptions.

Additionally, the three concepts are suggestive of a process in connection to the emergence of this creative space. Creative space does not exist independent of its constituents. The constituents include *us* as well. Since man is the creator of most of the constituents, sustaining the creative space is dependent on man's doings. The means to creative space is through production of space and conceptions of space.

---

generic visualization and explores multiple dimensions.

I am hoping that identifying the attributes of creative space as envisioned above, may provide important insight to creative act. The thesis intends to shift the vision of this particular creative space from being utopia to a useful framework for creative act. So far, I have defined an idealized creative space. It is "creative" because of the abundance of possible relations among the constituents. The presumption is that it collectively enhances the perceptions of individuals interacting with the space. Questions regarding how it comes about still hold. Primarily, it requires a consciousness towards distinctly creative acts. It clashes with fixed notions and configurations. And it is continuously unfolding. In the next chapters, consecutively, I will give explanations to how space is produced, the issues and problems of this production in terms of creativity, and the unfolding character that overcomes these problems.

(Chapter One) Clearly, our only effect on the space we inhabit is again through our interventions or productions. (Chapter Two) Yet, it is not the case that all interventions or productions are positive contributions to the anticipated open structure. I suggest that understanding the – distinction between – linear and nonlinear paths for progress helps clarify the criteria involved in the succession of this "creative space." (Chapter Three) The desired creative progress works free of limiting constructs unlike the linear path. Through de-compositions and re-compositions of any piece from the accumulating knowledge, creative process weaves a build-up of broad variety and of unforeseen quality. The unfinished character of a creative space formed as such, addresses needs of an ever-changing universe. (Chapter Four) Looking at the critique of linear progress in science as a frame of reference in this thesis, I propose some criteria and attempt to develop a loose framework for progressive and creative production of space.

Despite the fact that the thesis is dealing with issues of creativity in space production, there is cross-disciplinary feedback. One significant extrusion is done to the field of science, which provides some guidelines for discerning progressive steps. My take on science is especially through the critique of fixed conceptions. Science may not have been considered an ideal model for designers to follow up until recently. However, the mechanistic view of science has been under change since the beginning of the century. And what has been proposed as criteria of knowledge production to replace all that was criticized in the methodology of classical science, might in fact help designers who will enhance the sensibilities.

1 Making of Space

The primary issue of concern is then, to revisit the general ways of how we intervene with space. This will help me conceive the emergence of space conceptions before speculating on the use and limits of the conceptions themselves.

Producing and representing space.

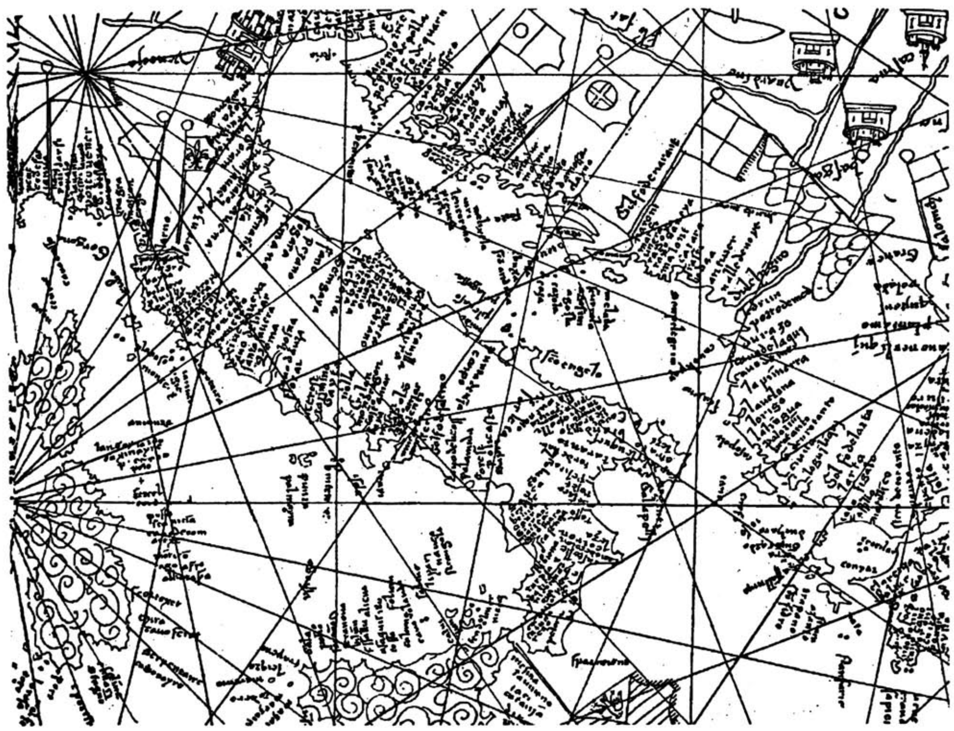
Spaces/environments we inhabit are being shaped, by us. We shape our surroundings according to the conceptual settings we create. These conceptual settings serve as means of our understanding and intervention with the surrounding givens.

We intervene with space in a process that includes perceiving, understanding, abstracting and formalizing a concept of it, and "doing". We encounter, conceive and devise means to eventually take a stand with the material, conceptual or tactile. An intervention is emergent at any of the phases of this sequence.[10] Nonetheless, the outcome of the doing, the stand one takes with the material, becomes our only apparatus to actually recognize and appreciate the intervention. This outcome, is the [devised] means, abstract – mental or physical – representation of a concept that is being communicated to others and/or acting on an object itself – product. It may be a scheme for a future act, a simulation of an object or some other sort of substitute (a metaphor?). It may be a transformation, an action taken accidentally or on choice to modify an object to suit needs or desires. In this layout, each intervention is then possibly subject to other interventions. The accumulation of these interventions, especially those that are deliberate, is how knowledge or any other kind of production, i.e. material, is possible.

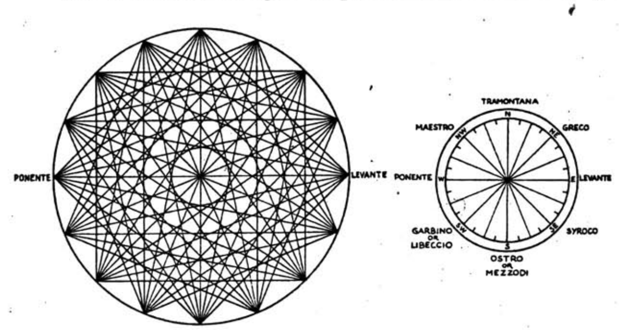
At this point, I want to avoid a confusion of terminology before it is too late. When I refer to the outcome of interventions as representations, I attach a broader meaning to the word representation. From the way I declare in the above paragraph, it subsumes even

---

[10] The intervention act in which I throw a stone to the still water – that I have not touched before – is an experiential intervention that changes my conceptions regarding that space. I encounter with a tool in my hand and conceive. In a later discussion, this tool of intervention will be distinguished in definition from a tool of



The 'Catalan Atlas' for navigation, 1375; a portion showing Italy, the Adriatic, and Sicily. This map is reflecting information regarding tides. The topographical knowledge on this map is set out on the rays of a sailor's compass of 32 points. The similar compass illustrated below-left is divided to 16 quarters instead. The idea of the compass is to divide the horizon to reference points. The sailors would make their temporal calculations by observing the sun, moon and other "heavenly bodies" and referring to these thirty-two points. They had not acknowledged the obliquity of the local horizon and assumed the paths of the objects could be divided into equal fragments for equal times. An example to how they operated would be: marking the location of observation on the appropriate part of the related rhumb-line and write something like 'Moon NE – SW full sea' according to the position of the moon during the observed tide.



(left) Scheme of rhumb lines on a sailor's compass divided into 16 points.
(right) The Italian division of the compass or the wind-rose into 32 quarterss or points.

All images from Charles Singer et al., *History of Technology Volume III From the Renaissance to the Industrial Revolution c1500-c1750* [New York and London: Oxford University Press, 1957], 524-5)

(Singer, Charles et al. 1957, 525)

productions! Nevertheless, I do distinguish between the meanings of two words being as true as I can be to Merriam-Webster. "Representation" subsumes, or assimilates, "production" *only* when the particular production is subject of discussion with its conceptual aspects, i.e. when I want to refer to the conceptual foundations of the object and emphasize the link between these and the object, I temporarily name the object a "representation." When I am referring to representations in relation to their physical existential properties, i.e. their materiality, I temporarily call them "productions."

I doubt that this will clarify what I have asserted above, but I also wish to relate the "terminology confusion" to a more familiar lexicon. In architecture, representation implies architectural drawings or models of projects. Buildings are not representations but actual objects that are worked out in detail and erected in three dimensions. In my use of the word representation, buildings and other actual objects of production are included as another – further – degree of representation, given that I want to refer to them in terms of the conceptual models they have been developed according to.[11]

The process of intervening with space could be better explained through an elaboration on the definition of intervention and on what sort of effect we have on the space through that. Our conceptions of space are formalized through experiences. The representations we use to reflect them onto others and the space itself are rational acts. When I say "rational," I mean an unexaggerated rationality with a state of consciousness. This aspect is the gist of the act of intervening. It basically is the – positive – difference we bring onto space.[12]

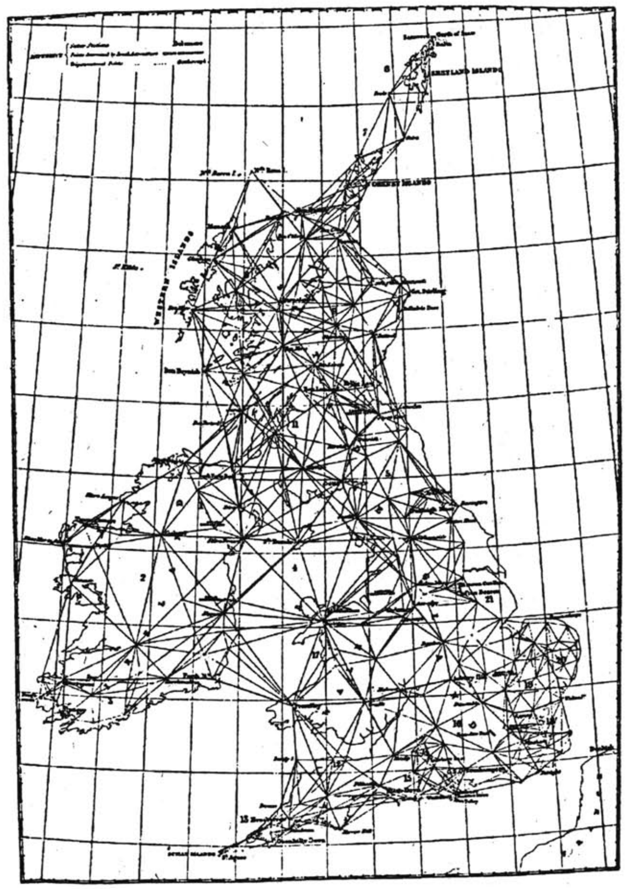
---

creation.

[11] Lefebvre writes of a socially formed space in *The Production of Space*:

> Is this space an abstract one? Yes, but it is also 'real' in the sense in which concrete abstractions such as commodities and money are real. Is it then concrete? Yes, though not in the sense that an object or product is concrete. Is it instrumental? Undoubtedly, but, like knowledge, it extends beyond instrumentality. Can it be reduced to a projection – to an 'objectification' of knowledge? Yes and no: knowledge objectified in a product is no longer coextensive with knowledge in its theoretical state. (1997, 27)

[12] And also, there is the issue of who it is that does the "rationalizing." Lefebvre cites Hegel for iterating that "the state" occupies and rules [and rationalizes and produces] space (1997, 21). It does not recognize the individual who is able to reason as well, but only sees groups and systems in a coherent whole of institutions. This is a social critique of who really holds the control over a space and it is a little detached from my agenda. Nevertheless, the point is well taken: state [or any other power institution] effects space as much as we do.



The triangulation in land surveys represents land in reference to a web of shortest distances rather than the rich three dimensional topography as conceived in contour maps or differently.

Land surveying. The principal triangulation of the British Isles completed in 1852. From Charles Singer et al., *A History of Technology Volume IV The Industrial Revolution c.1750-c.1850* [New York and London: Oxford University Press, 1957], 609.

Smooth **and** ***Striated*** **spaces.**

Referring to the discussion in the previous paragraph, I want to distinguish the two modes of space *before* and *after* an intervention. Such a distinction, which will supply me with subject matter to work on, could be as the following in the most oversimplified way: unregulated space and regulated space, consecutively for before and after.

The consecutive relation in between the two is surely particular and intrinsic to each intervention. Extrinsically, regulated and unregulated spaces are simultaneously existent, and are emerging in any order. In addition to this, I also want to pinpoint that a regulated space does not necessarily replace the unregulated one. That means to say that the ontology of that prior space is not lost. The phrase "regulated space" is only to explain that certain aspects of a particular space have been regulated. The particular *concept* of space is replaced by the representation in the mind(s) of whoever intervened.

In *The Production of Space*, Henri Lefebvre gives (three) different degrees of regulated-ness for space. (1997, 36-53) His categorization is significant for me not only as a slightly more detailed model interpreting interventions, but also as it emphasizes – mental – representations. The triad of the Lefebvrean model accords with my notion of intervention above: nature, what man perceives; representations (of spaces), what man conceives and/or conceptualizes out of his perceptions; the representational spaces where perceptions and conceptions ideally converge in, and which hold imagination and reality together. Although the relation among the first two implies similar notions to the cycle I phrased above, the third category, and seemingly the most important of all, given that it is the piece that provides the continuum, is supplemental. All of these issues are better illustrated in Deleuze and Guattari's similar set of modes of space. In his visions of striated and smooth spaces, Deleuze and Guattari delineate the continuity in between the modes involved in process.

> ...the sea is a smooth space par excellence, and was to encounter the demands of increasingly strict striation...the striation of the sea was a result of navigation on the open water. Maritime space was striated as a function of two astronomical and geographical gains: *bearings*, obtained by a set of calculations based on exact observation of the stars and the sun; and *the map*, which intertwines meridians and parallels, longitudes and

> latitudes, plotting regions known and unknown onto a grid…A *dimensionality* that subordinated *directionality*, or superimposed itself upon it, became increasingly entrenched. (1987, 479-80)

I relate the example of navigation to land surveying which I have more knowledge of. In archaeological land surveys, for example, land is a "smooth space par excellence" as well. The topographical properties, which comprise most of the information, are surveyed through certain methods. The triangulation performed by taking short distances between certain points, sets up a two-dimensional layout. [Later, this layout is to be used as a reference for placement of all other objects on the land. The placement of those objects is also done through triangulation. The triangulation is applicable at different scales. As the points on plan are categorized according to heights from sea level, the plan will gain the third dimension and be transferred onto contour maps.] The triangulated plan is reflecting a conception different from what the perceptual experiences give. It is a strict regulation to understand and achieve a "manageable" representation of the smooth space. With triangulation, land is understood through a series of the shortest distances between certain landmarks. Just a reminder, these shortest distances do not even match those one bodily experiences on that particular piece of land. The actual measurements are projected onto a single flat plane. The "landmarks" of the triangulated land – for purposes of the archaeological studies – are selected on quite different basis than those that would be selected by someone on a leisurely expedition on that land, or by someone who is surveying the drainage of that topography.

Smooth space is the absolute space, prior to explicit definition or intervention. It is a totality in itself, and is not yet explored. Striation is the process of regulating; it is the attempt to explore and define the smooth space. Smooth space, in Deleuze and Guattari's writings, is never given as an ideal. I feel it coincides with both of the natural and representational spaces that Lefebvre has specified. It is the space of creativity, "nondelimited, unpartitioned" and in a two-way act: "there exist two non-symmetrical movements, one of which striates the smooth, and one of which reimparts smooth space on the bases of the striated." In this sense, striation is an adequate term for regulation, abstraction and representation. Man in order to proceed – understand and modify according to needs – striates/regulates the smooth space. As was explicit in the navigation, and surveying examples above, striations illustrate our rationalizing of the space we inhabit. And in the two-way act, smooth spaces – might – emerge out of striations.

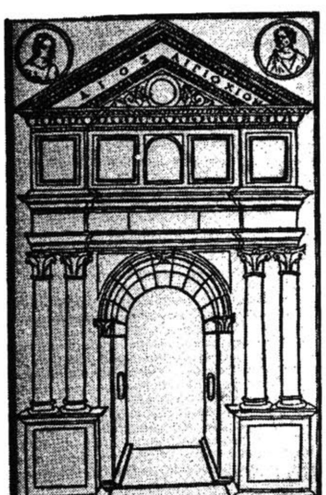
The two-way act does not imply a closed system, where one follows the same paths over and over again. It should be remembered that the phrases "smooth and striated spaces" refer to modes rather than finite states. A once-striated smooth space is not lost, but its state is shifted. The time in this scheme is irreversible as our very own universal time.

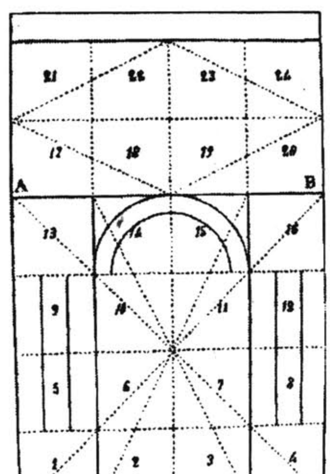
Certain aspects of the two-way act might be further illustrated with an example. While mentioning Soja's vision of the city as a creative space, I had iterated that the city offers a space where one is able to deconstruct and create. Lefebvrean representational space, as Soja interprets it, corresponds to the Deleuzean version of smooth space. The city – accidental, coincidental, indeterminate – is thus assumed a smooth space, even though it is, concurrently, a result of numerous striations.

