Dear Reader,

My thesis is currently titled: *Science for Architecture: Building a Corporate Identity of Postwar Sweden.* The following text distributed for the higher seminar on March 29 is a very early draft of a chapter of my thesis.

My thesis will highlight a history of architecture where business corporations have let science and technology become a market strategy with the aim to portray Sweden as a leading country in those areas. In this discussion I am interested in the role of architecture building a corporate identity of postwar Sweden from three different aspects; by looking at building technology—steel construction—where it seems plausible that knowledge in concrete construction was transferred into steel construction. Secondly by looking at how the image of Sweden was strengthened by the industry, technology and architecture. Third, I would like to make an argument based on highlighting architectural means, in this case drawing techniques and discuss in what ways this changed in order to give shape to technically advanced architecture. The Wenner-Gren Centre is a good study case in the two first respects because of its steel construction as well as in its use of new innovations such as Robertson’s Q-floor (first time used in Sweden) Further on, because of the primary idea of Wenner-Gren Centre was to place Sweden as an international hub for scientific research.

From a broader perspective I am interested in:

- The Swedish Identity and how images of Sweden are exported
- Power: the negotiations and infrastructures of power as mechanisms for architecture
- Building technology and innovation in regards to design

I am interested in input from you on for example:

- Placing Wenner-Gren Center in an international context
- How to build an argument based on technical progress as well as visionary architecture
- How the discussion relates to current discussions on architecture and technology
- Relevance of issues and information

Looking forward to see you on Thursday!

(Ps. I apologize for not including any images… more of that in the presentation.)
Abstract

In what ways did steel as a building material influence post-war architecture? Placing Swedish advocates for the steel building industry in an international framework this paper argues that material developments in steel construction as well as Atlas Copco’s technical invention of the modern impact wrench in 1950s allowed for architects to envision taller and grander structures, which were feasible to construct from a rational, economic and effectual point of view and thus arguably with socialistic institutional structure in Sweden at the time.

Tall structures provide the main argument for steel construction. The introduction of rolled steel and the electrical elevator towards the end of the 19th century has arguably been the two most important factors for the possibility to construct tall buildings. The number of floors of the American high-rise steadily increased following these two inventions up until the 1930s when the sky-scraper reached a hundred floors. The number of floors remained at that height until the 1980s.

High-rise construction in the US was not the only reason for increased use of steel structures in buildings. As important were visionary architects like Konrad Wachsmann and his developments of a steel connection for space frames, Buckminster Fuller’s Geodesic Dome, as well as the Spatial City by Yona Friedman. In this paper I will argue that visualizations of avant-garde steel structures were as important as technical developments in the same field allowing for a returned interest in steel building in postwar Sweden constructing the Wenner-Gren Centre in Stockholm in 1962.

My hypothesis is that because of lowered steel prices after the Second World War, steel structures became a possibility as well as a trend, which coincided with utopian dreams of flexibility and attitudes of democratic space. This reached a momentum with the Japan Expo of 1970, where most pavilions were steel space frame structures. At the same time, the past ten years low steel price increased and terminated a trend.

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1 Göran Alpsten, Stålbyggnadslagen 1969, 147.
Superstructure

*The steel skeleton is stiffened by two pairs of wind braces in the longitudinal and the transverse directions. The transverse truss is designed as a K-truss sitting in the end walls, the longitudinal truss is a combined frame and lattice truss in the longitudinal walls of the building core.*


Sweden’s first steel framework structure, without poured around concrete for fireproofing, which was the common method in the 1930s, was the high-rise structure of Wenner-Gren Centre (WGC) in Stockholm. This building together with the Fifth high-rise at Sergels Torg—a combined steel framework and concrete joist system—laid the foundation for continued development in steel building, which had gained interest towards the end of the 1950s. What are the reasons for this returned interest in steel building? Answering this, the following chapter will look at innovations in building technology, American high-rise developments and the function of theoretical and utopian dreams, which were nurtured by cultural ideologies of flexibility and rationality. The relationship of power structures, ideas and institutions, described as society’s superstructure by Marx enters this discussion quite literally.

