

Practices of Reduction, the Creation of Grace

This paper is an investigation of the aesthetic consequences of reduction and economy in the creation of light weight structures and the physical movements of the wire walker. I will compare the energy consumed in the wire walkers performance to the mass used in a light weight structure, showing the parallels. In both of these endeavors there is an interest in reducing the energy or mass which is used while simultaneously maintaining the integrity of the outcome. I will attempt to reveal some insights into the question of why in the light weight structures of Frei Otto and in the movements of Philippe Petit beauty is reached tangentially, created as a product of a devotion to a practice which involves qualities of simplicity, reduction and economy. It also is interesting that in both these endeavors great care must be taken to avoid tragedy.

I will study Frei Otto's work and practice. His passion and life have revolved around the study and creation of structures whose mass has been reduced to a minimum and strength increased to a maximum. By using measurements, mathematics and carefully investigating natural forms, his focus has been not upon creating a beautiful object, but rather in the interest of finding the essentials in what give a structure its integrity. He then removes all superfluous material. Why when he has distilled structure to such elemental purity in the building's form does he uncover a beauty in harmony with nature and the human spirit?¹

We will enjoy the words of engineers, writers, a philosopher, a wire walker, and a martial artist, whose unique visions have created bold legacies. We will look at majestic movements and forms which reach skyward, their lightness and grace seemingly operating in a world beyond physics. While under a grand roof, the volume of an enormous anticlastic surface built of cable and plexiglass "scales," a deep touch of body and spirit arises. When we see the arc of a funambulist high above his wire in a full layout salto landing in a silent pli , so effortless, it exalts our perceptions of time and space. But also in our mind and soul we sense that in this beauty resides the potential for loss, the existence of a terrifying scene—snapped cables, twisted and buckled steel tubes, a fallen performer in great pain or worse.

During the 20th century materials have arrived which allow new approaches to the development of structures, changing what is possible in the field of design.² High strength steel alloys have been employed in ropes and columns allowing unprecedented structures to rise. The great bridges of the twentieth century owe their existence to steel's structural prowess. In the 1960's a new approach to engineering and building gathered momentum. Engineers such as Frei Otto and Robert Le Ricolais looked into using high strength materials in new ways to create structures whose goals were to use a minimum of material to create a maximum of structure. The core

1. Le Corbusier (1985), *Towards a New Architecture*. Dover Publications. 1.

2. J. E. Gordon (1988), *The New Science of Strong Materials*. Princeton University Press: Princeton, NJ. pg. 17

concept was to remove material which was not under stress, material that was a hinderance to the structure because it added weight and cost. By doing so, the structure's members would exist in either pure tension or pure compression which would lead to a great reduction in the mass of a structure itself. The unachievable desire of the lightweight engineer was most simply articulated by poet engineer Robert Le Ricolais when he asked a structure to be:

“Zero weight infinite span.”³

The secret to gaining insight into how to create such structures—which capitalized on this distillation of forces—was to find examples of where it already existed. The books of Robert Le Ricolais and Frei Otto are full of plates of bones, spider webs, jelly fish, radiolarian, and other sorts of animal and plant structures.⁴ As John Tyler Bonner tells us in *Morphogenesis*,

“There is a great feeling of satisfaction, that no one can deny, in being able to take a living phenomenon and apply the ruler and balance to it. Our rational minds tell us we do this to learn and penetrate deeper into the phenomenon, and often this is true, but this never removes the aboriginal pleasure of measuring.”⁵

By looking at the work of both Otto and Le Ricolais, we find an immense wealth in their studies of nature. Nature, using materials which are not nearly as strong as our steels and fiber reinforced resins, is able to achieve structural economy (i.e. a weight to strength ratio) which we are still unable to achieve in our most exotic lightweight high strength materials.⁶ The calcium matrix of our bones is nowhere near the strength of alloy and tool steels, not to mention newer lightweight material such as carbon fiber, yet skeletons are efficient structures and have inspired many designs.