The dyad suggests that when one intervenes with a smooth space, where there is always something new to perception, and discovery, one has to come to terms with it. Then, one rationalizes in attempts to understand this new entity and conceptualizes. The next chapter articulates this process of rationalizing, namely striation, of space and conceptions of space. The inquiry I want to follow is of making and sustaining a creative space as I have discussed so far, through striations as the process of production. As I have shown striation to be the doing that constitutes the creation of space, it is essential to primarily develop a better understanding of striating in order to reason the emergence and sustaining of creative space.

Striations as of concern to this thesis are ways of rationalizing in order for one to control and manipulate space. It is important to prolong the awareness that these striations are temporary rationalizations and are subject to change. The world and the lives we live are constantly unfolding due to the vast range of temporal and material input. The strict rationality and some of its setbacks will be explored in examples of the next chapter.

The issues of physical stability and the idea of shelter were important to form the aesthetics of architecture.
From Marc Antoine Laugier, *An Essay on Architecture.*
[Los Angeles: Hennessey & Ingalls, 1977]





Architecture and its aesthetic prescription:
"referring to generation of forms to a coherent cosmos and its transcendent values."
From Introduction to Alberto Perez-Gómez, *Polyphilo or the Dark Forest Revisited*
[Cambridge: The MIT Press, 1992], xv.

2 Striae in Space

Based on the explanations of interventions and representations from the previous section, I want to articulate below the mode of regulated space and discuss the issues and problems of – creativity in – space production.

Architecture and geometry.

Architecture, as the prominent form of space production, alongside with its social and cultural contexts, emerges partly as an extension of geometry whereas geometry reflects striations of space.

The origins of geometry (apart from the Husserlian inquiry [13]) and the origins of architecture (apart from Laugier [14]) do not clearly designate their own boundaries. There is no certainty to whether geometry or architecture comes first. Geometry, in the service of architecture in terms of measure and precise repetition, is also geometry acting in the formation of architecture, providing the "catalogue" of architecture's "proper" forms.

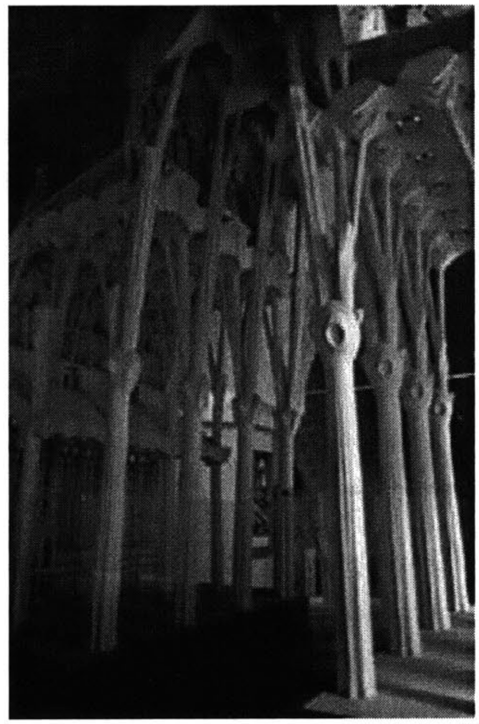
Even though the origins of the relation between geometry and architecture is debatable, a direct relation has always been assumed. Architecture is dependent on geometry, where geometry is the tool for rationalizing about space. Architecture emerges as the physical form representative of that rationalization.

Man has been building, and continues to build [onto] the surroundings. This act is not only dependent on understanding and rationalizing about materials, but also forms with socio-political, economical and cultural contexts. Of course it is not incorrect to say that these contexts are shaped with the physical objects. But, particularly, these are not the issues I

---

[13] Edmund Husserl's inquiry in his Origins of Geometry is not into the [philosophical-historical] "tradition" of geometry but "that sense in which it had to appear in history for the first time." (Husserl 1978, 158). For a brief review of the philosophical history of geometry and architecture, refer to Rajchman (1997, 91-100).

[14] Perez-Gómez gives the main point of Laugier's 1755 Essai sur l'Architecture, as the following: the essential elements of architecture can be derived from the primitive hut. This meant the beginnings of architecture are formally unprejudiced, and natural. The issues of physical stability and the idea of shelter were important to form the aesthetics (1996, 62).



Antonio Gaudi's Sagrada Familia, radiosity-based rendering for study of the nave.
From Kent Larson and Takehiko Nagakura
The MIT Sagrada Familia Project of the School of Architecture and Planning, MIT, Camridge, MA,
continuing, to be completed November 1999.

want to discuss. I am interested in a different – type of – history of building: its origin in terms of *shape*. It is questionable how one can detach this history of form, from the broader social history, but undoubtedly it is possible to a certain extent. I choose to emphasize the formal properties of space. Nonetheless, I do not intend to isolate their formations from the social and cultural, especially the philosophical contexts.

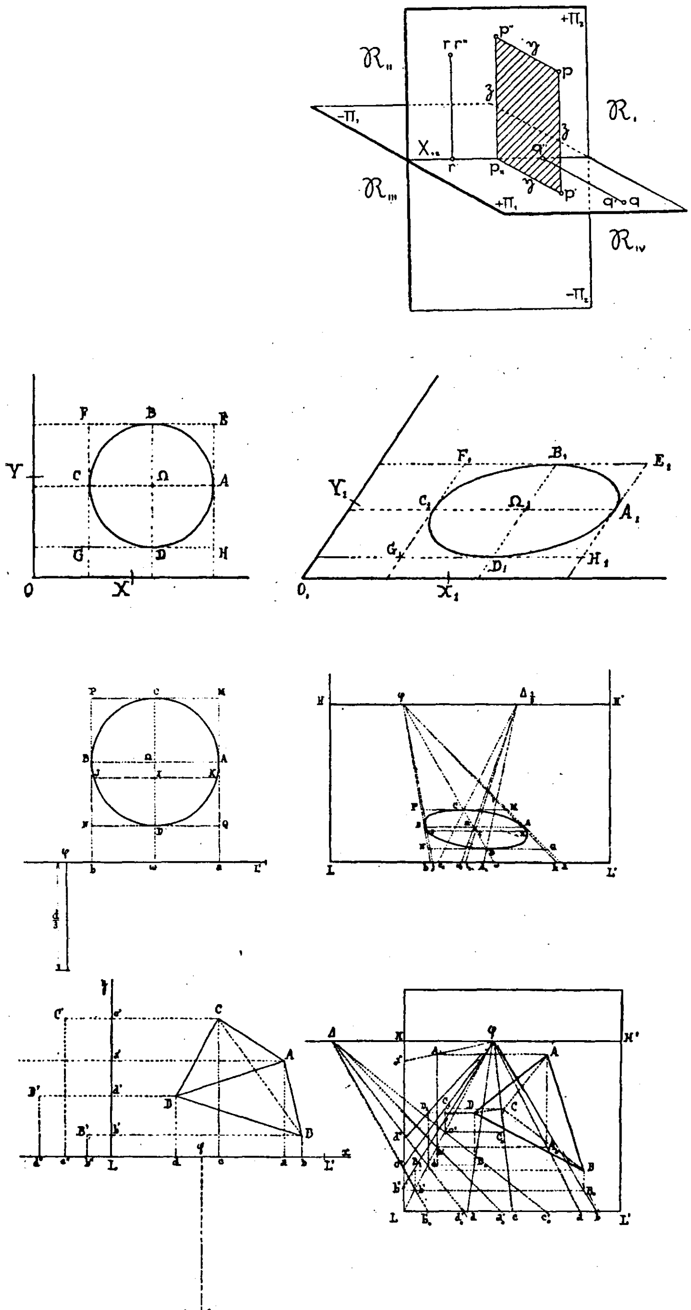
There are some straightforward characteristics of buildings, which are not spoken of as much as those more popular discussions of meaning, aesthetics, material quality, and social context. Primarily, buildings conform a relationship with gravity; they are, with an exception of one or two, ordered geometrical; they usually have straight walls, or circular, if not that, parabolic, or hyperbolic paraboloid. In all cases are explainable through algebra – including Antonio Gaudi's work and other instances where the math is done after the forms are conceived. These characteristics are simply inherited from the production process of the materials or components being used, which technically relies on math and calculation. Even when architects such as Gaudi and Frank O. Gehry can push technical means to build unusual geometric shapes, they still depend on calculations of generic math.

This, of course, is perfectly valid. Nonetheless, there is a further point to be made in this discussion. The conventional space conceptions that are posts of production processes have their effect [on the designs] within the design process. Especially due to the technologies available today, the math is more incorporated into the design process through tools such as drawings, i.e. not only computer but also manual ones. Tools are developed based on particular convenient mathematical formulations. They already assume a particular conception of space. By choosing to use that tool, one is committed to the limitations of it as much as the benefits.[15]

Geometry provides a precision in representation of any designed object, including the finished building. Referring to axioms of geometry, American philosopher Alfred North Whitehead asserts:

---

[15] Alberto Perez-Gómez clarifies this relation to geometry in the design process to a certain extent. In his point of view, geometry is the means of realization for designs (1996, 4). It is required in how they are represented, or built, or even maybe of how they are conceptualized. Design decisions have to reconcile with mathematical



Descriptive geometry systematically maps three-dimensional objects to two-dimensional space.
All of its constructions are translatable to algebra.
It allows techniques for perspective as well as axonometric and ortographic drawings.
From Emil Müller, Lehrbuch der Darstellenden Geometrie für Technische Hochschulen [Berlin: Verlag und Druck von B. G. Teubner, 1918], 14; Maurice D'Ocagne, Géométrie Descriptive et de Géométrie Infinitésimale [Paris: Gauthier-Villars et Fils, 1896], 37, 173, 203.

> Any one of these systems can be applied, and in an indefinite number of ways. The only question before us is one of convenience in respect to simplicity of statement of the physical laws. This point of view seems to neglect the consideration that science is to be relevant to the definite perceiving minds of men; and that (neglecting the ambiguity introduced by the invariable slight inexactness of observation which is not relevant to this special doctrine) we have, in fact, presented to our senses a definite set of transformations forming a congruence-group, resulting in a set of measure relations which are in no respect arbitrary. (1947, 265)

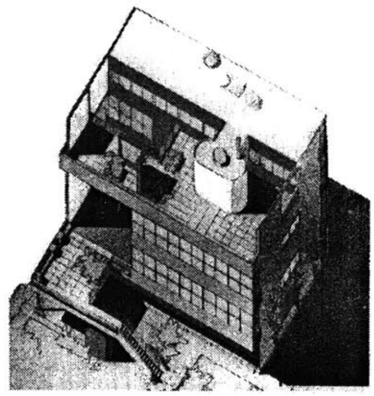
The creation tools employed in design processes are devised as interfaces between the designer and space by means of math and geometry. Geometric representation requires and achieves a quantification of the object. Ortographic drawings, excessively used in design processes, are based on principles of descriptive geometry accordant with the Euclidean Cartesian system, and processed through planar and linear projections. They present measured, although disproportional to the eye, proportioned universal representations, through rules of geometry. It helps the designer operate more comfortably with properties of space. In architectural practice especially, ortographic drawings, i.e. plan, section or axonometric, are applied for purposes of precision of construction and other technical detailing that is of concern to the manufacturer.[16] The objective presentation seems to be the premise in architecture in its relations to technology and sciences of material production.

In the case of the ortographic drawings, descriptive geometry objectifies the world. There are also instances of representation where the world is not quantitatively objectified. There are for example, subjective representations such as perspective drawings, sketches, landscape paintings. These relate to the actual experiences of the subject more directly. Architect

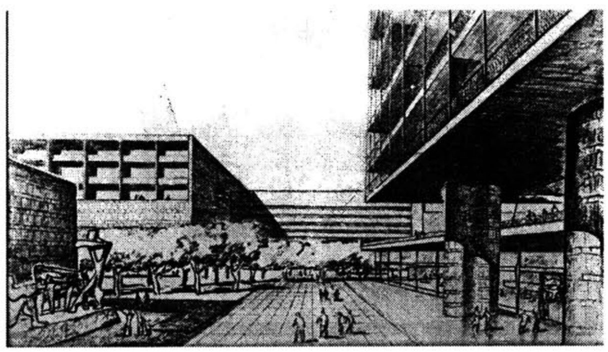
---

configurations despite that they are not scientific. It is more of a demand of materialization. Geometry in this sense, is never an igniting key in design, but is rather like the vocabulary of the end-product.

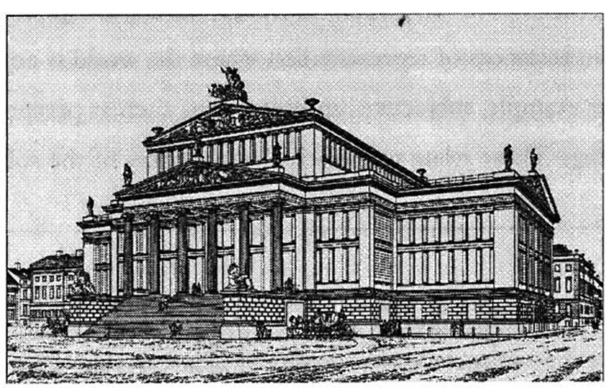
[16] Computer drawings today serve the purpose of precision well. Even a perspective drawing [promoted to being a "model"] has the technical precision of a technical drawing! As the computer is popularized as a design tool, the question regarding the involvement of precision in the design process gains importance. The growing research on computational design issues implies that the design process is to be carried to this medium at great length. Conventional computer representation along with its precision is becoming more integrated into the earlier experiential stages of the process. Since the computerization is associated with manufacturing procedures, as well as efficiencies of time both in presentation and designing, I feel we have to soon guard against a possible slogan such as "form follows praxis."



Le Courbusier, Villa Stein.
Subject view is absent.



Louis Kahn, Project for the Philedelphia Midtown Civic Center.
The horizon line is not constructed at the subjects' eye-level.



Karl Friedrich Schinkel, Neuen Spielhauses.
The horizon line is constructed at the subject's eye-level.

All illustrations from Penny Yates, Distance and Depth, in Gabriela Goldschmidt and William L. Porter (eds.) *The 4th International Design Thinking Research Symposium* [Cambridge, MA: MIT, 1999], I/49-74 historian Penny Yates (1999) distinguishes between different representations in terms of the presence of the subject/viewer. The inclusion of the subject – with the eye and the vanishing point – and the absence of objective measure seem to sustain the connection between the human subject and the objective world. Yates articulates that the application of depth – versus distance – has promoted such representations closer to reality of subjective experience. These aspects as well as the fact that it is simulative of visual reality serve the purpose of representing the "qualities" rather than quantities in a design work. Nevertheless, perspective drawings, as invented in the Renaissance, technically operate with the same mathematical conception of space as in the ortographic ones. Methods differ; projection on a Cartesian coordinate system is replaced with vanishing points and proportional divisions in depth, but geometry, as we know it today, is the source of reference in both. More than being the quantified version of space, geometry is reflective of how we conceptualize about space.

Striae by Geometry

The architectural/built environment around us is the consummation of early interventions in terms of math or geometry. I will briefly summarize these as synthetical and analytical geometries. Descartes conceptualized space with algebra, and grounding it on the synthetical geometry dating back to Greeks, invented analytical geometry.

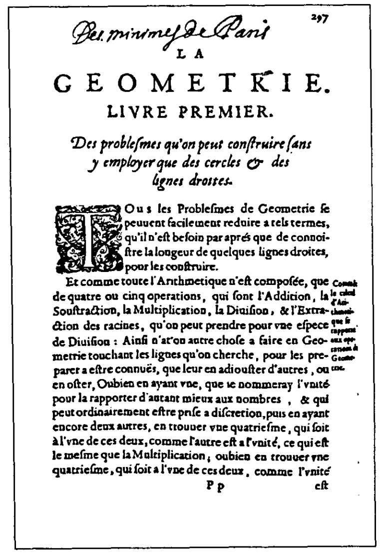
Synthetical geometry is the pure shape geometry we initially learn in high school. It historically dates back to Pythagoras and the Greek mathematics. It is based on its own "unquantified" axioms. At the time, the linear magnitudes of geometric shapes were numerically incommensurable. These distinct units had relations to one another in terms of ratios. The physical world was studied based on the model of geometrical forms.[17]

Descartes' most prominent contribution [to the modernization of mathematics] in 1673 *La Géométrie* was the revelation of the missing link between algebra and this geometry.[18]

---

[17] See Appendix A for axioms of Euclidean geometry.

[18] The concept of studying curves by means of equations in analytic geometry is said to be founded as early as 500 BC, by Menaechmus, Alexander the Great's tutor. Descartes has other precedents as well. The French theologian Nicole Oresme's system of "latitudes and longitudes" hinted the use of coordinates in graphical representations of arbitrary functions. And Francois Viete improved notation systems as to facilitate the algebraic work.



Des minimes de Paris 297

LA

GEOMETRIE.

LIVRE PREMIER.

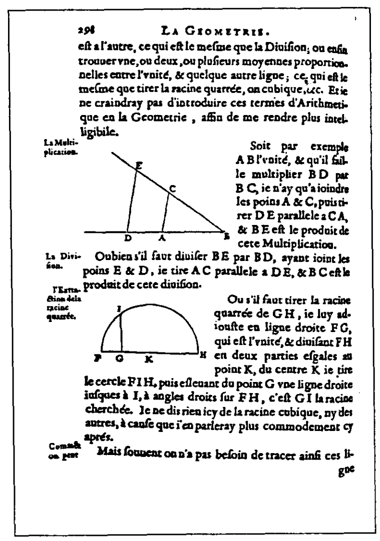
Des problesmes qu'on peut construire sans y employer que des cercles & des lignes droites.