The Wenner-Gren Center, built in 1959-62, is located at the northern edge of Stockholm along the north end of *Sveavägen*. The complex, which includes three structures; *Pylon* a 25-story office building; *Helicon* a semicircular four story apartment building for visiting researchers; *Tetragon* a conference building holding an auditorium, library, restaurant and business facilities, is designed by architects Sune Lindström together with Alf Bydén of VBB (*Vattenbyggnadsbyrån*). The three structures together make up a center for international research visitors. It was made possible through the successful business leader Axel Wenner-Gren who donated eight million Swedish kronor for its purpose. Together with Government support providing the designated property in vicinity of the Karolinska Institute and The Royal Institute of Technology, which was an important aspect, the centre was a result of Mr. Wenner-Gren’s vision of an international research centre. Of the three structures, the high-rise building is the most interesting from a building construct point of view.

Planning the office building at WGC at a height of 74 meters started from the engineering point of view in spring 1959. The office building of 50 000 cubic meter volume sits on a site, which is made up of mud and gravel. The site’s difficult ground conditions in relation to building loads,

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2 Steel Construction in Sweden, Arne Johnson, byggnadsindustrin 12/962
3 Wenner-Gren Center
4 Wenner-Gren Centre, Byggmästaren 1962, nr. 2, sid 165.
made the engineers carefully choose the appropriate material for the frame. Concrete was the most common building material at the time. However, due to weight of the building volume and foundational costs steel was considered instead of using concrete.

Choosing steel would bring on new challenges. “Steel constructions of this kind had not been built in Sweden over the past two decades, and it became quite clear that the construction techniques used in the past would not be reasonably from an economic perspective.” Some of the complications included the fact that it was not possible to resolve fire codes by using concrete casting around a column structure and that it was necessary to use new joint methods other than rivets and welding. It was also necessary to find a suitable joist system.

Calculating costs for a frame in concrete versus steel proved the steel frame to be more advantageous. Thorough technical investigations were made in close collaboration with the authorities; Stockholms Stads Byggnadsnämnd and Statens Provningsanstalt. Building a mock-up in steel, which included four modules, became the main investigation site and was used to solve the major technical problems at hand.

Tekn. Dr. Arne Johnson was responsible for the structure together with Rolf Baehre and they would both publish a series of articles on the Wenner-Gren Center as well as documents on steel construction in the years after its completion. Arne Johnson has been identified as great sales-personality and became very successful though his business in particular constructing warehouse structures where large spans made steel the ultimate construction material. He was later appointed professor in Structures at KTH. However, voices of the institution express his absence in academia giving priority to his production.

In his own publication—*Tekn. Dr Arne Johnson Ingengörbsyrå Tekniska meddelanden*—he describes the high-rise building as follows: *The whole framework is made of steel, even the stairwell and wind braces. The flooring is of steel cells of the Q-floor type, with 10 centimeters of applied concrete.* This was a superstructure. A superstructure that was made possible according to “new fireproofing rules approving Vermiculite surface plaster and new construction regulations standardizing, for example, high-strength bolts”. In addition, new techniques in construction and building methods paved the way for WGC.

Clearly, the Arne Johnsson and Rolf Baehre’s involvement as consultants for the structure of WGC was significant. With detailed knowledge in construction from an analytical standpoint they supposedly were eager to try out new techniques in order to resolve the construction. Construction documents reveal that several calculations and additional engineers from Luxemburg and Germany were consulted, who had more knowledge in building with steel.

