AN ASSEMBLAGE OF PARTS

by

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Thesis submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

MASTER OF ARCHITECTURE

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(ABSTRACT)

Architecture is the pursuit of the integrity of materials, clarity of purpose and craftsmanship in building. These pursuits are embodied by a new style of architecture which is slowly emerging from Great Britain. It is an architecture of the world, not of a region. It is an architecture of exoskeletons and curtain walls. It is an open, airy and versatile architecture for our rapidly changing high speed world. It is High Tech Architecture.

ACKNOWLEDGMENTS

My interest in and understanding of architecture are the result of many people's help. To them I dedicate this thesis.

To my Mother and Father for their continuing support and understanding.

To my Grandfathers for their lessons on construction.

To Mike O'Brien, Bill Galloway and Heinrich Schnödt for their guidance and resistance.

To for pushing me through.

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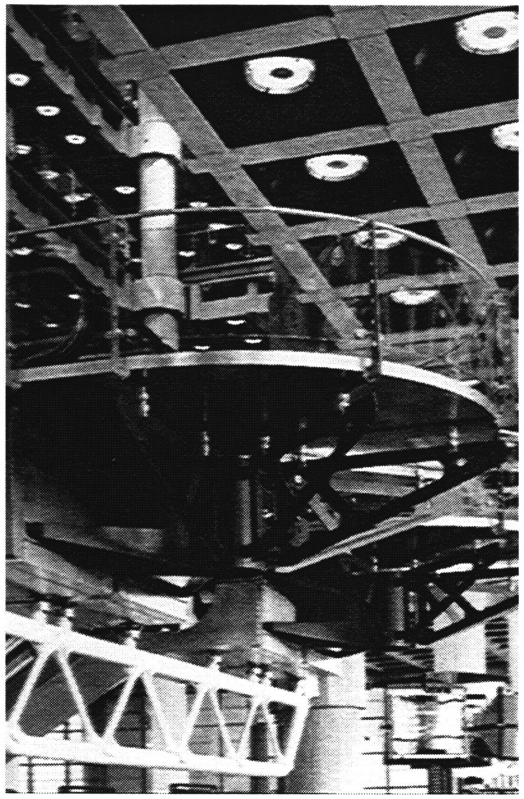
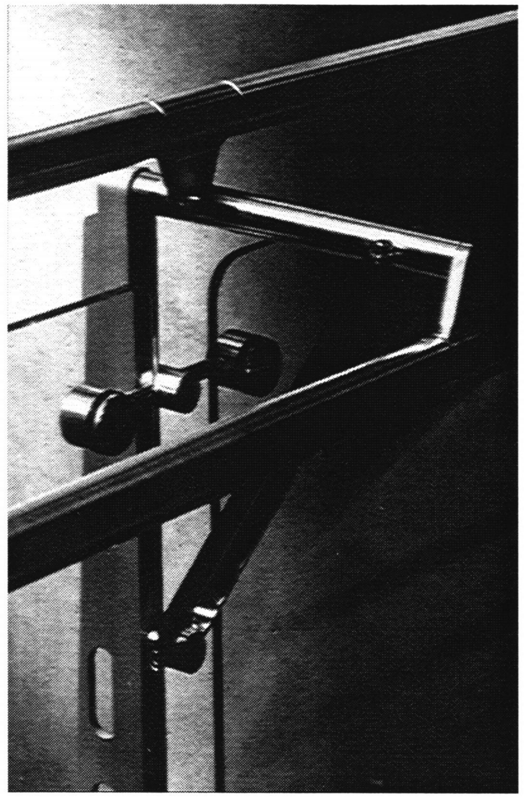
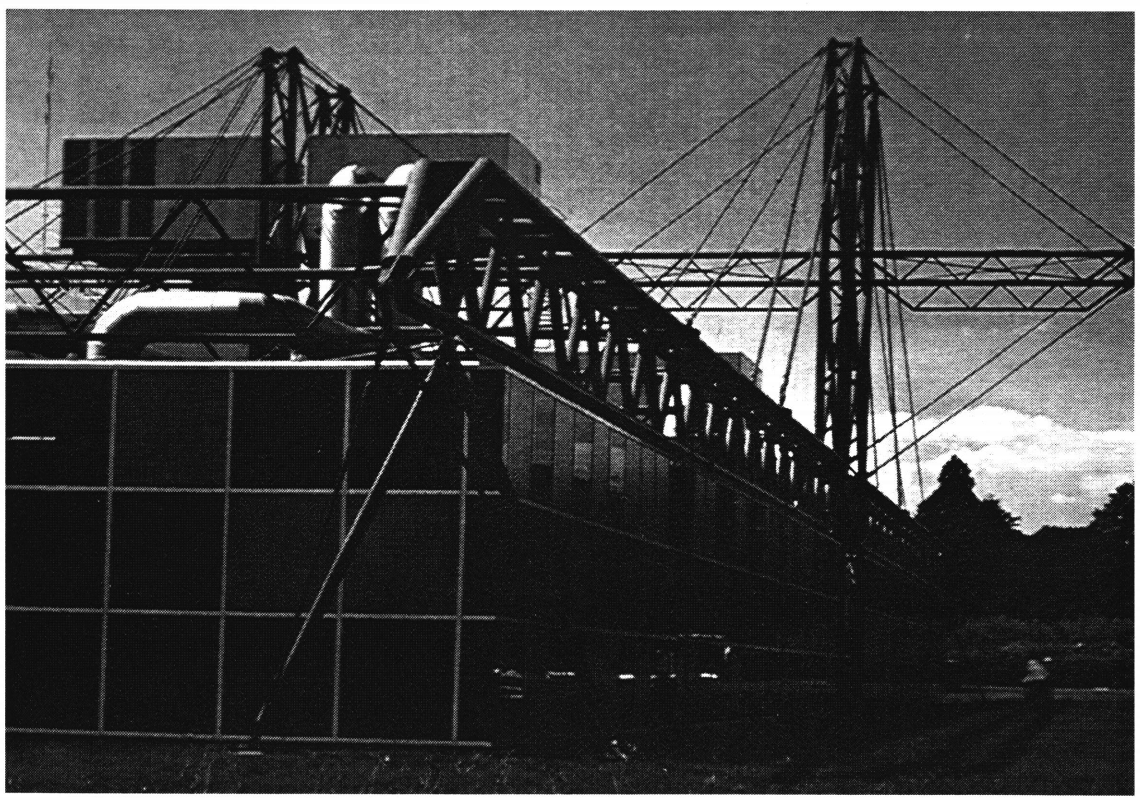