TOus les Problesmes de Geometrie se peuuent facilement reduire a tels termes, qu'il n'est besoin par aprés que de connoistre la longeur de quelques lignes droites, pour les construire.

Et comme toute l'Arithmetique n'est composée, que de quatre ou cinq operations, qui sont l'Addition, la Soustraction, la Multiplication, la Diuision, & l'Extraction des racines, qu'on peut prendre pour vne espece de Diuision : Ainsi n'a-t'on autre chose a faire en Geometrie touchant les lignes qu'on cherche, pour les preparer a estre connuës, que leur en adiouster d'autres, ou en oster, Oubien en ayant vne, que ie nommeray l'vnité pour la rapporter d'autant mieux aux nombres, & qui peut ordinairement estre prise a discretion, puis en ayant encore deux autres, en trouuer vne quatriesme, qui soit à l'vne de ces deux, comme l'autre est a l'vnité, ce qui est le mesme que la Multiplication; oubien en trouuer vne quatriesme, qui soit a l'vne de ces deux, comme l'vnité

Comment le calcul d'Arithmetique se rapporte aux operations de Geometrie.

Pp est



298 LA GEOMETRIE.

est a l'autre, ce qui est le mesme que la Diuision; ou enfin trouuer vne, ou deux, ou plusieurs moyennes proportionnelles entre l'vnité, & quelque autre ligne; ce qui est le mesme que tirer la racine quarrée, ou cubique, &c. Et ie ne craindray pas d'introduire ces termes d'Arithmetique en la Geometrie, affin de me rendre plus intelligibile.

La Multiplication.

Soit par exemple A B l'vnité, & qu'il faille multiplier B D par B C, ie n'ay qu'a ioindre les poins A & C, puis tirer D E parallele a C A, & B E est le produit de cete Multiplication.

La Diuision.

Oubien s'il faut diuiser B E par B D, ayant ioint les poins E & D, ie tire A C parallele a D E, & B C est le produit de cete diuision.

l'Extraction de la racine quarrée.

Ou s'il faut tirer la racine quarrée de G H, ie luy adiouste en ligne droite F G, qui est l'vnité, & diuisant F H en deux parties esgales au point K, du centre K ie tire le cercle F I H, puis esleuant du point G vne ligne droite iusques à I, à angles droits sur F H, c'est G I la racine cherchée. Ie ne dis rien icy de la racine cubique, ny des autres, à cause que i'en parleray plus commodement cy aprés.

Comment on peut

Mais souuent on n'a pas besoin de tracer ainsi ces ligne

The first two pages from the first edition of La Géométrie by René Descartes, 1673.
From James R. Newman *The World of Mathematics vol. I.* [New York: Simon and Schuster1956], 238, 240.

Analytical geometry that he founded is the algebraic one constituted of equations for geometric shapes including circles, hyperbolas, parabolas. Descartes featured a straight line as an equation of the first degree, and a conic section as an equation of the second degree, and looked for their points of intersection in the common solutions of these equations. In analytical geometry, all forms of space – i.e. lines, angles, surfaces, volumes – are treated as quantities and determined by means of other quantities; all known space-relations are measurable and are expressed in terms of magnitudes. Problems in geometry can therefore be solved through calculation methods and unknown magnitudes could be derived from known ones (La Géométrie by Descartes, the English edition in Newman 1956, 239).

To the extent that I am concerned with, the Cartesian invention, which is "handed down" as an accustomed construct, has represented the void we inhabit in terms of three directionalities. This conception has been quantified and mathematically/geometrically represented in terms of the coordinate system. The system offers precision, quantified and calculable representations based on universal reference points. It is able to simply "map everything."

Our built environment today follows this construct, for its undoubted convenience. Each physicality can be represented in terms of this system, and new physicalities can be envisioned in the same way. It is a closed system with a point of origin as its reference. It is a system of coding. The long-lasting affects of this abstract model of space could be seen in the construction/production technologies/industries as well as conceptual mathematical models. The economical after-affects especially make it inevitable. The economizing production industry depends on this basic model for efficiency, precision, and equity.

The abstract conceptions work very well not because they reflect the facts precisely, but because they are consistent. For example, even though geometry is lacking experimental grounding, disciplines dependent on it, like architecture, which continually calculate relations of space by these principles, never seem to fail because of this. [19] On the contrary, given the

---

Contemporary to Descartes, Pierre Fermat founded the modern theory of numbers and advanced studies of probability. Following this work Descartes arithmetized analytic geometry in 1673. (Newman 1956, 236)
[19] Helmholtz, in his Origin and Significance of Geometrical Axioms, reiterates the familiar instances of how geometry is utilized in regulating space.

high-tech and/or mass-producing material and construction industries of today, this is the only way they can be realized. There are two conclusions one can make from this. It is either that this abstraction is indeed the ideal model for reality. Or everything else is thought within its bounds, so that there are no failure points.

The Cartesian construct is very convenient, and it is capable of mapping everything that physically exists, as it is an absolute system based on fixed points. However it has to be acknowledged as a mere representation, rather than a basis for life. Its appearance as a base is only valid in terms of the construct it has been the grounds for. As it was with the case of the tools, by choosing to ground every other form of representation on this system, one is committed not only to the benefits but also the limitations.

Restraints of Striae.

The perpendicular minimalism of this most basic conception of space has already been the main point of focus in the above paragraphs. With the abstract basis of three reference axes, Euclidean geometry and the Cartesian coordinate system seem to be sufficient for us in describing our physical experiences. Yet, our experiences that reach a little beyond our perpendicular vicinities tell us differently. The reasoning behind the perpendicular space configurations applies locally as we are too small to perceive the "curve of the earth" or other strict geometries at the molecular level. The straight lines we see around us are our constructions and all depend on the abstract notions developed to describe our physical experience in an efficient way. We produce its history ourselves. Geometry appears as a succession of everyday experiences, especially the perception of the geometrical similarity of great and small bodies, only possible in flat space. This leads to the rejection of every other geometrical representation at variance with this fact. There was no need for knowledge of the necessary logical connection between the observed fact of geometrical similarity and the axioms except for an intuitive apprehension of the typical relations between lines, planes, angels, etc. obtained by numerous and attentive observations.

Land surveying, as well as architecture, the construction of machinery no less than mathematical physics, are continually calculating relations of space of the most varied kind by geometrical principles; they expect that the success of their constructions and experiments shall agree with these calculations;

The recognition of the detachment of the abstractions to experience is not a new idea. The notion of living in a curved world has been largely articulated in literary works such as Sphereland, by Dionys Burger, and in the world of mathematics through non-Euclidean geometries, independently in the works of Wolfgang and Johann Bolyai, Karl F. Gauss, and Nikolai Ivanovitch Lobachevsky in the early 19th century.[20]

Another instance of the similar awareness, came about in the concept of multiple dimensions – instead of just three. Einstein's Special Theory of Relativity, which situated time as a fourth dimension, is the most easily conceived manifold. Today, through logical constructions and with the help of computers we can conceptualize spaces of as many dimensions as we can. In kinetic theory, a gas volume of N particles is described in a space of 6N dimensions – where N is the number of particles in the system, and 6 is the degree of freedom of each particle consisting of 3 co-ordinates and 3 momenta![21]

Geometry does not have to be confined to the description of direct physical experience, since it is arguable that the physical experience is independent of the already existent construct. Inability to visualize non-Euclidean and higher-dimensional geometries given the Euclidean geometry today should not mean to reject them.

In as early as 1884, Edwin Abbott Abbott (reprint 1992) wrote his popular book Flatland in which he remarked the limits of "dimensional prejudices." He developed dimensional analogies with the intention of encouraging people to consider the new mathematical creations. The book is written through the eyes of a square, an inhabitant of Flatland – the two-dimensional space. The Square receives a visit from the Sphere one-day who introduces him another dimension. The conceptual function of the Square is restricted to the extents of his perceptive or physical capacity. Eventually he is able to conceptualize the third dimension. Possibly, his contemporary Helmholtz influenced Abbott. Hermann von

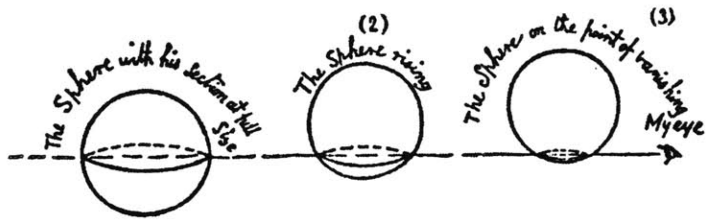
---

and no case is known in which this expectation has been falsified, provided the calculations were made correctly and with sufficient data. (1995, 226)

[20] For a short account of non-Euclidean geometries, see Appendix A. For further reference, see Newman (1956); for reference in context with art and architecture see Henderson (1983); Banchoff (1990); Helmholtz (1995).

[21] Through computational means, we can conceptualize an n-dimensional space where n represents the number of physical attributes as well as other quantifiable parameters of design. And such a conceptualization might be realized by "being mapped" onto the three-dimensional space.

Thomas F. Banchoff, Beyond the Third Dimension: Geometry, Computer Graphics, and Higher Dimensions [New York: Scientific American Library, 1995], 2.



An occupant of a two dimensional space overcomes the constraints of his perceptions, and is able to conceive the third dimension, even if in his dreams only, as he encounters a sphere.

Square teaches the second dimension to Line.

From Edwin A. Abbott *Flatland: A Romance of Many Dimensions.* [New York: Dover Publications, Inc. Original edition, London: Seeley & Co., Ltd., 1884, 1992,]59, 51.

Helmholtz (1995) had already introduced a two-dimensional space and its inhabitants, in his 1870 lecture *Origins and Significance of Geometrical Axioms*. His idea was to "get a distinct view by taking a region of narrower limits than our own world of space." (1995, 229) In his take on the vision as well, the inhabitants of a two dimensional space are only able to conceive the planar geometry of two dimensions.[22] Dependent on their everyday experiences, they could not conceive a further spatial construction generated by a solid moving out of itself as we could not easily conceive a solid moving out of the space we know.

These insights were important in projecting to the awareness of being able to re/de-construct the established assumptions. In addition to the mere fact that "other" abstract configurations were mathematically or geometrically possible for same or similar constraints of space, there is another significance of this notion. These alternative conceptions of space, suggest(ed) that reference points might change. The emergence of new constructs for further enhancement of perceptive consciousness is possible through altered perspectives. The perspective broadens through retaining that vision of the representational space, and the awareness that man constructs and can de-construct.

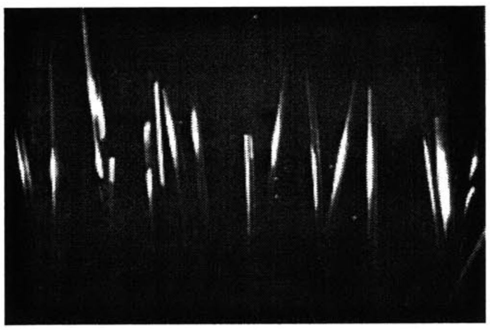
To sum up, by remarking above non-Euclidean and multi-dimensional geometries, I do not wish to imply an argument defending alternative systems. My intention is more in the line of developing an awareness of the limitations of a steady one. I believe noting that there are other ways of representing the space – even if they are not any better than the common one – is an evocative insight.

> Alternative geometries suggest that there also exist another kind of abstraction based not on isolating form, celebrating its purity or autonomy, but on the contrary, on releasing it from the sort of spatial system that defines and fixes shapes, organizes visibility, ensuring there will be no surprises… (Rajchman 1997, 104)

As 20th century philosopher Ernst Cassirer (1950) states, when the Euclidean system that has held authority for centuries is suddenly faced with the discovery of non-Euclidean

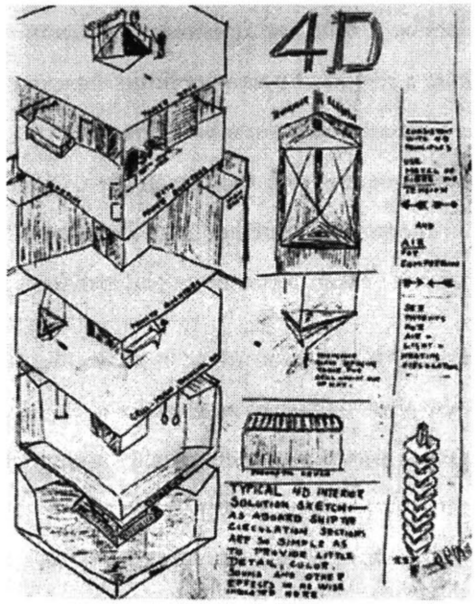
---

[22] Of the two accounts, Abbott's is less scholar and theological. Helmholtz develops his arguments within relation to cognition/perception and experience.



Light comes forward as the essential element of space in how Nathan Lerner conceives and represents.
"Study of Lightspace," School of Design, Chicago.

From Gyorgy Kepes, Language of Vision [New York: Dover Publications, Inc. 1995; Originally Chicago: Paul Theobald, 1944], 51.



Buckminster Fuller designs in four dimensions! as he equates and links time to the other three dimensions of space.
4D Interior Solution Sketch.

From R. Buckminster Fuller, *4D Time Lock* [Albuquerque, N.M., Lama Foundation, (1930)1972].

Three-dimensions are mapped onto two dimensions in Cubist painting. The physical appearance of the "man in the café" is broken into pieces of various view-points as Gris challenges the conventional one-to-one relation of space and time.
Juan Gris, The Man in the Café, oil on canvas, 1912.

From Linda D. Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art* [Princeton, NJ: Princetion University Press, 1983], Plate 23.

geometry, entirely new questions were introduced for mathematical thought and it was forced to a new interpretation of its own logical structure. There are a number of geometries unknown to Euclid, in which the angles of a triangle never sum up to 180°. It is by no means evident which of these geometries fits the universe at large distances from us. In the same way, the physical sciences have found that their fundamental entities and axioms are a great deal less obvious than was hoped. Similarly, in the natural sciences, the conception of the world as considered by classical physics becomes open to more doubt as the quantum theory and the special and general theories of relativity shake the mechanistic view of the universe.

3 Critical Issues of Striation

Philosophy for the Striated Space.

The Cartesian system, beyond the technical implications, has a philosophical formation as well. Historians recognize that the unfolding of scientific thought between 1500 and 1700 was critical in the creation of modern civilization. The scientific revolution of the period was primarily an intellectual revolution. It implied a basic change in the way in which people pictured the world in their minds.[23] The world was observed through a mechanistic view and was considered a static and therefore predictable system slowly revealed by the sciences.

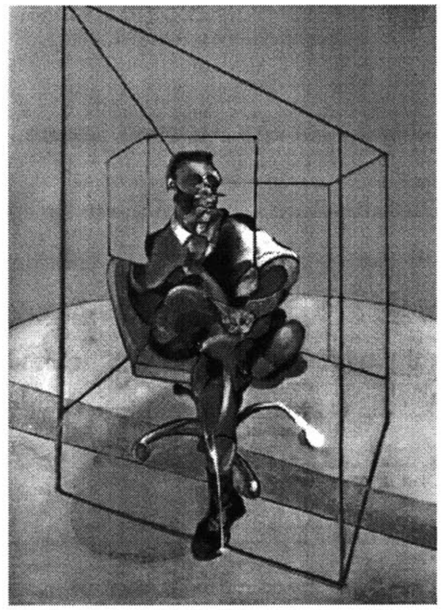
Descartes holds a prominent place in the development of this world-view. His conception of nature expounded a mechanism of exact and logical formulas. For him, mathematics was the appropriate tool for an adequate description of the universe. He followed the Euclidean procedure – the method of deriving results from a set of axioms by a sequence of cause and effect. He proposed that the universe could be constructed by thinking alone. He himself aimed at constructing the mechanistic conception of the world by deductive methods. He operated on a fundamental set of axioms and thus, his work, which describes geometrical figures by the formulas of algebra, came about.

This static mechanistic view could have partly influenced what Kant later proposed in the 18th century. Kant's interest was in *a priori* foundations in nature. He has concluded that there are some necessary relations in nature, such as space and time, which are the necessary fundamentals of thought. He has claimed that space and time are presumptive knowledge. Space and time should be conformed to whatever the empirical laws of nature are. Basically, we cannot imagine a world in which either could be different. This connotes that conceptions of space and time are permanent. (1965, 65-82) [24]

---

[23] For elaborated accounts of this history see The Origins of Modern Science (Butterfield 1952).

[24] The notion of space and time being "givens" rooted in Kant's belief that there is a reality independent of men (1965). This is in part related to the upcoming sections.



The subject, portrayed by Bacon, becomes ... and it distorts the space it inhabits along with itself.

Francis Bacon, Study for a Portrait 1971.
From Ernst van Alphen, *Francis Bacon and the Loss of Self* [Cambridge: Harvard University Press, 1993], 161.

Kant's vision faced its "technical" critiques especially following the discoveries mentioned earlier: one that there are consistent geometries which are not Euclidean and, that of special relativity in this century (as early as 1905-1929) which has shown that different observers may see the same sequence of events in a different order of time. Disturbed by new "facts" the fixed system has gone under reconstruction attempts.