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5 Wenner-gren center ett stälhus, 3
6 Tekn. Dr Arne Johnson Ingengörbsyrå AB
7 Tekniska meddelanden 9 och 10, 1962
8 Tekniska meddelanden 9 och 10, 1962
The timing was also right, steel prices dramatically dropped in 1957. This was also the year that Konrad Wachsmann, a German architect who had immigrated to the US through Paris, published his Seven Theses, in which he “advocated an internal logic of interconnectivity through the methods of buildings themselves.”\(^9\) Wachsmann’s focus on modularization through standardization of building components leading to a particular joint for space-frame structures, which was first published in the in the September issue of *L’Architecture d’aujourd’hui* in 1955.

Wachsmann, who first had been working with a large producer of prefabricated wooden buildings in Germany, became associated with Walter Gropius whom he had met in Europe. Together “they developed a revolutionary prefabricated building system from 1941 to 1952 that lead to the design and construction of prototypes for the General Panel House.”\(^10\) 150 houses were built in the Boston and New York area before the two went separate ways. Yet, Wachsmann is most well known for the Mobilar Structure, a tubular steel and proprietary joining system, which was similar to Buckminster Fuller’s tetrahedral structures. The two became close friends in Chicago in the 1950s, as of Wachsmann’s appointed professorship at the Illinois Institute of technology in 1949.

Yona Friedman, the French architect whose life was devoted to imaginations of how architecture could be made mobile—not moving, but in the sense of changing across time, was deeply influenced by Konrad Wachsmann, who introduced the space-frame.\(^11\) Wachsmann’s space-frame had two complications according to Friedman, first the joints and secondly that the joints were too determinant in terms of the members configuration.\(^12\) This lead to the idea of using circles instead of “polygons to delimit the polyhedrons that determine the space-frame grid.” In 1959, while working on a competition for Tunis, Friedman developed a technique, which he later termed space-chains.

Yona Friedman’s proposals allowing for alternation has always been systems of flexible structures. Paraphrasing Abraham Lincoln’s definition of democracy, the monograph on Hungarian architect Yona Friedman entitled *Architecture with the People, by the People, for the People* signified his architecture by his own words; “If I had to qualify my approach to architecture, I see it as “democratic” in the sense of Lincoln’s interpretation.”\(^13\) His Yona Friedman’s projects “have always been closely related to the political and scientific topics of their time.”\(^14\) In response to pressing issues of an increased urbanization and world population of the 1950s, he elaborated extensively on the projects *L’Architecture Mobile* and *La Ville Spatiale*.

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9 Rethinking Technology: a reader in architectural theory, 119
10 *Dwell* feb 2009, Itohan Osaimwese, 98-102
11 ...something about the fact that a spaceframe was invented for airflight in 1917, but then never further developed until Konrad Wachsmann invented the joint making it possible to construct spaceframes.
12 Architecture with the people, by the people fro the people 151
13 Yona Friedman, Architecture with the people, by the people fro the people, 15, 2011
14 Yona Friedman structures servicing the unpredictable, 12
In these and other projects the human being, the individual, was at the center for his argument allowing for individual adaption of the habitat or mobility of the urban plan.

The manifesto *L’Architecture Mobile* of 1956 outlines a principle that architecture should allow for the occupant to design their own space. This is inherently different than the concept of user participation. Friedman did not argue for the participant to design in collaboration with the architect on the contrary he argued for a design that could be altered and modified. Thus, architecture has to be compatible with individual preferences. He later added a theoretical introduction “Ten principles of a New Architecture”, where illustrations of later project strengthened the imaginations of his manifesto.

One of these projects, which were an illustration of the “structural principles outlined in *L’Architecture Mobile*, such as flexible spatial arrangements within an empty skeleton and minimum impact at ground level”, was *La Ville Spatiale*. The essential part of this evolving project in 1958-62 was a “spatial infrastructure—a multilevel space-frame grid ten meters above ground level”15. Central to the idea of the space-frame structure was that this infrastructure was fixed in the city and partitions—wall- and floor surfaces—were movable parts supported by the grid. *La Ville Spatiale* provided innumerable user patterns, which were to become adopted as an idea worldwide.