“D’Arcy Thompson tells the whole history of the discovery and understanding of the Trabeculae;(the microscopic structures in bone) and quite appropriately their significance was first seen by an engineer... He was at the time in the process of

3. Robert Le Ricolais (1973), *Things Themselves Are Lying And So Are Their Image*. Graduate School of Fine Arts University of Pennsylvania, PA. p. 81

4. Frei Otto (1972) *IL5 Convertible Roofs*, Institute for Lightweight Structure (IL), University of Stuttgart, Stuttgart, Germany.

Frei Otto (1975) *IL8 Nets in Nature and Technics*, Institute for Lightweight Structure (IL), University of Stuttgart, Germany.

Robert Le Ricolais (1973), *Things Themselves Are Lying And So Are Their Image*. Graduate School of Fine Arts University of Pennsylvania, PA.

5. J. Bonner (1952), *Morphogenesis, An Essay On Development*. The Murray Printing Company.: Forge Village, Mass. p. 57

6. Le Ricolais, *Things Themselves Are Lying And So Are Their Image*, p. 87

designing a crane and...[when] he saw the trabeculae in the head of a bisected femur, with a sudden flash of insight he exclaimed, "That's my crane!"⁷

How nature creates such efficiency out of less capable materials is interestingly stated in the following idea of Le Ricolais. He tells us that the art of making a efficient structure lies in understanding the placement of its cavities, in using the absences of material, and then in orienting and connecting as best as possible the structural members around these voids.⁸ I am reminded of the advice of Bruce Lee in regards to developing physical skills when he says,

"It's(one's practices) not daily increase but daily decrease—hack away the unessentials"⁹

After the second World War in Germany, Frei Otto as a young engineer faced a compound problem in the creation of structures, the severe shortage of materials along with a great need for housing. Perhaps this played some part in his focus towards economy and efficiency which is so clear when he approaches a structural problem. As Philip Drew says of his process,

"In the absence of conventional architectural habits and routine fishing in the ocean of old forms the dissection of his work for stylistic influences- indeed the very notion of style- is alien. His denial of architectural product in deference to structural process enthrones concept and method over self conscious aesthetic manipulation as the determinant of form."¹⁰

By these words and looking at his work, we understand his designs to be responses to structural problems rather than meditations on aesthetics. But underlying these structural pragmatics lie solutions which are not only economical, but also which are beautiful and embody elegance. In the Munich Olympic Stadium great masts rise up high into the sky. Anchored to the masts' heads enormous roofs of cable nets supporting plexi-glass panels swoop down and over the stadium seats, creating an mesmerizing topography. In places large masts float high above the spectators, held in space by tensegrities. In all cases these forms, the shapes the material articulate in space, are creations of structural solutions whose design it is to carry the forces of the architecture in the most slender and lightest way.

This monumental structure's organic nature is due to this simple fact of its lineage. These immense roofs are the giant descendants of little soap films clinging to wire models which Otto dipped into and raised out of soap baths, photographed and measured. It has been long known that soap films have a uniform tension on all parts of their surface.¹¹ In this way they can only

7. Bonner, *Morphogenesis, An Essay On Development*, p. 68

8. Le Ricolais, *Things Themselves Are Lying And So Are Their Image*, p. 103

9. Bruce Lee (1975). *The Tao of Jeet Kune Do*. Ohara Publications Inc.: Burbank California. p. 42

10. Philip Drew (1976). *Form and Structure*. Westview Press.: Boulder, Colorado.

p. 6

11. *ibid.*, p 14

take the shape of what engineers call “minimum surface.”¹² The beauty in a minimum surface is that it can be a pure tension and compression structure. All areas are in equal tension and restrained by the inherent double curvature of the surface and the compressive forces can be isolated in the supporting structures. In this way one arrives at a roof, which is both strong and light. As Robert Le Ricolais said, “Who knows a better structure than a rope?”¹³ And a minimum surface can be made entirely from a rope or a cable net and supported by tubes or other compressive elements.

{picture of Soap models}

“The Munich roofs convey the sense of effortless grace which is so much a feature of a great athlete’s performance.”¹⁴

The shapes created by this enormous architecture are the results of Otto’s measuring and translating of natural physical dynamics. In this I am reminded of the words of Le Corbusier.