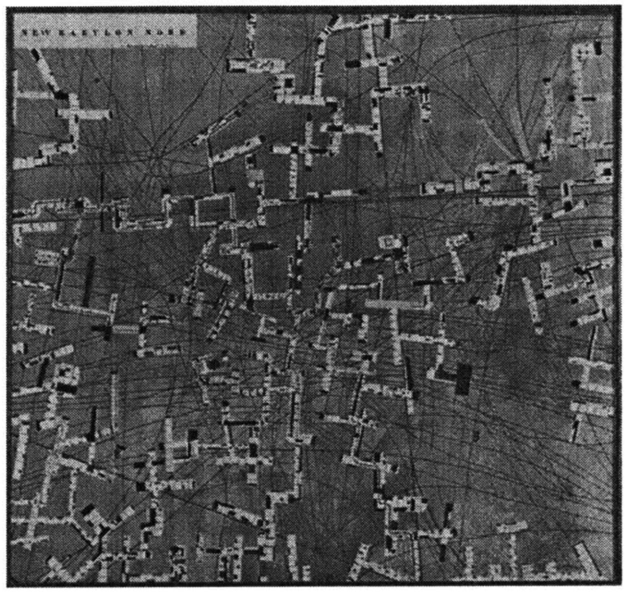
Related to the emergence of a – constructive – critique of the mechanistic view there seems to be two issues – namely becoming and progress. I give an account of these two issues in relation to each other. The relation is such that our productions address the unfolding nature in order to progress accordingly.

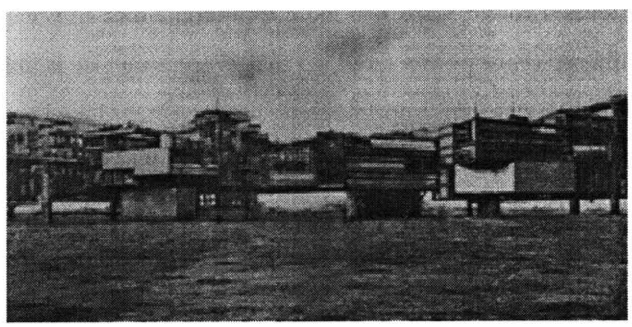
Issue of becoming.

Conflict of subject and object-

As explained above, Cartesian logic applied the idea of accepting the most primitive and essential reference points fixed, so that everything else is universally defined in reference to these. This constructive approach to space, reintroduced geometry within an absolute set of references where three coordinates were designated sufficient to explain all physical existence. This was a method that was deliberately exclusive. I cite two similar approaches to this point although in different contexts.

"Exclusion" in the Cartesian system is addressed in a social critique such that the system neglects the dynamics of the bodies occupying the space. This lack of flexibility for a becoming universe was the main point in Henri Lefebvre's social writings against the Cartesian box (1997). This being the case, the Cartesian space faces a more grounded argument one that is especially related to architecture. The Cartesian system, the adaptation as well as the initiation, has shifted the notions of space-time to an absolute. Lefebvre refers to the shift as the shove of *res extensa* [object] against *res cogitans* [subject] (1997, 14). Cartesian tradition implies an external box detached from the actual content of space – man. It is an ideal [with its straight lines, angles and perfect circles] although as Whitehead suggests, "artificers do not work with perfect accuracy." The implied imperfection comes solely from the fact that the content changes constantly.





The architectural spaces in a city for nomads, namely New Babylon designed by the Situationist COBRA group, change along with the inhabitants and constantly evolve in time.

From Simon.Sadler, *The Situationist City* [Cambridge MA: MIT Press, 1998], 31,154.

Lefebvre writes *The Production of Space* based on a critique of "abstract space. " His argument is that the abstractness of the Euclidean space that surrounds us is an imposition on us by science (in his words, by technocrats hired by the state). In this tradition, individuals are not building (or ever re-building) the space themselves, from within. It would have been only right however, that individuals are able to de-construct this abstract configuration in order to build again, -not what surrounds them but what they belong in.

In his writings, Lefebvre is mostly referring to architecturally built space, which is indeed formed by the social political constraints. In this context, his main critique elaborates the social aspects more than I want to emphasize here. Following Lefebvre's somewhat Marxist discourse[25], a group of artists, namely Cobra, along with architect Aldo van Eyck designed in the early 60's a "city" known as New Babylon – the Situationist City – for nomads (Sadler 1998; Lefebvre 1996, 11-4). Literally it is a city where the inhabitants constantly change. I suggest that Bernard Tschumi's discourse of event architecture also fits in the same critique: architecture is not defined simply by walls but the inhabitant events and people.

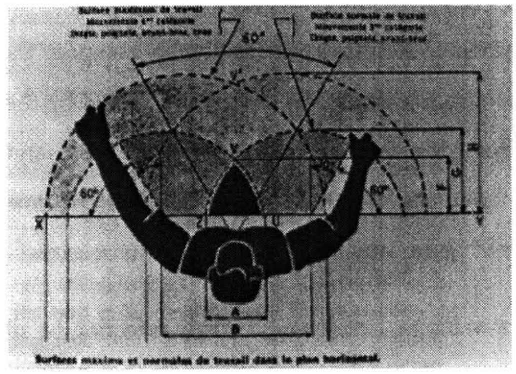
Defining a becoming system-

The main idea behind the social critique was that the reductive 'abstractions' excluded the social components of space. I will drop the 'social' context that Lefebvre has emphasized, but continue with the exclusion of components in general terms. Exclusion implies a false acknowledgement of the component that it is static. However, components interact with the space and this process is a significant factor in conceptions of that space. Alfred North Whitehead's definition of the coordinate division serves as a follow-up to one of the main issues of the critique.

Whitehead, in his *Process and Reality,* presents an argument that provides the set backs of fixed reference points and namely the coordinate system. He distinguishes between two ways of organizing the components of an entity: genetic and coordinate divisions (1955, 448). In contrast to the coordinate division iterated through analytic geometry, in the genetic

---

[25] Edward Soja writes on the Marxist connections of Lefebvre in the first chapter of his book (1996, 3-5, 8-9). For further information on Lefebvre's influences on the Marxist communities refer to Kofman and Lebas's Introduction in Lefebvre's Writings on Cities (1996).



In ergonometric studies, the key reference to definitions of space is the body. The subject, through his bodily movements, carves out its own space from a void. This illustration was published in the article Commentaires Contre l'Urbanisme in *Internationale Situationiste*, no.6, 1961.
From Simon Sadler,The situationist City [Cambridge MA: MIT Press, 1998.] 6.

Architectural space will be defined by ideas as much as by real walls. Architecture will be the tension between concepts of space and experience of space. (Tschumi, 1975)

Advertisment for architecture.
From Bernard Tschumi.. *Text 5: Questions of Space.*
[London: Architectural Association Publications, 1990], 10.

division ["of coalescence and concrescence"] the components are observed in terms of *genetic* –meaning interdependent – relationships they had with each other. Unlike the static system of the coordinate division, the overall entity is seen as a process; there is a growth – a smart accumulation – in each phase in time; there are *processes of integration and of reintegration.* [26]

Primary difference between the genetic division and the coordinate division is that the first is concerned with concrescence and immediacy of it, whereas the latter is concerned with the final 'satisfaction' [of having explained the whole]. The coordinate division is devised to fit a set of functions only. Once the ideal system that accords with serves these functions is devised, there is satisfaction. "Thus in coordinate division we are analyzing the complexity of the occasion in its function of an efficient cause" (Whitehead 1955, 448).[27] Whitehead asserts critically that with the attainment of the satisfaction, "the immediacy of final causation is lost, and the occasion passes into its objective immortality" – research comes to an end point.

I find Whitehead's distinction very significant for the critique of the mechanistic view. The system that follows the genetic concrescence, seems to be non-reductive and open. It becomes obvious that the mechanistic view, particularly applying the Cartesian coordinate system as a tool of ultimate reference, is insufficient in reflecting the unfolding character of the system. The universe is reduced, for the sake of being operable, to a fixed set of references. The components are understood in terms of a secondary entity. The idea [Whitehead expounds] of bridging the abstract and the experience fades. The becoming system is reduced to an absolute abstraction.

---

[26] Whitehead (1955) envisions the complex unity that is obtained throughout this process in genetic division to be "a contrast of actual entities, eternal objects, and proportions, felt with the corresponding complex unity of subjective form." The idea that such an entity of contrasting components is legitimizing itself as a unity is an interesting one and it will find its way in my arguments in the sections to come.

[27] He continues:

> In the genetic morphological way we obtain analysis of the dative phase in terms of the satisfactions of the past world. These satisfactions are systematically disposed in their relative status, according as one is or is not in the actual world of another. Also they are divisible into prehensions which can be treated as quasi-actualities with the same morphological system of relative status. (1955, 449)

The idea presented here is not very different than the earlier discussions on the Word Machine. These reflections of Whitehead on a becoming system [of genetic division], that will address the becoming characteristic, is also reminiscent of Bergson's creative evolution model to be discussed in future sections.

There is a supportive argument. The limitations of thought do not acknowledge the ever-changing extrinsic factors to an object. In Whitehead's example, the Newtonian notion of fixed space i.e. a definite division of space, quantum, does not correspond to the organic theory, and has "its birth as its end." (1955, 124) Whatever we have extracted out of the broad range of knowledge, based on experience, should go under change as the range of knowledge goes under change with new experiences. "This is a theory of monads; but it differs from Leibniz's, in that his monads change. In the organic theory [he proposes], they [monads] merely *become*." (1955, 124) [28]

Hegel-

J. Bronowski and Bruce Mazlish assert in their encyclopedic book *The Western Intellectual Tradition*, that Hegel had already introduced the notion of life as "becoming" to the critique (1960, 482).[29] His opposition to static systems and permanent solutions/formulas, dismantles the Cartesian idea of nature being governed by mathematical rules. In contrast to the Kantian idea of a *thing-in-itself*, or *a priori* knowledge of nature, Hegel had a relativist view, that we exist knowing the world and the world exists through our knowing (Bronowski and Mazlish 1960, 483; Russell 1972, 733).

Similarly in Helmholtz's writings, the static systems are our doing. Helmholtz (1995) disagreed with the Kantian view that "the properties of space are integral parts of our understanding, determined by the given form of our capacity of intuition" (Newman 1956, 645). According to Helmholtz's argument we might as well have been living in a spherical world (are we not?) where our sensible impressions of the world "dictate" us to adopt the curvilinear non-Euclidean geometry. In such a world our intuition would not be able to adopt the "flat-space" Euclidean system. We could undoubtedly speculate about it, and maybe devise accordant mathematical systems, but we would never be able to customize it. The axioms of our geometry are partially suggested by experience; but definitions are

---

[28] For further reference on Leibniz and monads, see Russell (1972); H. G. Alexander, The Leibniz-Clarke Correspondence [New York: Philosophical Library Inc., 1956]; Translation of Leibniz's Monadology in Nicholas Rescher, G. W. Leibniz's Monadology [Pittsburgh, PA: University of Pittsburgh, 1991], 17-29.

[29] His passage they quote on incompatible successive events recalls a becoming system. Russell also writes of Hegel's ideas of becoming in relation to the dialectic. He continues that for Hegel the process was essential to our understanding the result (1972, 733).

composed of ideal figures that can only approximate the physical objects of the actual world. So these definitions are idealized versions of actuality instead of accurate models of the physical world. The view, which accepts geometry as being developed upon experiences, is accordant with the notion of becoming as it includes the subject factor.

Kant's philosophy implied that some rational *a priori* knowledge of nature was innate to man (1965, 65-82). However, relativity theory and quantum mechanics iterated revolutionary ideas regarding space [and time] and the relation between the *knower/observer* and *what he knows/observes.*[30]

Hegel's emphasis on process and his dialectic method – simplified as thesis-antithesis-synthesis – had displayed this perspective to a certain extent.[31] Long before the discovery, he had relativist thoughts. The dialectic follows the argument that there is no reality until we know it. The world exists only by our knowing it. The synthesis of the thesis of knower/being and antithesis of knowing together could only be through experience.

Dialectic method is similar to a succession of revolutionary steps. Bronowski and Mazlish (1960) draw attention to this point as well. They interpret the dialectic process as a progressive one. In Hegel's dialectic, they find that "the passing of time is elevated to the rank of a creative force." At each step, something new, particular to the immediate phase – a synthesis – is anticipated to come out. "The dialectic process always moves to a higher synthesis. It is by its very nature, a progress" (Bronowski and Mazlish, 485).

Bergson-

---

[30] In both Kant and Hegel's lines of thought, it is assumed that there must be a profound unity between the knower and what he knows, and that knowledge would be impossible without such a unity (Bronowski and Mazlish 1960). Kant had already addressed the issue of man as an active receiver. The knower and what he knows influence one another. But Kant also believed that there is a reality independent of men, there is a *thing-in-itself* behind everything that is known as it is known. Unlike Kant, Hegel thought of the unity between the knower and what he knows in an unfolding process involving opposites.

[31] Given a thesis such as man who seeks to know, the nature presents an antithesis. There is a conflict between the thesis and the antithesis, and this is resolved by synthesis which blends the two; the knower and what is to be known generate knowledge itself. For Hegel, every process in life causes a contradictory process and life takes its most important steps through synthesis. "The essential step of progress is always in the synthesis of the two: becoming." (Hegel 1974, 95-9)

The notion of "becoming" is also inherent in Henri Bergson's discussion of intuition versus intellectualism as two different ways of using the mind. In *Creative Evolution*, the French philosopher Bergson (1998) introduces intuition as the use within the immediate *duration* – durée – in which we act: "By intuition I mean instinct that has become disinterested , self-conscious, capable of reflecting upon its object and of enlarging it indefinitely" (Bergson cited in Russell 1972, 793).

It is not too clear what its implications could be in terms of an anti-thesis of intellect, but I can see that intuition connotes to understanding the act from within, and thus fits well with the earlier discussions of a becoming system. In the intellectual case however, the mind is practical. The concepts of the intellect are [non-living] objects in space, and have stability. Devising of the Cartesian coordinate system, such as in Whitehead's definitions, is an intellectual act for example. Bertrand Russell gives a very clear account of Bergson's reflections on the intellect:

> The intellect separates in space and fixes in time; it is not made to think evolution, but to represent becoming as a series of states… Geometry and logic, which are its typical products, are strictly applicable to solid bodies. Solid bodies, it would seem, are something which mind has created on purpose to apply intellect to them. Intellect is the power of seeing things as separate one from another. (1972, 794)

The intellectual knowledge is an inadequate one,[32] and is only useful because of its practicality that enables us to make "short cuts through experience." What Bergson criticizes in the intellect is the consistency factor. Rather than the general intellect, the problematic is caused by the fixation of one absolute. [33] American Pragmatist William James (1977) accentuates that the essence of life has a continuously changing character. He writes,

---

[32] Recall Whitehead's assertions for the axioms. And as opposing to the Kantian idea Whitehead writes in *Science and the Modern World* "…space-time cannot in reality be considered as a self-subsistent entity. It is an abstraction, and its explanation requires reference to that from which it has been extracted. [Space-time is the specification of certain general characters of events and of their mutual ordering]" (1967, 65).

[33] Otherwise, the opposition appears too sharp. Instead one also needs to recognize the benefits of the intellect more. Creative acts are possible within rationale. Specifically, rationale is needed in creative acts as will be shown in the next chapter. For example, if we are to refer directly to Bergson's assertion, the power of seeing one thing separate from another is essential for conceptual leaps.

"Despite this, our conceptions are fixed" (112). These concepts are not part of reality, but rather suppositions.

Issue of progress.

The successive steps of the dialectic, as much as those of the genetic growth had implied progress. Similarly, Bergson's theory proposes an articulate argument for understanding progress. In becoming systems, progress is a must condition by definition of the system. The system is explained with its temporal movement and growth. But the definition of the particular progress in the becoming systems has to be clarified for it has to be distinguished from the strictly intellectual one.

Linear progress-

The intellect when applied at the absolute is capable of producing fixed systems. The construct derived from previous conclusion(s) operates on a linear progress. However, "A civilization which cannot burst through its current abstractions is doomed to sterility after a very limited period of progress" (Whitehead 1967).

Progress is not a rigorous concept. It is already very much embedded in most of our makings. John Rajchman instances these usual makings as "effective" insertions into a larger system that precedes and maintains them (1997, 92). Nevertheless, these belong in a particular progressive process. I will refer to this version Whitehead pinpoints as limited, as linear progress. I should reflect that I do not have the intention to neglect the significance of this conformist type of progress. It provides expansion to the available knowledge and is valuable. However, another process seems inevitable to *enhance,* rather than to expand, the available knowledge as well as the ways we conceive the world. What Rajchman calls "affective spatial disposition" implies this other kind of progressive process. This "seeks to release figures or movements from any such organization, allowing them to go off on unexpected paths or relate to one another in undetermined ways" (1997, 92).

Hence, I distinguish here in the line of many others (Kubler 1962; Kuhn 1996; Rajchman 1997) a creative progress. This is rather a comparative between two different ways of progress that actually work together. Linear progress is a conditional advance along a paradigm. A paradigm is assumed to have started with a very significant conception. It is constituted of very specific and specialized little steps of advancement, which are more likely to be better quantitative achievements.

> Knowledge falls into a trap when it makes representations of space the basis for the study of 'life', for in doing so it reduces lived experience. The object of knowledge is, precisely, the fragmented and uncertain connection between elaborated representations of space on the one hand and representational spaces on the other… (Lefebvre 1997, 230)

> …our ability at any moment to accept new knowledge is narrowly delimited by the existing state of knowledge. (Kubler 1962, 65)

Whitehead, Lefebvre and Kubler all reflect on the drawback of absolute intellectualism in production of knowledge/space. Creative progress, on the other hand, is progress that is free from the radical line of intellect, and occurs across different paradigms. It is acquired with the awareness of and flexibility between various conceptions. Below I will elaborate on some of the criteria for creative steps in progress.

Propagation-

Kubler gives a basic account of various aspects of our production [of knowledge].