When Yona Friedman was invited to the CIAM 10 in Dubrovnik in 1956, he was unknown. Presenting his ten principle of *Ville Spatiale*, where “he argued that cities would become automated” and that “physically they will consist of structural skeletons”16 he was welcomed with interest and was published in the main international architectural reviews. “He anticipated and influenced the utopian and radical avant-garde, such as the British Archigram or the Japanese Metabolists.”17 It was important that *Ville Spatiale* was based on a sociological idea in the sense of freedom of expression. In relations to the CIAM 10, which was the beginning of the end, where Le Corbusier would no longer be the central figure for urban ideas, meaning that Le Corbusier was not a humanist per say, using human nature as a foundation for urban and architectural visions. This shift is important in relation to the avant-garde scenery that would arise.

Friedman’s *Ville Spatiale* was very well received, in particular by the Metabolists. Kenzo Tange invited Friedman to Japan in 1959 to expose at the Festival Plaza at the Osaka World Expo in 1970 leading to publishing *Ville Spatiale* in Japan before it had been published in France. In Friedman’s eyes, the Metabolists were “rebels” that followed his radical ideas. In explaining the radicalism, Friedman identifies Team 10, as the mainstream—also emerging in the 1950s. In doing so the fundamental difference was that; “Team 10 followed the classic Bauhaus concept that architecture had to do everything for people. And I launched the idea that the architect

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15 Yona Friedman structures servicing the unpredictable, 29
16 Yona Friedman, Architecture with the people, by the people fro the people, 107, 2011 keneth Frampton
17 Yona Friedman, Architecture with the people, by the people fro the people, 117, 2011
cannot do everything for people; on the contrary, we should leave the decisions to people, to the resident.”\textsuperscript{18} As the grandfather of coming architectural manifestations, recent studies have tried “to reread Freidman within the context of the utopians of the 60s”.\textsuperscript{19} Previously neglected in genealogy of architecture in the same manner as Superstudio and Archizoom, Friedman has continually been invited by the art circuit. Yet, Friedman has never regarded himself an artist. With the most honest research, his objective has been to resolve structures for the future urban inhabitant.

Space structures have an advantage over column-beam systems. Foremost in resisting loads. In a space structure the component parts form a three-dimensional assembly, which can resist loads applied at any point. This is different from a two-dimensional structure, such as a roof truss, where all the elements lie in the same plane. It is therefore the roof truss can only resist loads applied in the same plane. Space structures are systems, which can give greater freedom of design, lower costs by prefabrication and standardization of component parts. Engineers realized early on that space structures require less material than linear systems.\textsuperscript{20} At Black Mountain Collage, Buckmeister Fuller developed tensegrity structures together with Kenneth Snelson, leading to the design of the Geodesic Dome, which Fuller was given patent for in 1954. He has been credited to have popularized the use of space structures, which at this time gained an increased interest in both Europe and the USA.

\begin{verbatim}
( The connection back to Sweden is SBI and Stålbyggnadsdagen 1969 and 1971, where Sten Samuelsson and Prof. Ove Pettersson refer to Friedman and Fuller. I am also interested in connecting visions to Billy Klüver—the Swedish born engineer who formed E.A.T., which did the Pepsi pavilion at the Japan Expo 1970. )
\end{verbatim}

Returning to the construction methods used in WGC

Importantly, project procedures preparing for building WGC was managed a little different in regards to common construction drawings. Primarily more accurate and complete construction documents were issued. This meant that in the workshop, steel components were constructed exactly according to already prepared drawings. This meant that time spent on preparing and issuing drawings was distributed in the following: 75% of the time was spent on making construction drawings, 10% on project management and 15% calculations. The construction documents consisted of 3 separate files; material specifications, list of pieces, and an additions

\begin{verbatim}
\textsuperscript{18} For this paragraph, See conversation with hans Ulrich Obrist, Architecture with the people, by the people fro the people 143
\textsuperscript{19} See Manuel Orazi , 131. Examples listed are: Exit Utopia. Architectural Provocations and The Urban Utopia in France.
\textsuperscript{20} Steel Space structures makowski p.8
\end{verbatim}
list. All of the steel junctures were drawn in 1:1 scale, which were used to fabricate the pieces in
the workshop.