“The Engineer, inspired by laws of Economy and governed by mathematical calculation, puts us in accord with universal law. He achieves harmony.”¹⁵

Frei Otto’s process, employing careful study of the physics of nature, has transformed steel and membranes into something which appears to have life. By doing so, there is a psychic sense that it may also have an eventual death. To me this becomes one of the most profound aesthetic implication of what Otto has created. For art to be deeply touching there must be more than just grace and beauty, it must take our imagination beyond the tangible aspects of the form along a boundary between chaos and order, stirring a deeper part of our being. To better understand these deeper psychological influences and these experiences of humanness, we shall turn and look at some views of what creates and constitutes a sublime experience.

First for clarity, I wish to narrow this investigation of the sublime to something internal, an experience of mind and soul. The sublime is not an external object, but is catalyzed by extraordinary external phenomenon of nature or man to which we are exposed.¹⁶ For example it can be internally catalyzed by practice of mantra causing a spiritual realization,¹⁷ but we will not delve into that area in this brief exploration. What I find to be a sublime phenomenon, for others may not be. It is an experience of the individual, and we cannot create a system of

12. C. V. Boys (1959), *Soap Bubbles, their colors and the forces which mold them*. dover Publications, New York, NY. p. 48

13. Le Ricolais, *Things Themselves Are Lying And So Are Their Image*, p. 96

14. Philip Drew, *Form and Structure*, p. 39

15. Le Corbusier, *Towards a New Architecture*, p. 1

16. Emmanuel Kant (1914), *Critique Of Judgement*. Macmillan and Co.: London. p. 129

17. yoga quote on internal paractice.

consensus and measurement to define the sublime.¹⁸ In fact we find it very difficult to define as its definition exist paradoxically. The manifestation of the sublime cannot be measured or cataloged. But none the less attempts are many and intriguing, and a good start is to look at some approaches thinkers have taken to understanding the sublime. The sublime experience is described as a feeling which exists in vibration between attraction and repulsion. In this state our feelings exist on a porous boundary between senses of both wonder and terror. This creates a transcendence in our minds where we find ourselves lifted from an ordinary state to a freer place where we sense the infinitude of existence which is both liberating and also terrifying.¹⁹

Roland Barthes speaks of this experience while describing what makes a certain photos great and others only good. In *Camera Lucida* he explores what it is in a certain photographs that grabs us while in others we are just interested for a brief, but passing moment. He defines the ordinary and transcendent in a photograph by using two terms which are not mutually exclusive, but must coexist. One which he calls the “stadium” in his words is:

“that very wide field of unconcerned desire, of various interest, of inconsequential taste: I like / I don’t like. The Stadium is an order of liking, not of *loving*; it mobilizes a half desire, a demi-volition:”²⁰

Antonin Artaud speaks more inflammatorily of a similar banality in the conventionality of theater which he warns has a tendency towards mental subjugation.

“This idea of a detached art, of poetry as a charm which exists only to distract our leisure, is a decadent idea and an unmistakable symptom of our power to castrate.”²¹

Barthes defines the element of a photograph which grabs us, which creates a transcendence, as the Punctum. He says it is,

“it is this element which rises from the scene, shoots out of it like an arrow and pierces me.”²²

He goes on later in the text to repeatedly speak of the Punctum as a psychic disturbance, something which wounds or disturbs us, which induces a deeper stirring in our psyche. Antonin Artaud also prescribes to a similar sentiments of art, in this case he refers to theater.

18. *ibid.*, p. 130

19. *ibid.*, p. 120

20. Roland Barthes (1980) *Camera Lucida*. Hill and Wang.: New York, NY.
p. 27

21. Antonin Artaud (1958), *The Theater and Its Double*. Grove Press Inc.: New York, NY.
p. 77

22. Barthes, *Camera Lucida*, p. 26

“like the plague...there is something both victorious and vengeful: we are aware that the spontaneous conflagration which the plague lights wherever it passes is nothing else than an immense liquidation.”²³

In this philosophy not only is the sublime a disturbance, but it strips us bare, exposing inner layers of our psyche like the peeling of an onion. An experience becomes sublime when it causes an interruption/reduction in our sense of order, during which a more instrumental self and a greater connection to reality arises. This experience, in the words of Artaud:

“is in reality untranslatable. To express it is to betray it. But to translate it is to *dissimulate it*. True expression hides what makes it manifest.”²⁴

Bruce Lee uses words a little differently to articulate the sublime.