> The occurrence of things is governed by our changing attitudes towards the processes of invention, repetition, and discard. Without invention there would be only a stale routine. Without copying there would never be enough of any man-made thing, and without waste or discard too many things would outlast their usefulness. (1962, 62)

What I refer to as creative step finds an articulate definition in Kubler's use of the word invention. In Shape of Time, invention is the key word for Kubler's argument on progress. He proposes two types of knowledge: what we know and what we will know. The "penumbra shadow of the two" is where possible events are perceived. Kubler recites that invention lies in the penumbra. He posits it as variation, rare but remarkable leaps.

However, it is important to note that Kubler is particularly talking about aesthetic inventions as opposed to *useful* ones[34] – for example, late medieval invention of perspective drawing rather than the [technical] invention of oil painting. More examples to the former could be that of atonal music and abstract expressionism from the early 20th century (1962, 65-6). Although not in full sync with his categorization, I agree with this promotion of so-called aesthetic invention, because it is more relevant in my discussions of creative progress due to the involvement of perception directly.[35] The aesthetic inventions, inherent in many fields and other kinds of production in addition to fine arts, enhance something more inherent in us: perceptive sensibility, our own library of perspectives.

Most importantly, there is a value of newness in inventions. In contrast to acts and perspectives that endure the existent paradigm, each invention is a new serial position: it starts a whole new paradigm with a new perspective into things. It is also – mostly – in denial of preceding perception, prevailing only among very closely related field: it does not annihilate all that is before, it is a perspective that is repositioned according those that are the most related. They are inclusive of the individual but by no means limited to it.

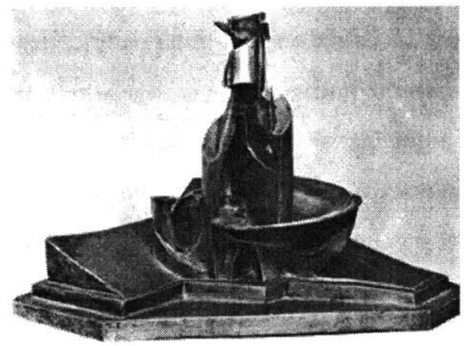
An instance of this in art, is the work of abstract expressionists especially of the Cubists from the beginning of the century. It was Siegfried Giedion, in *Space, Time and Architecture*, who initially proposed the link between the Cubists' approach and the paradigm-shifting concepts developed in math and sciences at the time such as the General Theory of Relativity and the alternate geometries ([1941] 1982, 436).

Cubist work stands as a paradigm-shift as well in terms of its break from the descriptive Renaissance perspective. It presents radically abstract images of the world. In the works of

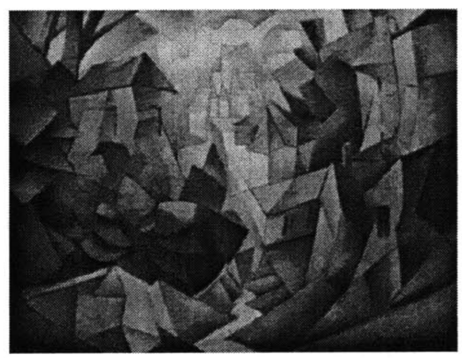
---

[34] Kubler also asserts that useful inventions follow a continuous line, whereas artistic inventions are leaps. This is not of course true for every artistic invention, rather is true for "good" inventions.

[35] Kubler (1962) interjects that perception is our channel to the whole universe. I am not convinced that the criterion for his distinction applies at all times. But he gives aesthetic invention in the way I understand creativity to be enhancing the perceptiveness. Though I would argue that this enhancing the perceptibility, altering the sensibility of man in one way or another is almost true for all "good" inventions and not only aesthetic ones, I will agree that artistic inventions could be promoted for directly serving the purpose. Still, I doubt some of what he calls useful inventions. They appear to be trivial if at all inventions, i.e. rearranging furniture, confrontation, and application of a theory. Maybe, it is possible to speculate the distinction between "good" and "not as good" inventions dependent on the impact they have: either through changing our perceptions of the environment or through changing the physical environment without changing the concepts.



Umberto Boccioni, Development of a Bottle in Space, 1912.
From George Rickey, *Constructivism: Origins and Evolution* [New York: George Braziller, (1967) 1995], 16.



Jean Metzinger, Cubist Landscape, 1911.
From Linda D. Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art* [Princeton, NJ: Princetion University Press, 1983], Plate 27.

Relation of space and time are modified. Any recognizable reference to the known world disappears. Both the creation and viewing of it requires one to distill experience and reconsider the common perception.

Gris, Metzinger and Boccioni, any recognizable reference to the known world disappears. The abstract expressionist work is a complete creation in itself with or without unpredictable references. It is for sure an element of creative space. Engagement with such work can enable the mind to perceive freshly. Both the creation and viewing of it requires one to distill experience and reconsider the common perception. One can then acquire a new perspective. To experiment in this way with the formation of new structures is a creative act. A new sensibility of perception itself is provoked.

Invention versus Convention, and Creative progress-

As with the Cubist work, invention is a creative act that is differentiating from convention. This act does not only work instantaneously but also gradually until the new particle of knowledge has been woven into every individual existence. An act following conventions contributes to a linear progress. The first concerns radical shift, while the latter concerns small discoveries and slight variations from its archetypes. A radical invention is more likely to occur at the beginning or at the inflection point of a series; and the conventional acts with various degrees of inventive content occur along the series. As a series "ages," relatively-inventive/qualitative – as will be discussed below – acts are less numerous than at the beginning. The linear progress along that series eventually is reduced to quantitative productions (replicas or objects of slight variation) only. In order to produce and sustain a creative space, I propose a creative progress, which incorporates more radical inventions into the linear one to lessen its quick-deaths and long-lasting haunts. Surely though, because rarity of invention/inventive variations is due to their differences from conventions, conventions – meaning long-lasting paradigms – are needed.

> Both in science and art the inventive behavior rejected by the mass of people has become more and more the prerogative of a handful who live at the crumbling edge of convention…The great mathematicians and artists, who stray farthest from usual notions, lead the procession. (Kubler 1962, 68)

I would like to articulate a creative progress with reference to Bergson's theory of knowledge. Like Whitehead, Bergson advocated that in knowledge production, an adequate account of reality with all of its aspects could not be given. He criticized the rigid scientific opinions prolonging the pre-19th century era. He wanted to encourage and achieve new scientific insights, which would endure the becoming nature of matter ([1903] 1955, 54-5).

Ideas, concepts and representations are tools by which we adapt to our surroundings. In particular, the concepts that have ruled the sciences since the 17th century are accepted to be complete or final even if they were not. Bergson shows in his "biological theory of knowledge" – which is very much like the genetic division – that our adaptations are never complete. This is due firstly to the limitations of our perception, and secondly to the constant change of socio-physical systems in time. New concepts should be formulated continuously. Matter as perceived today cannot be the ultimate data of science: the knowledge of matter has to fit a changing universe. In biology it has been acknowledged that organisms in the course of their evolution progress either through expanding an old adaptation or by producing a new one. In the latter case – given Bergson's concept of evolution – an appeal to a fresh intuition and a new conceptual orientation is inescapable.[36]

Bergson himself had developed ideas towards a new paradigm for physics (Papanicolaou and Gunter 1987, 12). In *Matter and Memory* he attempts to replace the atemporal – time-symmetric – world of Newtonian physics with a physics of real duration (1991, 9-10, 194-5). The idea originated in the missing link between the knowledge on microcosm and macrocosm. The problem of the inconsistency between the macrocosmic realm, which was explained through relativity theory, and the microcosmic realm, where Newtonian mechanics still had to rule, is similar to that of bridging the world of perception and the world of science that Whitehead (1955) wishes to take on in his *Process and Reality*. The idea later found its precise materialization in the new interpretation of Thermodynamics by 1977 Nobel Prize winner Prigogine.[37]

When *Order Out of Chaos*, originally titled *La Nouvelle Alliance*, was published in France in 1979, it really appeared in the science scene as a new perspective. The authors, Ilya Prigogine, and Isabelle Stengers, aspired to introduce the significance of thermodynamics to the non-physics communities. They remarked the significance of thermodynamics in its

---

36 Bergson's philosophy is much more broad and complex than I want to incorporate into my text.

37 See Appendix B. Prigogine and Stengers shared a particular line of thought with figures such as Bruno Latour,

explanation of the irreversibility of time with entropy and that Boltzman's theorem succeeded in describing the irreversible processes "that we create and live" unlike the classical dynamics and quantum mechanics had done. Their view, accordant with Whitehead and Bergson's ideas, and parallel to what Thomas Kuhn had started in 1970 with *The Structure of Scientific Revolutions*, demonstrated how social-philosophical context and technical content are both essential to a proper understanding of a scientific activity.

Pending questions are how one acts with the awareness when constructing and how one allows re-constructions? Through the incorporation of creative progress in becoming systems, the critique of the classical scientific method has produced some constructive criteria in the methods of producing knowledge. Alternative conceptions have been possible through seeing beyond the constructs, leaps across paradigms, falsifying theories, and subjective interventions. This constructive criticism also addressed issues of constraints in space production, i.e. geometry and general space-time conceptions. I especially bring these more recent critiques of scientific objectivity into the argument to further conceptualize the particular issues mentioned above, i.e. concepts of production across paradigms, creativity, and progress.

Rigid conceptions and striations are critiqued for not fulfilling the requirements of a becoming universe, and the criticisms are produced depending on the notion that we need to progress. So far, I have called attention to some of the problems and certain issues in space production that concerns creativity. To come is the line of critique and the compliant arguments in the scientific rhetoric. I believe these will make it possible to reiterate and further articulate the aspects of creative space from the earliest chapter.

Michel Serres, and Brian Massumi, Michael Hardt, Paul Bains, whom they "allied" with.

4 Making of Creative Space

Striae by sciences.

Throughout the preceding text, I have given emphasis to science as an initial source to space production, and have pointed out constraints that are coming precisely from that end i.e. constraints which correlated with the rationality of scientific concepts. It seems right to me now, to review how these problems have been addressed in the rhetoric of scientific method itself in order to understand the framework for production of space.[38]

Natural sciences, at the turn of the last century, incited questions about "the method" as traditional views on universal phenomena faced alternative theories. New perspectives and a new consciousness revised the inherited notion and gave rise to a critique: Scientific knowledge at the most, is only closer to truth, but never the Truth. Its reliability is in its method, which follows certain constructs of abstract and valid reference points.

The critique of classical science was mainly of its static systems that do not directly comply with our open-system universe. These static systems, mainly symbolized in Newtonian mechanics, fell apart over a long period of time in which quanta were defined, relativity was theorized, thermodynamics were formulated, and non-Euclidean geometries were proven. As the constructs were questioned through different perspectives, the methods were challenged as well. In this inquiry, the dichotomy of the linear and inventive[39] progress came forward. Kuhn's famous book *The Structure of Scientific Revolutions*, more than anything, stressed a concept known as paradigm-shift to reiterate inventive progress as opposed to linear progress along a paradigm.

---

[38] The earlier metaphor of points as acts/events applies to the arguments of methodology below. However, the act of producing [space] shifts into producing knowledge. This is mainly due to the fact that the methodology of scientific research is actually specific to knowledge production. Yet, this does not diffuse the argument. Firstly because scientific method and thought applies to all kinds of knowledge not only scientific, is applicable to almost every act, including our everyday life spatial experiences. As I have already pointed out in the previous section, it also gives way to the space-time conceptions. Secondly I have already assumed too much from space production in context with architecture, and have talked of it in a sense as knowledge production. Even if space production is more form based, I have reviewed mostly conceptions of space.

[39] I will simply use invention instead of creation here to comply with the terminology of science.

Science has been acknowledged as less creative because it is dependent on constructs. The critique of scientific method, which specifically addresses this issue, certainly does not map, but helps me understand the criteria that are significant in creative emergence of knowledge. My construction of a critique in space production in the previous chapter is in parallel with the late 20th century rhetoric in scientific methodology that I will trace below.

The historical and philosophical frame of the scientific method and its critique can actually be traced to the very recent day, from Descartes, Hegel and the Pragmatists, and through the Postmodern half of the 20th century. I have already covered the beginnings earlier in discussions of constructs in space production. Descartes signified strict intellectualization and rationalization in method. Hegel, on the other hand, has started the mainstream of the critique. The Pragmatists are significant as they distinguished intuition from the intellect and praised it over steady and closed systems, permanent formulas. They criticized the positivist thought behind the closed systems that are created temporarily in order to understand an object within given references.

Newtonian physics depicted a universe devoid of temporality. It described an absolute space that is accepted as motionless, and the mass particles exhibited no inner change. Motions, despite the discovery of Thermodynamics, were agreed to be reversible in principle. It was a deterministic world. It displayed the Laplacean vision that past, present and future are laid out simultaneously, forever unchanged for an all-calculating mind. Bergson had envisioned these before Heisenberg and Bohr.[40]

The arguments of the critique were eventually strengthened by more development in the natural sciences and the critique has grown to be more constructive. New interpretations of thermodynamics, and the emergence of becoming sciences for a becoming universe, were worth mentioning in this respect as well as to give the scientific setting in the second half of the 20th century.

---

[40] Bergson was writing in 1911, Heisenberg and Bohr appeared in the scene after 1913. For further reference in related topics in physics refer to The World of Physics. (Weaver 1987)

The method for *becoming* sciences has been mainly proposed in the arguments critiquing the absolute science. Below is the depiction of a part of this critique, namely of the method of the absolute science: objectivity.

On goals and methods in science.

An allied conception of the truth, implying a full consistency for all levels and far corners of existence, is what the scientists are hoping to carry out. The knowledge, developed and constantly expanded through science, must unify in order to satisfy a supposition of Truth. [Classical] scientific method has been developed accordant to this condition of unity with criteria such as universality and objectivity. Making predictions, writing hypotheses about truth, testing hypotheses for verification and induction partially comprise the scientific method being practiced in "search for truth" today.

One view of the notion [of unity of knowledge] is that unity is being continuously reformed, conditional of the revealed knowledge, rather than a rigid totality that is pre-known/assumed. As Lee Smolin (1997) argues, in his highly popularized book *Life of Cosmos,* the laws of the universe are evolving as well. The theories explaining a constantly altering world, or at least the methods in approaching these explanations, have to afford this constant change at the broader scale accordingly as well. This dynamic system of knowledge (acquired or to be acquired), under these circumstances cannot be a reductionist, or a deterministic totality. Progress, the methodology in such a vision seeks and eventually achieves, is not assessed with value according to a fixed goal/end.[41] This maps to the idea that static constructs will not serve this goal that I have introduced in the previous chapter.

Science, in order to pursue unified knowledge, has developed its methods accordingly. These methods of reaching at the truth are to follow objective, positivistic approach;[42] each

---

[41] Progress may be simply defined in comparing the sequential pairs. In such comparisons for scientific research, having attained success over the other, having addressed more problems, having accommodated more referential points is considered a progress. This statement surely assumes a lot in the criteria for such comparison, which are not clarified here. But these criteria are the subject matter of other broad discussions, about objectivity of "testing" in science and ought to be left out here in order not to get too skeptical. Questioning dissolves the problem at a certain point.

[42] This is in parallel with the criticism in the previous chapter.

problem is carefully specified, analyzed, and tested within its specific testing context, or domain of intervention, according to the universal methods. Objectivity stands as a common premise in scientific method, where the knowledge should correspond to a larger whole. Certain parameters have to hold common so that the facts are universally valid and accepted. This fits in an understanding of linear progress.

However, if goals of science are understood as such a becoming system, the method should be understood to be becoming accordingly. Impacts of subjective interventions constitute a major argument for advocates of a new perspective to scientific method.

In order to achieve a unified truth, science simplifies and generalizes facts, while applying them universally. Simplification, conducive for an efficient understanding, may easily result in reduction. And determinism rises simply in the preconceived notion of unity – of truth. It is the residue of biased perspectives regarding the end. This is precisely what Bergson has criticized in the intellect. Both reductionism and determinism relate to a methodology that does not detach itself from a static goal. However, the static ideals should be dispersed from methodology in pursuit of knowledge – unified or not – in order to refrain biased approaches.

Issues in a Constructive Critique of the Methods.

In the following paragraphs I will review certain issues in the late 20th century [Postmodernist] in science and how its arguments confront the objective method. [43] A different methodology to that of the classical sciences emerges from this tradition. An account of subjectivity leads to the concept of differentiation (and then maybe

---

[43] This whole discussion of the method could also be taken into consideration in the context of Postmodernism. It would certainly be a full discussion within itself. Below are some of my reflections: Postmodernism is commonly regarded as a rightful reaction to the "monotony" of a universal Modernist vision of the world. Generally perceived as positivistic, technocentric, and rationalistic, universal Modernism has been identified as being astringent to linear progress, absolute truths, the rational planning of certain idealized social orders, and the standardization of knowledge and production. Post-modernism, on the other hand, claims liberating forces such as "heterogeneity (pluralism) and difference" in a redefinition of cultural discourse. "Advanced" Post-modernism, as I name it, frees itself from the aggressive perspective towards Modernism. It is more ideology-free and autonomous in that sense. Its sophistication, developed along the contemporary social premises, comes from its unique rationale reconciliation among virtues of Modernism (such as futuristic progress) and the unavoidable contextualism within the Post-modernist trends. It is simultaneously critical of both Modernism and the early stage reactionist Post-modernism.

fragmentation). Here are some issues introduced for scientific method in reference to overcoming limitations of constructs, especially those resulting from an absolute objectivity. These issues lead to a fragmentative methodology which supports the creative progress discussed earlier:

Falsificationism-

Lakatos (1970) reflects that "a theory is 'scientific' [only] if one is prepared to specify in advance a crucial experiment (or observation) which can falsify it..."