(Here it seems plausible to discuss how this way of issuing drawings relates to today’s
fabrication methods)

7000 steel parts specified in over 190 drawings (A0 format) made up the extensive drawing- and
measurement specifications for WGC. The building’s skewed angles and inclination towards the
top had an effect on the ability to calculate and predict the exact detail measurements of the steel
construction. As a general rule, each member included a tolerance of 20-100 millimeter because
the detailed measurements were not yet fixated.

Traditionally, a building of this size would be engineered in two steps, first drawings which
would mainly specify the dimensions, the number of fastening bolts, thickness and main
measurements. In the second step, taking place at mallvinden, more detailed specifications are
made, which is out of the control of the engineer.

The frame construction was stabilized with lattice gable walls and a combined frame- and lattice
work in the central core. The parts were produced off site21 as elements spanning across several
floors (core= two floors, façade=four floors) and assembled with friction joints on site.22
Installing the elements on site was done in sequences of four floors at a time over three weeks,
which made the total of twenty-five floors be completed in six months.

When one stage was completed, q-floor-elements made of steel were put in place. Together with
a 10 cm concrete casting, the system of joists were used as a platform when beginning the
construction of the next phase. The finished surface material of each floor was a combination of
gypsum and vermiculite, which was sprayed on to a metal meshwork which is dressed over the
q-floor element. All of the wind stiffening dressings was put together with high-strengthening
bolts. These were first tightened by hand; thereafter the bolt was completely secured with an air
compression screwdriver. 10-20% of the bolts were checked using a torque indicator in order to
affirm its tightness.23

Historical background of the steel

Steel frame construction was relatively common in Sweden up until the 1930s.24 The first rolled
I-beam was made in 1857 and in Sweden it was one of the chief construction elements in 1880-
1930. During this time five different versions of the I-beam entered and took over the Swedish
market and in 1959 the European- (or Economic) or simply the E-beam was just released. At the
same time as a discussion themed “steel or concrete in high-rise buildings?” set off at Stockholms
Byggnadsförening where Sven Dahlberg, CEO of SIAB (later NCC Construction AB) opened

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21 The exterior frame parts were traditionally produced using templates in the workshop of AB Bröderna Hedlund in
Hammarbyhamnen, whereas the core was produced according to drawings 1:1.
22 Stålbyggnad, 37
23 Friktionsförband i Wenner-Gren Centers stålstomme, Byggnadsvärlden nr 35, 1969, 742-743
24 Arne johnson Steel construction in Sweden tekniska meddelanden 12, 62 (extract from byggnadsindustrin)
the meeting. The discussion was reproduced in Byggmästaren- the Swedish architectural journal. That is to say that the arising interests from the building industry to use steel construction again, a construction method that had been asleep for almost thirty years was voiced and heard. The absence of steel construction had reached a momentum as a result of several events.

Already during the 19th century when building iron bridges across engineers’ learned to build quickly and noted the importance of standardized components. Proving this point is perhaps the most well known steel construction- the Eiffeltornet, which is 300 meters tall taking seventeen months to build. built in 1889 for the World exhibition in Paris. The advantages of building in steel are foremost time efficiency related to production. Due to the advantage of producing standardized elements with high dimensional accuracy in steel, it provides rational production and assembly process. This in turn leads to lowering the costs during building production. A steal frame has smaller dimensions than wood and concrete and therefore allow for more square meters. Its structural capacity also provides for greater spans—a prerequisite for the ability to construct a flexible building envelope that can have a long life span. This aspect provided together with cost efficiency was the main reasons for the increase in steel construction in the 1980s.