“Art reaches its greatest peak when devoid of self-consciousness. Freedom discovers man the moment he loses concern over what impression he is making or about to make.”²⁵

Lee tells us what makes something great is in the creative act itself. We are lead to a reduction of self which creates a freedom and transcendence for both spectator and participant.

In his quest to find the simplest, lightest solution to structure Frei Otto has reduced each part to only what is absolutely needed to carry out its essential purpose as part of the whole system. His process shares much in common with the athlete who over years of dedicated training rids his actions of superfluous motion, dissolves wasted effort. Like the trained muscles of an athlete, the beams of the roof have been reduced in stature to slender cables allowing great spans between columns. Strength does not fight itself by adding unnecessary bulk and mass. The great wire walkers, who in order to stroll in the sky upon a wire strung between mountains, reduce their motions in balance towards an allusive but intangible stillness.²⁶ The funambulist still is bound to the dance of balance which gravity and his narrow perch mandate, and to avoid falling he must move. The more distilled his movements become the more he finds comfort in the sky, seemingly to reside in a paradox. So too, Frei Otto must dance with gravity. He has no other option in building, he must use materials which have strength but also have mass. In addition, snow and wind may push upon them more brutally than the weight of the materials themselves. However, Otto's finesse in structure allows him to erect his materials, connecting them like a great tent rising from ground to sky. Everything is slender in relation to the space created. It is thus that the structure melds into the air soaring skyward, almost becoming an apparition where

23. Artaud, *The Theater and Its Double*, p. 27

24. Artaud, *The Theater and Its Double*, p. 71

25. Bruce Lee (1975), *The Tao of Jeet Kune Do*. Ohara Publications Inc.: Burbank California. p. 8

26. Philippe Petit (1985), *On The High Wire*. Random House.: New York, NY.

flying columns float over the heads of thousands.²⁷ The entire structure's transparent roof of plexiglass and wire rope nets has a transparency and delicacy which juxtaposes the great mass intrinsic to such a monumental space. The structure evokes a physical paradox. It is solid and carefully built so it does not endanger the 80,000 guest it hosts during sporting and concert events. All of the forces have been carefully examined and the members which support these forces have excess strength. Nothing has been left to chance. For it is in cases such as these, with so many lives on the line, that the structure cannot fail and that one can

“Leave nothing to chance. Chance is a thief who never gets caught.”²⁸

Yet when I page through pictures of the Munich Olympic Stadium, it feels like the whole roof is on the verge of lifting skyward. Like a giant paper kite flying at the moment, but in all its buoyancy it is fragile. In the presence of all its soaring grace and elegance, it also appears fragile, invoking notions of a possible collapse. It is this duality that also makes a great wire walker's performance so transporting. In his movements lie great stillness and calm, yet his perch is insubstantial. It barely exists, disappearing from the eye at a distance. The wire itself rolls and sways underfoot, not for a moment still. The situation has a profound uncertainty and ephemerality about it. Even if in this action lies a moment of repose it is brief and transient.

“Once you have built this flawless balance, so fleeting and fragile, it will be as dense for you as granite. If no thought came to disturb this miracle, it would go on and on. But man, who is astonished by everything, himself included, quickly loses hold of it. The minute point of balance hovers above the wire, knocks against the wire walker, and navigates like a feather in the wind of his efforts.”²⁹

As we watch this performance we feel a wonder, a joy—an exaltation of human spirit. What wondrous skill we are watching. As I watched *Man on Wire*, I saw the New York police commander struggling to describe the experience of witnessing Petit's performance on a wire rigged between the World Trade Center. He could not measure or compare the power of what he had felt in seeing Petit dance upon a wire. Petit was indifferent to over 20 NYC police calls for him to stop. This performance was a theft, the upsetting of a civil order, a reduction of law, a shattering of the care for consequence.