"Falsification" rises out of a critical approach to reductionism and totalitarianism – dogmatic positivism.[44] To begin with, it is essential to define falsifiability. Falsifiability is a logical notion: a sentence or statement is falsifiable if it is incompatible with some clearly defined basic statements representing possible observations. When a theory T1 is tested in experiment E1 and the results of E1 turn out not to be as expected, T1 is to be revised. The British philosopher Karl Popper (1962) has proposed falsifiability as a "criterion of demarcation," to separate scientific assertions from nonscientific assertions. Falsifiability is shown to be a condition of scientific progress, in this sense.

Falsification is, then, deciding that a falsifiable sentence is false, depending on methodological rules given that certain observations are made. Demarcation between science and non-science is determined by falsifiability or refutability, and the method of science is one of looking for refutations or falsifying data for conjectural hypotheses or theories.[45] The success of science depends on its construction of falsifiable theories. Through falsification, it is possible to retain the critical perspective in quest for

---

[44] The major background problem for understanding falsifiability was explicitly raised by the logical positivists. Such views were discussed between 1917 and 1930. Their intention was to reconstruct legitimate scientific knowledge only in terms of what could be proved true by inescapable facts and incontrovertible assumptions, modern symbolic logic being their major tool. Popper discarded dogmatic falsificationism of this view and revised the method.

[45] Refutability is a slightly narrower technical notion because we can refute a theory by proving a contradiction in it, but we falsify either by proving contradiction or by finding falsifying data determined by the relevant methodological rules. In Conjectures and Refutations, Popper (1962) suggests that induction cannot sustain the discovery of laws and theories (against Positivists), but lawlike hypotheses can still be subjected to severe tests by attempting to refute them. Those that withstand the best efforts of the scientist to show that they are false are the best guesses about what is true. However that they have withstood these efforts provides them no guarantee of truth, because the scientist may have not yet discovered how to refute them.

truth. Theories, in acquisition of falsification, are to be challenged by "severe testing." Popper argues that we learn from our errors. Once a theory is falsified and error eliminated, we are nearer a correct theory with greater verisimilitude – truthlikeness. The more errors we make, the greater progress we are likely to make.

Sometimes, scientists will not reject a theory that has been apparently falsified by data, because it still is in close approximation to the data to be useful in solving problems and no alternative non-falsified theory has yet been constructed to replace the falsified theory. On Popper's contrasting view, a reproducible false observation should simply falsify a theory. In an example according to this view, Newton's theory, while paradigm example of a falsifiable theory now should be considered falsified. Einstein's theory has replaced and corrected it. Can Newton's theory no longer function in scientific explanations? On the contrary, it is a fact that Newtonian mechanics is used by scientists in solving certain problems, and is not treated in history books as a fallacy.

Thomas Kuhn (1962), the American historian and philosopher of science, has contrasted the Popperian view. A theory is never regarded as falsified until a better theory is found to replace it. The Kuhnian standpoint is that of "incommensurability," which is the relationship between two theories or "paradigms" when one cannot be understood in terms of the other. A theory is thus not given up until there is a replacement theory, provided that the theory can still be regarded as useful in explaining and predicting a wide range of data.[46]

There is one very important issue that I want to underline here. An accepted theory/paradigm is – and should be – abandoned for another theory/paradigm only when the new theory/paradigm improves upon the old by explaining the same old phenomena and *at least* some of the anomalies unexplained by the old one. Until these conditions are fulfilled by a new theory, the old theory will exist. This means numerous theories/paradigms might exist simultaneously. Each theory/paradigm is accepted as consistent within itself and is available as source. To go back to my earlier examples, even though the foundation of non-Euclidean geometries refuted the solitude of the Euclidean geometry, Euclidean geometry did not drop out of use.

An important idea is that the knowledge we have is not determined or constrained by what we have knowledge of. One must see that correct or true or viable knowledge comes in sets of alternatives. One can describe the planetary system by Newtonian mechanics or Einstein's General Theory of Relativity. When there are alternatives, the succession of alternative views constitutes the historical dimension of knowledge.

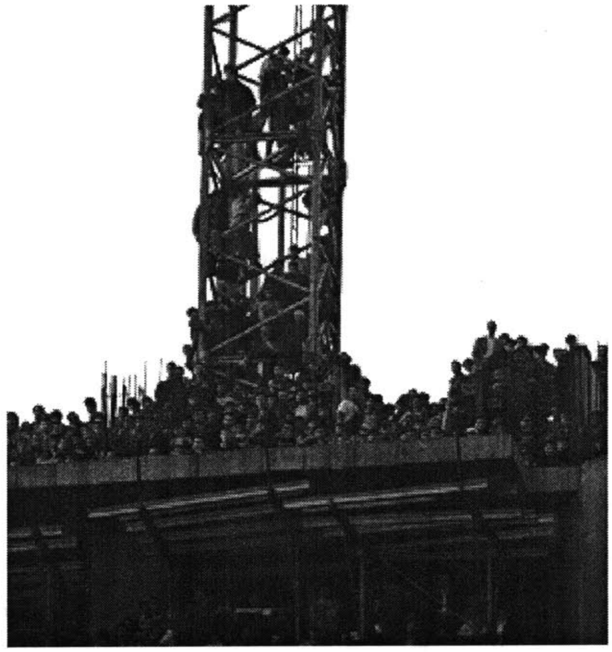
Moreover, as long as we are *not* adapting to a new theory, and only to that theory, which does not fulfill the given condition above of improving upon the old, we build up a memory – of falsified theories in the case of science. We do not discard anything unless we know for sure that there is something to "replace" it, and thus never start from scratch. We might prefer the new to the old ones for obvious reasons, but we acknowledge all of them simultaneously (until they are replaced with new ones). Such a paradigm shift is never a *tabula rasa.* This is concordant with my idea of multiple constructs. We do not necessarily abandon our accustomed ways of thinking if we want to question and eventually construct alternative paradigms. Even then, once we have constructed such a conception, we don't need to strictly choose between. If the new paradigm is not replacing the existent one, then we can choose to see them as compatible theories forever.

The Hungarian born scientist Imre Lakatos' idea of research programs extends this understanding in a different way that is useful for our use of the concept of paradigms. His falsificationism appraises a theory only in terms of a sequence it belongs to (1970). That sequence could either be one of theories that is generating new facts – i.e. a sequence of linked theories that gradually becomes falsifiable in new ways – or one that is on the contrary, not doing so but gradually restricting its scope instead.

This maps to the linear progress, which eventually diminishes the creative attribute of inventions. The "gradually restricted scope" is residue of a linear build-up, which negates what has been falsified, and is assumed to be eventually getting closer to the Truth which does not exist as a rigid ideal to start with.

---

[46] This accords very much with the idea discussed under the Word Machine.



Crowd looks down on a stadium during a soccer game in Istanbul, as they transform the scaffold and the crane which in fact were intended for the construction of a skyscraper on a neighboring site.

From Kerem Yazgan, Olay, Programlanmis Mekan, Mimar in *Mimarlik* no.272, Nov. 1996, 31.

Lakatos, through his methodology of research programs, suggests that the unit of science is neither the individual scientist, as Popper proposes, nor the entire community, as Kuhn maintains, but rather groups of scientists who pursue programs of research.

Emphasis put on subject-

-social subject

To explain falsification above, I had given the following statement: When a theory T1 is tested in experiment E1 and the results of E1 turn out not to be as expected, T1 is to be revised. Let us assume for now that the observations of E1 are reliable, and T1 is definitely falsified. A case could be, that it might not be T1 that is failing but the background knowledge it built its predictions upon. In a very straightforward description, this background is formed of the previous decisions, assumptions and accepted customs. These decisions are taken by the whole scientific community (Kuhn 1962) or a group of scientists in a specific research program (Lakatos 1970). For reasons of clarity, I will adhere to the notion of "community" which Kuhn remarks.[47]

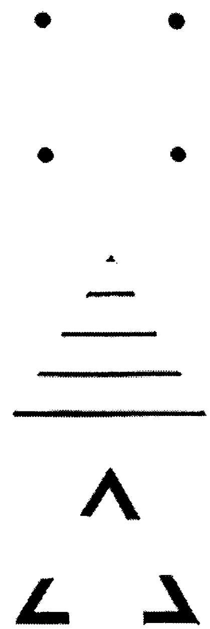
Kuhn (1977) introduces notions of "decision making[48]" and subjective interventions in science and thus a cultural formation upon these. Questioning the selection process between any theories T1 and T2, he inserts *desideratum* as the relevant criteria for choosing the better. A choice on a better theory is necessary for Kuhn to proceed with the next step. That better theory which is selected by the scientific community, is to be the subject matter of research in the upcoming "normal science."[49] These criteria for the "better theory" are accuracy,

---

[47] Lakatos and Kuhn disagree on the degree of effect of culturally formed subject in scientific research. Kuhn emphasizes the social subject whereas Lakatos' agenda is shaped around of programs of research and the notion of hard-core.

[48] As Pickering (1984) has remarked, in Kuhn's theorizing, science is incommensurable if each theory is relevant or true in its own phenomenal domain. This is similar to "hard-core" theory of Lakatos, and nonetheless the pluralistic tendency.

[49] Kuhn distinguishes between revolutionary and normal sciences in The Structure of Scientific Revolutions. Normal science is the science where theories are being nurtured in an effort to eradicate any anomalies they confront. This, in my terms, would coincide with linear progress. Unlike me, Kuhn does not indicate a preference towards the "revolutionary." I would suggest that is due to the distinction between the content matter and aims of the two different inquiries of science and design. In design inquiry, it is more a matter of concern for progress that an act is creative/revolutionary. Of course, still, this usage of "revolution" is still attached to the idea of preserving the existent in some way. Another minor note related to the upcoming sections of this chapter, is that in Feyerabend's literature, the pluralism he praises is associated with crises/revolutions.



"A psychological filling-out of the intervals between the units occurs and one constructs latent connection."

From Gyorgy Kepes, *Language of Vision* [New York: Dover Publications, Inc. 1995; originally Chicago: Paul Theobald, 1944], 51.

consistency, broad scope, simplicity, and fruitfulness. Even if the concept of having desideratum is objective, the argument is that the desiderata themselves actually imply the role of subjects -the scientists- in scientific progress.[50] In this framework, the decisions are dependent on social, cultural background information. They include individuals, interaction among individuals, a consensus for the interactions, and thus form a history and are manipulated within that history and culture. The fact that the scientific community decides on which part of the system is failing, and which theory is going to be preferred over another, associates science with a cultural formation.

As mentioned earlier, Lakatos' point of view is slightly different than this scientific community which decides together upon certain presumed criteria. In his scheme, there can exist MANY scientific programs within the system, without having to choose from among one over the other. This is similar but slightly different than choosing between theories. He constructs each research program, with a "hard-core" around which hypotheses are modified. Auxiliary hypotheses are under modification where necessary, to accommodate this hard-core. As long as the hard-core is there and legitimate, only the *buffer* theories are under reconstruction where necessary. Further, out of competition and comparison of different scientific research programs, the science gains efficiency in terms of success. [51]

The hard-core is particular to the program it belongs to. Each is "accepted by conventions," and is valid within its context. The underlying structure is of historical, cultural character, building upon the relations within and between these different conventions. In this pluralist idea of validating through context, and subscribing to "particularity in each" problem situation, "anything goes".[52]

And, since *anything goes* – although I advocate that it doesn't really – I will praise such a pluralism for now, and even extend the notion through Feyerabend's arguments. I feel the multiplicity of different programs is significant to my arguments.

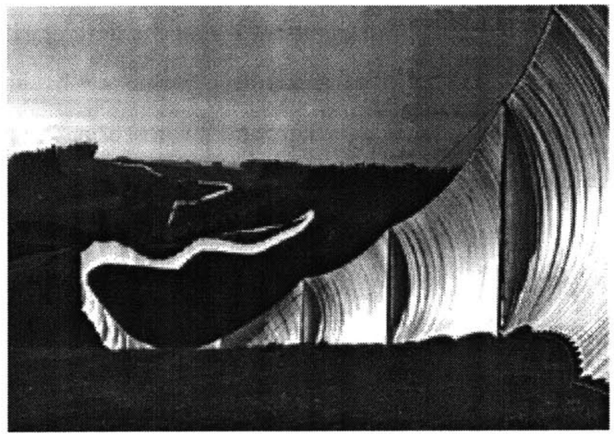
---

[50] This point about science being a culturally unique social production can also be found in Laudan's writings.

[51] I will reiterate this in the upcoming discussions on Feyerabend's alternatives and different co-existent fragments of a system.

[52] Feyerabend's slogan that I will eventually come to in the flow of this text:

> The only principle that does not inhibit progress is: anything goes. (Feyerabend 1975, 23)



[Anarchic subject] Christo, Running Fence, Sonoma and Manin counties, California 1972-76.. From James Wines, *De-architecture* [New York: Rizzoli International Publications, Inc. 1987], 97.

-perceptive/cognitive subject

There is another important facet to this issue of subjective input in science. Before it comes to selecting between theories, the scientist already has a subjective input to the theory (Pickering, 1984). Let's go back to the example of the falsified theory T1 dependent on results of E1. Can scientific judgment can based on experimental facts, and should the observation reports for experiments be accepted as objective facts? In addition to the validity of observations -as determined by Kuhn's selection criteria- the interpretations in those observations are highly subjective as well.[53] Pickering's answers to questions about the process, conclude that the theory development almost has a life of its own and the dynamics of theory formulation are inevitably dependent on particular cultural resources at all levels (1984, 403-14).

-anarchic subject

I have been discussing above the socially identified scientist (community of science) and the individual within a group of scientists working on a particular research program(Kuhn 1962; Lakatos 1970). The individual subject, that concerns me most in an argument about creativity, is emerging in Feyerabend's writings. Feyerabend stresses a *conscious subjectivity*, rather than the one involved and identified within the collective social-cultural context. Progress suddenly complies with concepts of anarchism and (more) pluralism. It is defined as loosely as liberalism. It is not only a historical fact that the practical reference between idea and action should be "liberal" but it is an "absolute" necessity for progressive growth of knowledge. Feyerabend reflects that progress is in "any one of the senses one cares to choose." So, scientific development is a choice. Building arguments mainly upon the epistemology of falsification, Feyerabend asserts that progress in science has been existing so far, due to all those who have refused to consist with the limits of methodological rules. "The invention of atomism, the Copernican revolution, the rise of modern atomism through kinetic theory; dispersion theory; stereochemistry; quantum theory" have all emerged out of a *negation* (I see this similar to falsification) (Feyerabend 1975, 23). All these "unwittingly"

---

[53] The cognitive particularities to observations have been widely discussed by Hanson (1965) in his book Patterns of Discovery.

broke the obvious methodological rules.[54] The rules that are broken are not those of the testing procedures or the degree of objectivity in scientific proceeding, but rather of the general coherence and meta-narratives.

> There is not a single rule, however plausible, and however firmly grounded in epistemology, that is not violated at some time or other... [S]uch violations are not accidental events, they are not results of insufficient knowledge or of inattention which might have been avoided. On the contrary, we see that they are necessary for progress. (Feyerabend 1975, 23)

Feyerabend advocates to invent, and elaborate, theories that are inconsistent with the conventional view, even if this view is ratified and agreed on. (Preston 1997, 138) This is a slightly aggressive version of Kubler's invention versus convention argument.

Negating the idea of a consistent whole is supportive of Feyerabend's arguments. The agglomerate structure of science surely requires continuity, and this continuity largely grounds in consistency. However, there is always a risk for a tendency to preserve the older theory and build upon it instead of starting a better theory. Furthermore, Feyerabend (1962) argues that a fixed theory of rationality rests on the craving for "intellectual security" in the form of clarity and disregards the rich material provided by the social human history.[55] Anyone can read the terms in his own way and in accordance with the tradition to which he belongs.

In empirical approach, the success of a theory is the agreement between data and theory. Then the disagreement between the two implies the elimination of the theory. Feyerabend instead, proposes a "pluralistic methodology" where the scientist has to take other views

---

[54] After the 70s Feyerabend came to embrace the relativist views, that there is no single rationality, no unique way of attaining knowledge, and no single body of truth. His main theme was the non-existence of scientific method. (Preston 1997, 7)

[55] Feyerabend puts forward his critique against the conformism in science below:

> [Modern science] is the result of a conscious criticism of the theses propagated and the methods employed by the great majority of scholastic philosophers. For the thinker who demands that a subject being judged 'according to its own standards', such criticism is of course impossible; he will be strongly inclined to reject any interference and to 'leave everything as it is.' (1962, 61-2)

Here, I would also like to remind the previous sections on critique of radical intellectualism.

into consideration, which comparatively will pursue him to understand clearly his theory's standpoint and expand the empirical content of his view. His prejudices are revealed out of contrast not analysis.

In agreement with this I propose that knowledge should not be seen as a gradual approach to truth. It is not a series of self-consistent theories, which converges towards an ideal view. It is an increasing entity of incompatible and "incommensurable" alternatives. A process of competition and increasing stimuli for greater articulation develops our cognizance [of truth]. The notion of the whole is sustained by a search for the truth where the trivial "[weaker] case is made to be stronger". This brings the argument to one of my main points that the goal [of knowledge] is not the Truth, or in a context that concerns me more, the goal of understanding space is not to come up with one fixed conception but sustaining constantly evolving creative space(s). Creative space(s) allow the potential cases along with the existent strong ones. The individuals are recognized with their particular intrinsic potential.

A System of *different* fragments

Similar to the arguments made earlier regarding conceptions of space, the aim here is to suggest the possibility of liberation from irrelevant/limiting constraints. Feyerabend's argument comes close to certain aspects of creativity I have earlier discussed such as multiplicity and co-existence of *points*, although it is far more aggressive.