Steel in modern times started to be produced in 1850s at the same time as the rolling technique was invented. In the early 20th century welding technology developed and this method together with bolted joints replaced riveting as a joining method. This was the foundation for the steel constructions in modern times. The first Swedish examples of modern steel constructions are the department store PUB (1925); the consert hall (1926); Åhlén and Holm (1928). The first steelconstruction norms were published in 1919

During the Second World War a deficit on steel occurred in Sweden and steel building came to a standstill, with the exception of industrial buildings. In the 1960s steel returned as a structural material and profile sheeting developed, which laid the foundation to today’s industrial buildings in steel. Hall building is the most common type of steel structure and it is used in many fields. Some examples are industrial-, storage- and agricultural buildings and hangars. The use age of steel structure in apartment and office buildings did not develop until the mid 1980s.

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At the annual conference of steel construction industry, Stålbyggnadsdagen, in October 1969, Carl Sebardt who was the president of Stålbyggnadsinstitutet (The Swedish Institute of Steel Construction), SBI, welcomed its members announcing that a great number of new members had joined SBI, whom together with Byggforskningsrådet BFR, and STU brought with

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26 accuracy
27 Stålbyggnad 18-19
it significant financial support. This was important in relation to the short lifespan of SBI, which was founded in fall of 1967. A less unenthusiastic news that Sebardt, who was the managing director at one of Sweden’s largest industry groups in mining and steel products Grängesbergsbolaget, was the fact that steel prices had increased during the last year after a ten-year period of “abnormally low” steel prices.

Steel had now reached the same index as in 1957, which at the time was regarded as an absolute minimum pricing in order for steel manufacturers to be profitable. Sebardt proclaimed to SBI members that the low steel prices over the past ten years that so productively had contributed to buildings in steel construction was the beginning of the end of an epoch. “If we are to achieve steady progress, research must be on a high and permanent level”, he said. He concluded his remarks by mentioning that it was exactly ten years ago since steel construction was raised in a public debate for the first time. This took place at Hindersmässan in Örebro, where Sven Dahlbergs ”pionjärinlägg karaktäriserades då som väckarklocka för stålindustrin”.

(Insert the debate on steel from Byggmästaren in1959)

Returning to Stålbyggnadsdagen and Sven Dahlberg’s speech entitled Husbyggnad i stål- igår, idag, imorgon (Steel construction- yesterday, today, tomorrow), where he quickly gives an historical overview of steel construction. As one of the strongest voices at the time for using steel construction he outlines the origin to the great advancement in concrete construction by comparing two diagrams.

The diagrams compares concrete and steel in terms of research and development in durability from 1920-1960. These diagrams showcase what happened as a result of the Second World War, when steel prices doubled over night leading to a shortage of rolled steel. At the same time housing production decreased from 60.000 apartments to 17.000. The increased steel price laid the foundation for engineers to choose concrete construction. Large scale buildings such as Södersjukhuset, which began construction in1939 using concrete, further implemented an attitude in terms of constriction methods. Dahlberg argues that the advancement in concrete construction towards the end of the 1930s was due to a purposeful, targeted and applied research of highest quality. This was in complete opposite of the scenario in the steel building industry up until forming SBI.

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28 Statens råd för byggnadsforskning, oftast kallat Byggforskningsrådet (BFR), var en tidigare svensk myndighet som existerade 1960 till 2000. BFR var ett forskningsråd som förmedlade finansiering till forskning inom byggnad och samhällsplanering.[4]

29 SBI began operating as an institute in 1968.
30 Stålbyggnadsdagen 1969, 6
31 Stålbyggnadsdagen 1969, 53
According to Professor emeritus in Bo-Göran Hellers, longterm conditions in university education of engineers had perhaps an even greater effect on the attitude towards using steel. Professor Kalle Forsell was against the use and production of reinforced steel (kamstål). Professor at Chalmers Hjalmar Granholm had studied under Forsell.