“The theater must give us everything that is in crime, love, war, or madness, if it wants to recover its necessity”³⁰

In these minutes of subtle movements alone on a wire, Petit, watched by thousands to whom he appeared as nothing more than a black dot, a hole in the sky, a tiny point in space, an absence of

27. A reference to the flying masts of the Munich Olympic Stadium, which have been employed to increase the free spans between column in the stadium's grand seating and thus provide unobstructed view to the spectators.

28. Petit, *On The High Wire*, p. 20

29. *ibid.*, pg. 22

30. Artaud, *The Theater and Its Double*, p. 85

sky, was a flirtation with such proximity to death that it burned itself into the collective memory of a world. In the simple act of walking without embellishment on an ephemeral path joining two towers, an immortal inspiration swelled in thousands.³¹

“the essential, this is to etch movements in the sky, movements so still they leave no trace. The essential thing is simplicity.”³²

In both the work of Petit and Otto, through rigorous practice, spanning their lifetimes, the focus is on the essential needs of the endeavor. Through optimization of movements and structures, an elemental connection to the world is created. Their approaches to reduction are similar to a spiritual tradition which includes corporeal practice. Shandor Remete, the founder of Shadow Yoga, explains yoga as a process of distillation.

“This process involves the skillful reduction of fixed patterns within the individual that obstruct or distort perception of reality and so create confusion.”³³

In the most direct translation of *The Yoga Sutras of Patanjali*, Pantanjali states

“Yoga is the *nirodha* (process of ending) *vrtti* (definitions) of *citta* (field of consciousness)”³⁴

Yoga is a practice of dissolving shadows, actions and thoughts which unnecessarily burden our spirits. Like the engineer looking to better his design by ridding it of unnecessary material, or like the wire walker practicing on his wire to find a minimum effort in balance, the practice of yoga is a reduction towards an essential self where illusions manifested in fears and misery are converted, their energy used to fuel compassion and generosity. The transformation is possible not by agenda or wanting to create something of importance and beauty by which one is still bound to a the limited sphere of social power and its corresponding misery, but to find within ourselves and in the world around us, the energy for continual growth and compassion. We must distill our actions and thoughts, our uses of materials and energy, to those which best nourish us. To feed the constructive essentials which will work to ease the continual combat within ourselves and with each other to which we so often become prey.

This distillation and clarification, must be embodied not just concepts.

31. Based on the statements of Dean Snyder in conversation with me who witnessed Petit walk. He remembers being on the streets with thousands and everyone was transported by the enormity of the event. He said it was the most beautiful and extraordinary thing he had ever seen and would ever see.

32. Petit, *On The High Wire*, p. 102

33. Shandor Remete (1948), *Shadow Yoga Chaya Yoga, The Principles of Hatha Yoga*. North Atlantic Books, Berkeley, California. p. 4

34. Vyass Houstin (1995), *The Yoga Sutra Workbook, The certainty of Freedom*, American Sanskrit Institute, Warwick, New York p. I. 2

“Listen to the man who works with his hands he may be able to show you a better way to do it”³⁵

But the real cultivation of activity and practice will ultimately act upon the human spirit. Our practices and the way we focus our attention will change our relationship to self, to others, and to nature. If through our attention we find a way to plunge ourselves into the instrumental, to take note of our sense organs with full attention, our mind ebbs from abstractions toward sharper focus. We come to better face our own challenges and can help or inspire others to do so through a recognition of this insight and a discipline to a practice of discovery. For it is in the moment that we are caught but only through this moment, not through dogma are we able to help ourselves and others.

“Were you talking about old Buddha? Why old Buddha is no Buddha. Real Buddha is a fish just netted leaping and Jumping”³⁶

“When a dog runs at you whistle for him”³⁷

“Shouldn’t every new generation search for its own understanding of nature, man, art, architecture, through profound observations and reflections, and thus create a basis for their own creative activity.”³⁸

35. Louis Kahn (1975), *Light is the theme : Louis I. Kahn And The Kimbell Art Museum*. Kimbell Art Foundation.: Fort Worth, Texas. p. 54

36. Korean Zen Master Ko Un

37. Henry David Thoreau

38. Frei Otto, in the book, Juan Maria Songel (2010) *A Conversation with Frei Otto*. Princeton Architectural Press, New York, NY. p. 14

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