> The only principle that does not inhibit progress is: anything goes.
> (Feyerabend 1975, 23)

Legitimacy in anarchic pluralism – fragmentation through differentiation-

Anything cannot go.

> ...working on a proof means searching for and "inventing" counterexamples, in other words, the unintelligible; supporting an argument means looking for a paradox and legitimating it with new rules in the games of reasoning. ...efficiency... comes sometimes tardily, as an extra...what never fails to come and come again, with every new theory,

> new hypothesis, new statement, or new observation, is the question of legitimacy:... `What is your `what is it worth?' worth? (Lyotard 1984, 54)

"Anything goes" is another type of conformism, and I take a stand against it. Yet, the endorsement of pluralism still holds. Here is how it is possible: As Lakatos had presumed, multiple research programs evolve around a legitimizing/legitimized hard-core. A hard-core should be legitimized in terms of creativity, and progress.[56] Anything goes only if it is legitimate. The particularity of a context is shaping the particularity of the object. And the object can be legitimized within its relevant context. By this though, I encounter more questions. What might the criteria of being in "context" be? Aspects such as efficiency and performativity in the case of design could be defining a context. These are rational feedback. There are also I assume inputs different to a rationality that will define the context, like morality. I think these questions are interesting to be dealt with, hopefully in subsequent research. For now I will assume that a context, defined for each particular object, consists of other objects "close in relation."[57]

Multiplicities-

Knowledge is categorized in order to be processed further. This rationalized taxonomy requires that the scientists specialize accordingly. Scientific research is divided into categorized and specialized topics, first of all, in order to work within a more controllable range of problems. Science requires this fragmentation to proceed. Thus, the method acquires fragmentation. It proceeds onto the goal of unity within this fragmentative structure.

---

[56] It has to be legitimized in terms of not simply progress but practical, cognitive, conceptual, and explanatory progress. (Kitcher, 1993)

[57] At this point, I want to bring into attention Whitehead's views on relativity he explains in the Concept of Nature. "It [theory of relativity] is not the usual way we think of the Universe. We think of one necessary time-system and one necessary space. According to the new theory, there are an indefinite number of discordant time-series and an indefinite number of distinct spaces. Any correlated pair, a time-system and a space-system, will do in which to fit our description of the Universe" (1964, 178). What he writes of creative advance in relation to this definition is very similar to my model of creative progress developing in and out of fragments. Whitehead acknowledges that our measurements, i.e. rationalization and quantification of experiments, are necessarily made in some one pair, which together form our natural measure-system. He resolves the difficulty of conceiving the existence of discordant time-systems "partially" by distinguishing between the non-serial "creative advance of nature" and one time series. The single-time series, he suggests, is what we experience and employ for measurement. And the difference between two single-time series and the measure in each for some aspect of

Although its fragmentative aspect seems obvious to hold significance in an investigation of how fragmentative methodology diverges from the unifying goal, this issue of specialization is actually significant to my discussion in another way. There are two types of fragmentation, and we need to apprehend the differentiation between the two in order to back an argument about a progressive fragmentative methodology. If we were to associate with categorization and/or specialization a quantitative fragmentation as implied by the fact that there are numbers of scientific research programs working in different domains, it shall help us to conceive an inverse concept of a qualitative fragmentation.

This distinction between qualitative and quantitative fragmentation is reenacting a theory of multiplicities. The relevance is that fragmentation, as I refer to it, brings multiplicity. G. B. R. Riemann, both a physicist and mathematician, has defined multiplicities in two headings (Deleuze 1988, 39). [58] One is determined in terms of its dimensions and the other of its independent variables. What he identifies as discrete and continuous forms of multiplication also appear in Bergson's distinction of two types of multiplicity. The numerical, discrete and quantitative multiplication is a process of dividing into more and more in numbers without changing in kind. This identifies with the fragmentation behind specialized scientific research as asserted above. In continuous and qualitative multiplicity, the division is non-numerical, where the dividing part "differs," in kind. I aim to dwell on this particular type of "differentiating" multiplication in the methodology for research programs. Such a fragmentation subsists of altering divisions. Differentiating theories perpetuates the increase in the number of programs. And such a process is in line with what will later be discussed about a fragmenting and progressivist methodology.[59]

---

creative advance might be very small indeed. But, be the difference big or small, Whitehead proposes that we "bundle" these and the bundle expresses all the measurable properties of the advance.

[58] Riemann differentiates between two types of multiplicities: discrete and continuous -or qualitative/heterogeneous and quantitative homogeneous. The continuous multiplicity, in Bergson-Deleuze's point of view, seems to belong to the discussions of duration. Duration for Bergson is "that which divided only by changing in kind, that which was susceptible to measurement only by varying its metrical principle at each stage of the division. (cited in Deleuze, 1988, p. 39) On the other hand, there are the discontinuous actual multiplicities in one homogeneous space. Deleuze refers to this other type of multiplicity as represented by a homogeneous space/time, and "numerical multiplicity, discontinuous and actual."

[59] Here I want to recall the previous discussion on inventions and their positive role in paradigm shifts. That discussion was implying that creative act is qualitative differentiation.

In the previous section I have already talked in a sense about a fragmentation while discussing the diffusion into multiple contexts, each of which is legitimate for the particular individual(s). This fragmentation by legitimizing implies a "differentiation" in such a way that, each fragment, a research program brought upon evidence, is valid in its exposition/approximation of the truth. [60] The ideal is refined constantly in this diffusion. The multiplicity of construction is the premise of progress towards a unity of truth as an ideal, where "one explanation [instead] might [have been] be the falsity of reductionism."

Progress in a becoming system of "different" fragments:

> Criticism must use alternatives. Alternatives will be the more efficient the more radically they differ from the point of view to be investigated. It is bound to happen then, that the alternatives do not share a single statement with the theories they criticize. (Feyerabend 1963, 7-8)

If the idea of falsification is followed to the extent that one does not erase but negates, it is a constructive path. Its implication is the significance of having alternatives.

> Now it is surely reasonable to demand that the class of refuting instances of a given theory be made as large as possible and that especially those facts which belong to the empirical content of the theory, which refute the theory but which cannot be distinguished from similar, but confirming facts, be separated from the latter and be thus made visible. However, this means that, given P(n), it is reasonable to use not only (x)Px, but as many alternatives as possible. This is the promised refutation of the modified generalization hypothesis. (Feyerabend 1964, 206)

The idea of differentiated fragments ["theories" as Feyerabend discusses above] infers that the *becoming* proceeds through differentiation amounting to the creation of the new. This creation of the new is a perpetual creation of differences, or a production of divergences.

---

[60] Although there is no direct link to my discussions, I want to mention the work of the Deconstructivists where the idea of fragmentation has been a maxim. Starting with an anarchic literature, where the text does not have a single reading anymore, as the "meaning differs along with the altering reader, the main idea of "differentiated fragments" resolved into institutions such as fine arts and architecture which dealt with "language."

This logic of invention implies a model of "creative evolution" which is amplified in Bergson's line of thought.

The differentiation inherent in the continuous creation process, as augmented above, brings in a multiplicity as I have identified before as a "qualitative multiplicity." It is made up of "elements in fusion" and accepts the new into its becoming. These new elements are necessarily heterogeneous in this definition of multiplicity as each differs from that which proceeds it. This differentiation is what designates the multiplicity as qualitative. The concept of multiplicities explains the co-existence of fragments, which also evolve together. It presumes a process that does not require an end. Continuous invention is the vital element of evolution, which is a well-observed model of existence, therefore of becoming.

How is [creative] progress possible through diversities? What makes it more valuable, or more valid? Both questions could be answered with the following: the more a theory takes into account and succeeds to bring together, the more valid it is to be; it addresses more issues. I also want to name this particularity as "complexity." Furthermore, in totality, this is not a static entity. The diversity of its components brings in dynamism.

The institution of science is a system building up a history and culture that emerges from dynamic processes among its pieces. The pieces, referred to here, are the research programs each of which are legitimized around what Lakatos calls "a hard-core." They do not have to interact negatively; the multiplication of research programs within a system can also be qualitative meaning they can exist as compatible alternatives for each other. The differentiative aspect of the process of multiplication in research is the promise of progress. Such a system is not linearly deterministic but open to successions and failures and thus progress, consequential to competence of different acts of creativity. The compatibility in between fragments challenges and enhances the perceptive sensibility of the individual. The necessity of such an understanding of progressive methodology holds for any institution of social production.

Such a system involves a progressive process that is agglomerating and creatively digressing. The knowledge has to accumulate in order to expand. However, the expansion is through alternatives. The accumulation is non-linear as in Swift's Word Machine. There is no predetermined unity but an open system of multiple components and multiple relations between components. The indeterminacy of the next phase, or more correctly its dependence on the current state of the complex system that is evolving in time, is reminiscent of the geometry of points. The method here implies "differentiation" among its qualitatively multiplying/increasing fragments. This way, the system is exposed to more criticism and is able to evolve.

Architectural design is concerned with production – of knowledge – particularly of space and the key characteristic of this production should be creativity, as it is [progress] for sciences. I believe the previous discussions of a creative progress, which is to complement its linear version applied in positivist sciences, shed light onto this process in architecture. The becoming system of different fragments and its progressive growth are relevant to architectural productions as much as or even more than they are for scientific productions.

I would like to reiterate that this thesis is not suggesting a fast-pace progress of ephemeral steps. It is also not advocating a constant negation of the existent body at each step. Each step is constructed upon the existent components. Nonetheless, the relations between the components are reconsidered each time in order to "create" new components.

Postscript

I have observed that the customary conceptions of space, such as the Cartesian geometry, do not suffice the task of mediating between the space and the inhabitant in terms of creative acts. The system that includes all these constantly evolves, whereas the mediating tools remain fixed. Instead, the mediators should accord with the becoming system. I have suggested that a particular version of progress, namely a creative one, is necessary to conceive them as such.

My intention has not been to prescribe a methodology for creative acts. However, I have proposed some criteria and argued that these are crucial in acquiring creative acts.

I have defined actions of the envisioned creative space as sustaining progress in a becoming system. And I have proposed the mechanisms for these as *falsification* and *emphasis of the subject*. I have posited that it is necessary to follow these criteria to form and sustain a creative space. Nonetheless these criteria do not sufficiently define a methodology for creative acts by themselves.

I have extracted the two criteria out of contemporary rhetoric on scientific method where the aim is to change the customary understanding of progress (linear) and adapt the scientific research to the becoming system it attempts to explain. I have brought together the philosophies of creation in art and architecture and those of research in sciences. The general critique that is constituted of the issues of the becoming system and progress holds common to both space and knowledge production.

This cross-disciplinary research could expand, based on the arguments and the footnotes, for circumstantial apprehension of the philosophies I have cited here as well as others in the same line. Aside from this, further grasp is needed regarding the traditional as well as alternative scientific configurations and conceptions of space, including those with which architects operate in design. I believe that through these, the inquiry will shift to the possibility of operating becoming methodologies in representations of space and form production, and materializing of these.

First page of first printed edition of Euclid's *Elements*, 1482.
From Thomas F. Banchoff, *Beyond the Third Dimension: Geometry, Computer Graphics, and Higher Dimensions* [New York: Scientific American Library, 1995], 180.

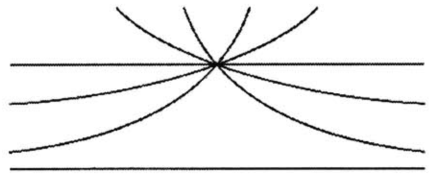
Appendix A

Euclidean geometry.

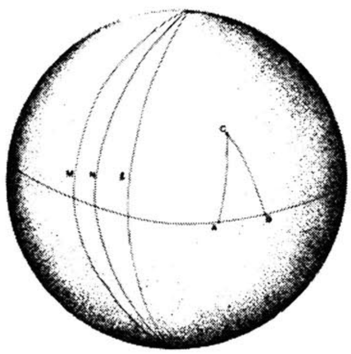
Helmholtz gives an introduction on axioms in his 1870 essay.

> Anyone who has entered the gates of the first elementary axioms of geometry, that is, the mathematical doctrine of space, finds on his path that unbroken chain of conclusions, by which the ever more varied and more complicated figures are brought within the domain of law. But even in their first elements certain principles are laid down, with respect to which geometry confesses that she cannot prove them, and can only assume that anyone who understands the essence of these principles will at once admit their correctness. These are so-called axioms.
>
> For example, the proposition that if the shortest line drawn between two points is called a straight line, there can be only one such straight line. again, it is an axiom that through any three points in space, not lying in a straight line, a plane may be drawn, i.e. a surface which will wholly include every straight line joining any two of its points. Another axiom, about which there has been much discussion, affirms that through a point lying without a straight line only one straight line can be drawn parallel to the first; two straight lines that lie in the same plane and never meet, however far they may be produced, being called parallel. There are also axioms that determine the number of dimensions of space and its surfaces, lines and points, how they are continuous; as in the propositions, that a solid is bounded by a surface, a surface by a line and a line by point, that the point is indivisible, that by the [perpendicular] movement of a point a line is described, by that of a line a line or a surface, by that of a surface a surface or a solid, but by the movement of a solid a solid and nothing else is described. (1995, 227)

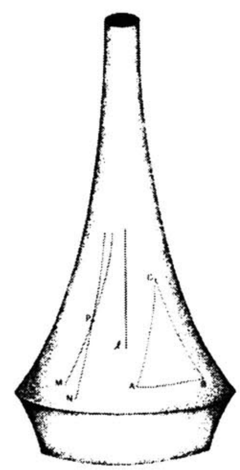
These are the basic axioms of the Euclidean geometry. The important idea amidst the technical knowledge is that geometry of axioms unlike the natural sciences does not



The axiom of parallels faces an alternative in hyperbolic geometry. There are many lines going through a point – that is not on a given line – that do not meet that given line.
From Thomas F. Banchoff, *Beyond the Third Dimension: Geometry, Computer Graphics, and Higher Dimensions* [New York: Scientific American Library, 1995], 180.



Riemannian Geometry represented in a Sphere. Lines such as l M and N – that pass through the two poles – will always intersect. The sum of the angles of triangle ABC is larger than 180°.



Beltrami's Pseudosphere for the Lobachevsky-Bolyai Geometry. Lines M and N, through point P approach line l, but never intersect it. The sum of the angles of triangle ABC is smaller than 180°.

Both images from Linda D. Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art* [Princeton, NJ: Princetion University Press, 1983], Plates 2 and 1.

necessarily associate with collecting experimental facts. Its method is deduction and the chain of conclusions Helmholtz talks of holds as the set of principles.

Non-Euclidean geometries.

With Karl Friedrich Gauss in 1824,[61] and other contemporary scholars such as Bolyai and Lobachevsky in 1829, the notion of a new surface geometry appeared, which is on the whole similar to that of the plane in the Euclidean geometry but in which the axiom of parallels does not hold good.

The axiom of the parallels was the following:

> That if a straight line falling on two straight lines make the interior angles on the same side less than two right angles, the straight lines, if produced infinitely, meet on that side on which are the angles less than two right angles. Through a given point can be drawn only one parallel to a given line. (Heath 1926, 155)

The axiom that Bolyai-Lobachevksy chose stated "through a given point not on a given line, more than one line can be drawn not intersecting the given line" in such a geometry an infinite number of lines can be drawn through a point and although these lines may approach a given line as they extend to infinity they will never intersect it (Henderson 1983, 4). On the same postulate of parallels, Georg Friedrich Bernhard Riemann developed and published in 1867 another alternative to Euclid's geometry. It is a geometry of constant positive curvatures, as opposed to the negative curvatures of Lobachevsky-Bolyai geometry. He defined a "finite" space where the line could not be extended to infinity as Euclid had assumed. And a line, represented and defined by a circle on the surface of a sphere such that it goes through the poles, would not ever have a parallel. This was particularly of interest because it shed light on a missing link that space beyond our immediate perceptions might be curved. This invalidates the linear perspective system, which already looks false.

---

[61] Henderson reflects that Gauss had never published his thoughts but this is roughly the date he concluded that alternative geometries to Euclid's must be possible (1983, 4).

New systems of geometry which exclude the particular axiom were devised on Euclid's synthetic – artificial – method and were proved to be as consistent as Euclidean. It was clear that there could be other systems, such as these spherical and pseudo spherical surfaces as long as they were consistent.

At a broader scope Riemann suggested geometry as a study of manifolds of any number of dimensions and of any curvature. This contribution of his to the emergence of n dimensional geometries has already been embedded within the text itself.

Multi-dimensional spaces.

Helmholtz summarizes Riemann's contribution in the discussions of multiple dimensional conceptions:

> the number of measurements necessary to give the position of a point, is equal to the number of dimensions of the space in question. In a line the distance from one fixed point is sufficient, that is to say, one quantity; in a surface the distances from two fixed points must be given; in space, the distances from three; or we require, as on the earth, longitude, latitude, and height above the sea, or, as is usual in analytical geometry, the distances from three co-ordinate planes. Riemann calls a system of differences in which one thing can be determined by n measurements an 'nfold extended aggregate' or an 'aggregate of n dimensions.'

This is applicable to more than just to space. For example Helmholtz points out that the system of colors is an aggregate of three dimensions, that can be represented as a mixture of three primary colors. Of course, time is an aggregate of one dimension. In theory of relativity space-time is a fourfold aggregate. Within the text, I had also given the example of the 6n space in kinetic theory.

Appendix B

Becoming sciences: New interpretation of Thermodynamics by Ilya Prigogine and Isabelle Stengers.