(Här vill jag diskutera WGC bjälklaget Q-floor som för första gången användes i Sverige)

Environment

George R. Bailey, a Chicago real-estate man that in 1949 calculated that full-serviced floor slabs including air-conditioning, fluorescent lighting and acoustic ceiling would only increase cost of a standard floor (i.e. notch-back without air-conditioning and only ordinary lightning) by 8%. “His calculus was timely—not only was the clear, well-serviced, rectangular floor plan attractive enough for its rents to absorb that extra eight percent, but architects had by now more or less unanimously decided that their post-War skyscraper dreams were going to be realized in a starkly rectangular aesthetic” So writes Reyner Banham on tempered environments and the introduction of systems for the new controlled building envelope. He argues, among other things, that these systems for environmental control led to one key invention— the suspended ceiling.

Historically, he traces how diffuser/lamp types of installations enters the market and how architects and engineers “exploit the lost volumes of the ceilings and beginning to treat the ceiling-surface as a multipurpose membrane of concealed power—another contribution to the evolving concept of the suspended ceiling.” In this outline, the Philadelphia Savings Fund Society building completed in 1932, play an important role as an “ancestor” for the use of … (describe what kind of floor) for the advent. Yet, it was not until the 1950s that the combination of air-condition handling and fluorescent lighting was able to mechanical engineer an efficient floor plate. In addition the 1930s depression and the Second World War slowed down developments. “Real progress was not fully resumed until the end of the forties, by which time the mechanical possibilities for office-bock air-conditioning had been reinforced by a new technical aid in the field of lighting, and new set of aesthetic preferences in the design of building envelopes.” So, it was not until the 1950s that multi-purpose membranes became economically attractive. In this sequence of events the steel industry played an important role.

The Rivet Grip Company, the Mellon Research Institute in Pittsburgh and the Burgess Laboratories, all put forward versions of steel floor/ceiling systems in the early 1930s. The steel industry, which was looking for new markets in economic difficulties, began to interest itself in fireproof floor structures, by “employing open-web lightweight joists with light steel decking and screeded floor laid on top.” This type of structure soon was understood as a possibility to use

32 Reyner banham well-tempered environment 182-183
33 Reyner banham well tempered environment 211-212
34 Eyner banahm 181
the hollow middle layer for services. Rayner Banham argues that these floor/ceiling systems and in particular the perforated Burgess Acoustic-Vent ceiling system brought with it “another kind of architectural consequence” because of the acoustic tile rectangular unit, which also “fixes the pattern of hangers and ribs, which will support the tiles”. Adding to this, these systems also introduced structural steel decking allowing for architectural superstructures.

The potentials of this integration systems approach of lighting, HVAC, sprinklers and structural framing was first seriously researched observed and commented on with the completion of The Technical Center for General Motors in Warren Michigan. Banham as well as Reinhold Martin argues this 320-acres industrial research and corporate complex, built in 1948-56 by Eero Saarinen to be the first integration of structure and services. Eero Saarinen took over the project from his father Eliel and his partner Robert Swanson after the auto workers strike in 1945 and at the same time established his research-driven design methodology through collaborations with engineering expertise of the GM project. On a 5’ 2” modular grid in three dimensions, Saarinen used space-frames to integrate mechanical and electrical systems, which in turn allowed for maximum flexibility in the three engineering buildings, which was the first cluster to be completed. The air-conditioning system was key for a successful integrated design. W.J. Caldwell was hired because of his manufacture of small enough ducts to pass through the trusses.

In terms of handling new systems for environmental control, issues such as labor cost as well as being able to handle air-flow and its bulky piping excluded building methods of casting conduits in position. Fireproofing was another issue that became apparent with the introduction of new systems in tall buildings. Commonly the resolution to this had been done by concrete floor slabs. Now, in making profit including that extra 8%, sliming every floor plate to a minimum became of great interest.

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35 Rayner banham 216
36 See Rayener banham 220, Reinhold Martin 145-148, See also Rosamund Fletcher 231-234
37 The GM Center included five building clusters: research, service, process development, engineering and styling