In early 1800s, there was no acquaintance with atoms and microscopic formations of matter. Scientific knowledge was formulated in terms of macroscopic parameters, whose relations were determined empirically. A dilute gas confined in a volume could be described in terms of three parameters: Pressure, Volume, and Temperature.

$$PV=N(k)T$$

Aside from these observable parameters, a fourth was energy. It was not an observable quantity like the other three, but a theoretical construct. The interplay between these three measures and the energy are given in thermodynamical equations.

Thermodynamic theory is based on (one-plus-)three laws: [0. Existence of temperature: a measure for equilibrium states in contact,] 1. The conservation of energy: Carnot in 1824, observed that some of the energy conserved during physical changes of matter, is released. This observation lead to the second law, 2. Entropy: entropy was first introduced by Clausius in 1854, who conceptualized it as the "transformable content of a system's heat." The law states that the entropy of the universe tends towards a maximum, 3. The final law of thermodynamics is the one that concerns us the least. It is a special case that entropy vanishes as temperature goes to zero. (There is no entropy at zero temperature.)

These laws did not provide an understanding of the universe at a microscopic level and lacked explanations concerning the relation between different scales of life. In Boltzman's reinterpretation of 1870s, the second law was related to the dynamics of microscopic particles. (Then, entropy was associated with the particle's degree of freedom.) Newton's classical mechanics were applied to gas particles. That way the behavior of each particle would have been determined according to universal laws. However, for 10^{23} particles in the universe, this was a formidable task. Thus, instead of applying it to every single particle, Boltzman applied classic mechanics to a probability distribution function for particles.[62] In doing so, he combined Newton's equations governing the dynamics of individual particles with a probabilistic description for a system of particles. With these microscopic applications of probability, he managed to define a function that is non-decreasing in time.

$$H=\int f \log f$$

Classic mechanics formulations do not allow us to detect a direction for flow of time in observing events. Its equations are time-symmetric. If we were observing a forward and a backward video run of two balls colliding, we would not be able to identify the difference in between; such a collision is time-reversible. But "if only reversible trajectories existed, where would the irreversible processes that we create and live come from?"

Boltzman formulated in his H function that in the course of time, all physical systems isolated from external feeds (closed system starting with a certain initial condition) evolve toward more probable states. With the H-theorem, given two random snapshots out of the time flow of one system, one can determine which precedes the other. Boltzman's contribution is the resolving of the dilemma between time-symmetric laws governing the universe, and the direction of "lived" time.

Entropy now is defined as a measure of the probability of a system being in a specific state, with respect to a better-ordered state of the system. Consider an isolated system with an initial arrangement. Let's assume that all the molecules are squeezed in the upper left corner of a volume, and let them evolve. Given all the possible states of these molecules in that volume, this initial state is a very atypical configuration (of low probability). This state is expected to evolve in time into a more typical configuration (of high probability). In contrast to atypical states, a typical state would be when molecules "uniformly" cover the volume of the room. It would either stay steady or shift to another typical state as it equilibrates at the maximum. This is stated in the H-theorem: H is a non-decreasing function in time. As one can conceptualize intuitively as well, there are many more microscopic states that will be

---

[62] This notion of the probability distribution function is a little too complicated to be explained outside of physics knowledge. Its definition lies in a flow of system that is observed in a space of 6N dimensions -where N is the number of particles in the system, and 6 is the degree of freedom of each particle consisting of 3 co-ordinates and 3 momenta. The time evolution of the system is observed as the vector field/flow in this space.

typical rather than atypical. It is highly unlikely, due to pure probabilistic reasons, that the system will evolve into a low probability state unless a special arrangement is made (and the system is disturbed) by an external force. Even though it is always a possible state we will never see the gas particles roaming towards the corner of the room. Hence, it is concluded that there is a direction of time for macroscopic events.

Order Out of Chaos, written by Ilya Prigogine and Isabelle Stengers was published in 1984. Prigogine, in his own work, has enhanced Boltzman's physics with theories on self-organizing systems. He suggests that order and organization can actually arise spontaneously out of disorder and chaos through a process of self-organization.[63]

Prigogine sees this transition [from being] to becoming to be in irreversibility and its "unexpected features." (1980 xix) Moreover, the "rediscovery" of the concept of time not only acquires knowledge about the self-organizing and open systems that we live in, but in doing so, breaks the static views of science as well.

In the static views, trying to understand the open biological and social systems with closed system models in mechanistic terms is "bound to fail." Prigogine stresses that Newton's physics is a deterministic closed system that is limiting explanations to universal constants. Despite their incorporation of time, the dynamical description [be it classical or quantum] and special theory of relativity, were considering time in a restricted way. Prigogine's book From *Being to Becoming* published in 1980 in San Francisco, outlines the emergence of a new physics in what he calls "philosophical terms." He distinguishes between the physics of being: classical dynamics and quantum mechanics, and the physics of becoming: thermodynamics, self-organization and non-equilibrium fluctuations. The transition between these two physics is provided by "the kinetic theory, microscopic theory of irreversible processes and the laws of change." More than the shift to the social and biological becomings in the content matter of science, with the reinterpretation of time in systems

[63] These concepts were further expanded in 1989 book *The End of Certainty* where Prigogine and Stengers again collaborated. The two books, maybe not as much as the Santa Fe group but still to a great extent, helped publicizing the science of complexity. With the publicized version, the authors were criticized in the scientific circles for dropping scientific patterns.

exchanging energy, information, and matter with their environment, physics itself is in transition to "becoming."

As introduced above, Prigogine infers a selected philosophical vocabulary. In *La Nouvelle Alliance*, Prigogine and Stengers make note of the necessary relation they see between philosophy and science: In their take on the critique of science in the Pragmatist tradition, they view philosophy as a counterpart to "the-alienating-science." (1984 96) Pragmatists such as James and Bergson, had identified between different ways of thinking as the intellectual and the intuitive, for a better understanding of the process of knowledge production. Pertinent to this idea with an emphasis on comprehending the process behind knowledge production, Prigogine and Stengers state that if science is a closed discipline, only feeding on itself -its past conceptions and configurations- "strictly intelligent" abstractions can bound the present before the future comes with its full potential. The process, instead, should infer an exploration of the unknown on top of the already-known.

One of the philosophers Prigogine and Stengers mention often in their discourse of process is Alfred North Whitehead. His basic conception of a creative evolutionary process, requires that such a process is never to be conceived, if its elements were defined as permanent. In *Process and Reality* he states that individual identities must not maintain their identity throughout all changes and interactions. And it is the task of philosophy "to reconcile permanence and change to conceive of things as processes," to demonstrate that becoming produces entities and individual identities that are born, die, or transform... Prigogine emphasizes on Whitehead's notions of relations – as identity of individual is gained from its relation with others[64] – and innovating becomings. And his point is that Whitehead's question concerning permanence and change applies to entities formed by their irreversible interaction with the world.

In addition to such an understanding of process, Stengers takes up Michel Serres' idea of "the disturbance that causes things to be born," in *Power and Invention* published in 1997.

---

[64] This issue of course expands into Relativist Pragmatism and broader contexts.

(1997, 48) As she discusses the creative process, she reviews *clinamen* -things "there, before one begins to dig and actually discover them."

Both the idea of clinamen, and relations between the permanence and change, recall a logic of invention.[65] This continuous invention process implies a model of "creative evolution" which is initially amplified in Bergson's philosophy. The logic of invention, of continuous divergences, does not produce "premises, nor techniques, nor conclusions, nor solutions, nor arguments, nor effects" and is -a- becoming. Prigogine and Stengers' new physics, that also bares these characteristics, is just as much a becoming.

As hinted above and also logically, the method of a becoming science acknowledges time. Prigogine and Stengers state that only when a system behaves in a sufficiently random way may the difference between past and future, and therefore irreversibility, enter its description. Irreversible processes are associated with randomness and openness, that lead to higher levels of organization, such as disintegrated structures. This is in line with Bergson's assertion that limitations of scientific rationality reduce time to a sequence of instantaneous states linked by a deterministic law. Bergson implies that such rationality can attenuate its content matter to a single and decisive statement due to its incapability of understanding "duration." For Bergson, on the other hand "life progresses and endures in time..."

> [Physics] is limited to counting simultaneities between the events that make up this time and the positions of the mobile T on its trajectory. It detaches these events from the whole, which at every moment puts on a new form and which communicates to them something of its novelty. It considers them in the abstract, such as they would be outside of the living whole, that is to say, in a time unrolled in space. It retains only the events or systems of events that can be thus isolated without being made to undergo too profound a deformation because only these lend themselves

[65] This conception is an articulation of Elizabeth Grosz in that the virtual actualizes itself, not through resemblances but through differentiation amounting to the creation of the new. This discussion will branch off away from ours, so we shall not elaborate.

> to the application of its method. Our physics dates from the day when it was known how to isolate such systems. ([1911] 1998, 341)

Prigogine and Stengers, are obliged to depart from Bergson's criticism though: Modern science, which Bergson had once criticized as being limiting, is overcoming its limits. Moreover, they revive the Kuhnian idea as they realize that it is doing this, not by abandoning scientific approach as Bergson suggests, but by perceiving the limitations of these concepts and by discovering new formulations valid in more general situations. And that is what makes their new physics a becoming science.

References

Abbott, Edwin A. [1952] 1992. *Flatland: A Romance of Many Dimensions*. New York: Dover Publications, Inc. Original edition, London: Seeley & Co., Ltd., 1884.

Asimov, Isaac. ed. 1980. *The Annotated Gulliver's Travels*. New York: Clarkson N. Potter, Inc./Publishers. Based on Jonathan Swift, *Gulliver's Travels*, London: Benjamin Motte, 1726 and Dublin: George Fulkner, 1734.

Benedikt, Michael. [1991] 1993. *Cyberspace: First Steps*, Cambridge: The MIT Press.

Bergson, Henri. 1955. *An Introduction to Metaphysics*. Indianapolis: The Bobbs-Merrill Company, Inc. Original edition, 1903.

Bergson, Henri. 1998. *Creative Evolution*. New York: Dover. Original edition, New York: Henri Holt & Co., 1911.

Bergson, Henri. 1991. *Matter and Memory*. New York: Zone Books. Original edition, Urzone, 1988. Original French edition, 1908.

Borges, Jorge Luis. 1970. *The Aleph and Other Stories: 1933-1969*. New York: E. P. Dutton & Co., Inc.

Boyman, Anne. trans. 1995. Preface to *Earth Moves* by Bernard Cache. Cambridge: The MIT Press.

Bronowski, J and Mazlish, Bruce. 1960. *The Western Intellectual Tradition: From Leonardo to Hegel*. New York: Harper & Brothers.

Butterfield, Herbert. 1962.*The origins of modern science, 1300-1800*. New York: Collier Books.

Cassirer, Ernst. 1950. *The Problem of Knowledge: Philosophys, Science and History since Hegel*. Translated by William H. Woglom and Charles W. Hendel. New Haven and London: Yale University Press.

Deleuze, Gilles and Felix Guattari. 1987. *A Thousand Plateaus*. Translated by Brian Massumi. Minneapolis: the University of Minnesota Press. Original French edition, Paris: Les Editions de Minuits, 1980.

Deleuze, Gilles. 1988. *Bergsonism*. New York: Zone Books.

Feyerabend, Paul. 1962. Explanation, Reduction, and Empiricism. In *Scientific Explanations, Space, and Time: Minnesota Studies in Philosophy of Science Vol. 3*. Edited by H. Feigl and G. Maxwell. Minneapolis: University of Minnesota Press.

Feyerabend, Paul. 1963. How to be a Good Empiricist: a Plea for Tolerance in Matters Epistemological. In *Philosophy of Science: the Delaware Seminar Vol. 2*. Edited by B. Bamrin. New York: Interscience Press.

Feyerabend, Paul. 1964. A Note on the Problem of Induction. *Journal of Philosophy*. vol. 61.

Feyerabend, Paul K. 1975. *Against method: Outline of an Anarchistic Theory of Knowledge*. London: NLB.

Giedion, Sigfried. [1941] 1982. *Space, Time and Architecture*. Cambridge: Harvard University Press.

Hanson, Norwood Russell. 1965. *Patterns of Discovery*. Cambridge: The University Press.

Heath, Thomas L. 1926. *The Thirteen Books of Euclid's Elements*. Cambridge: The University Press.

Hegel, Georg Wilhelm Friedrich. 1974. Hegel: The Essential Writings. Edited and with introductions by Frederick G. Weiss. New York: Harper & Row.

Helmholtz, Hermann von. 1995. On the Origin and Significance of Geometrical Axioms. In *Science and Culture*. Edited by David Cahan. Chicago: The University of Chicago Press.

Henderson Linda D. 1983. *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*. Princeton, NJ: Princetion University Press.

Husserl, Edmund. 1978. Appendix in *Edmund Husserl's Origins of Geometry: an Introduction* by Jacques Derrida. Translated, with a preface, by John P. Leavey, Jr. New York: Nicholas Hays. Original edition, in the *Revue Internationale de Philosophie* vol. I, no. 2, 1939.

James, William. 1977. *Bergson and His Critique of Intellectualism. In A Pluralistic Universe*. Cambridge: Harvard University Press. Hibbert Lectures on the Present Situation in Philosophy originally given in 1908 at Manchester College.

Kant, Immanuel. 1965. *Critique of Pure Reason*. Original edition, New York: Macmillan, 1929. Original German edition, Riga: Johann Friedrich Hartknoch, 1781.

Kitcher, Philip. 1993. *The Advancement of Science*. Oxford: Oxford University Press.

Kubler, George. 1962. *The Shape of Time: Remarks on the History of Things*. New Haven and London: Yale University Press.

Kuhn, Thomas. 1977. *The Essential Tension*. Chicago: University of Chicago Press.

Kuhn, Thomas. 1996. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press. Original edition, Chicago: University of Chicago Press, 1962.

Lakatos, Imre. 1970. Falsification and the Methodology of Scientific Research Programs. In *Criticism and the Growth of Knowledge*. Edited by Imre Lakatos and Musgrave. Cambridge, UK: University Press.

Laugier, Marc Antoine. 1977. *An Essay on Architecture.* Translated and with an introduction by Wolfgang and Anni Herrmann. Los Angeles: Hennessey & Ingalls. Original French edition *Essai sur l'Architecture*, Paris: N.-B. Duchesne 1755.

Lefebvre, Henri. 1996. Writings on Cities. Selected, translated and introduced by Eleonore Kofman and Elizabeth Lebas. Oxford: Blackwell Publishers.

Lefebvre, Henri. [1991] 1997. *The Production of Space.* Translated by Donald Nicholson-Smith. Oxford: Blackwell Publishers. Original French edition, Paris: Anthropos, 1974.

Libeskind, Daniel. 1980. *End Space.* London: E. G. Bond Ltd. (exhibition and catalogue of drawings and etchings, The Architectural Association.)

Lyotard, Jean-Francois. 1984. *The Postmodern Condition.* Minneapolis: University of Minnesota Press.

Newman, James. R 1956. *The World of Mathematics vol. I.* New York: Simon and Schuster.

Papanicolaou, Andrew C. and Gunter, Pete A. Y. 1987. *Bergson and Modern Though: Towards a Unified Science.* Chur, Switzerland: Harwood Academic Publishers.

Perez-Gómez. Alberto. [1993] 1996. *Architecture and the Crisis of Modern Science.* Cambridge: The MIT Press.

Pickering, Andrew. 1984. *Constructing Quarks.* Chicago: University of Chicago Press.

Popper, Karl. 1962. *Conjectures and Refutations.* New York: Basic Books.

Popper, Karl. 1965. *The Logic of Scientific Discovery.* New York: Harper & Row.

Preston, John. 1997. *Feyerabend: Philosophy, Science and Society.* Cambridge, UK: Polity Press.

Prigogine, Ilya. 1980. *From Being and Becoming: Time and Complexity in the Physical Sciences.* San Francisco: W. H. Freeman and Company.

Prigogine, Ilya and Stengers, Isabelle. 1984. *Order Out of Chaos.* New York: Bantam Books.

Rajchman, John. 1997. *Constructions.* Cambridge: The MIT Press.

Russell, Bertrand. [1945] 1972. *A History of Western Philosophy.* New York: Simon and Schuster.

Singer, Charles et al. ed. 1957. *A History of Technology Volume III From the Renaissance to the Industrial Revolution: c.1500-c.1750 and Volume IV The Industrial Revolution: c.1750-c.1850.* New York and London: Oxford University Press.

Smolin, Lee. 1997. *The Life of the Cosmos.* New York: Oxford University Press.

Tschumi, Bernard. 1979. *Architectural Manifestos.* London: Architectural Association Publications.

Tschumi, Bernard. 1990. *Text 5: Questions of Space.* London: Architectural Association Publications.

Weaver, Jefferson Hane. 1987. *The World of Physics Vol. I.* New York: Simon and Schuster.

Whitehead, Alfred N. 1947. The Axioms of Geometry. In *Essays in Science and Philosophy.* New York: Philosophical Library, Inc.

Whitehead, Alfred N. 1955. Process and Reality. New York: The Humanities Press. Original edition, London: The Macmillan Company, 1929.

Whitehead, Alfred North. [1920] 1964. *The Concept of Nature.* London, UK: The University Press.

Whitehead, Alfred North. 1967. *Science and the Modern World.* New York: The Free Press. Original edition, London: The Macmillan Company, 1925.

Whitehead, Alfred North. 1967. *The Aims of Education and Other Essays*, New York: The Free Press. Original edition, London: The Macmillan Company, 1929.

Whitehead, Alfred North. 1947. *Essays in Science and Philosophy.* New York: Philosophical Library, Inc.

Yates, Penny. 1999. Distance and Depth. In *Proceedings of the 4th International Design Thinking Research Symposium.* Edited by Gabriela Goldschmidt and William L. Porter. Cambridge, MA: MIT. (I/49-74)