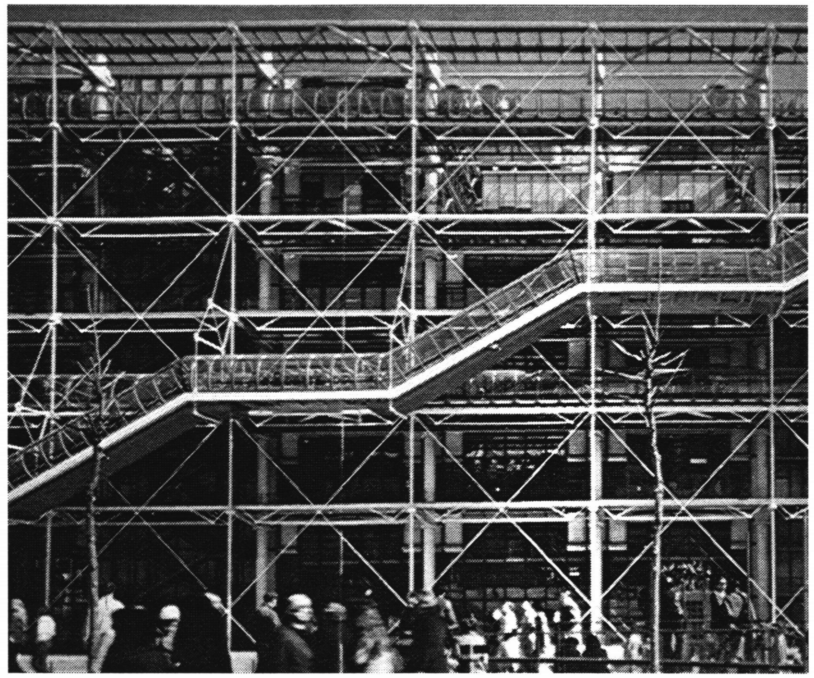
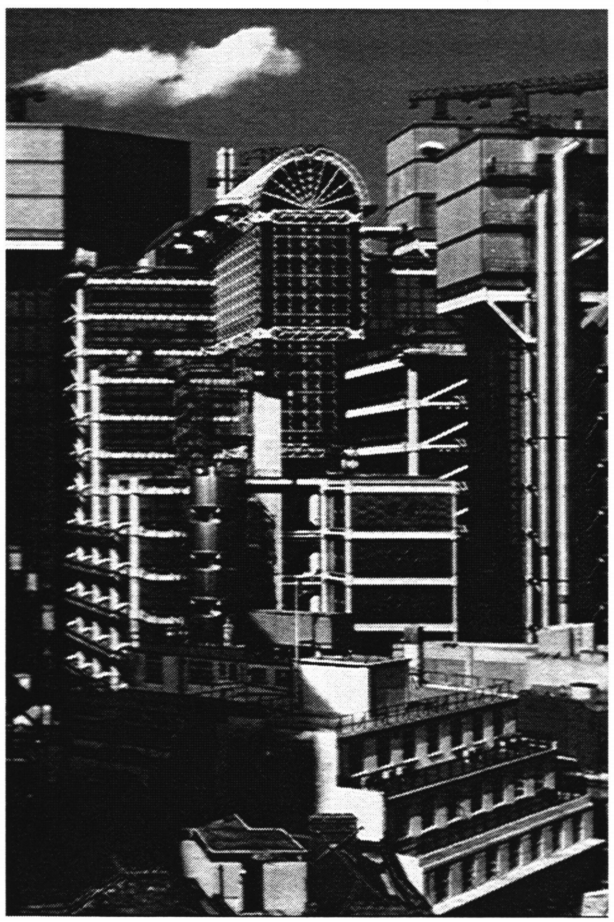


Clockwise from top left: Lloyd's of London, Lloyd's of London, Inmos Microprocessor Factory.

INTRODUCTION

There are three primary pursuits in architecture; integrity of materials, clarity of purpose and craftsmanship. Every building material has inherent strengths and properties. Integrity of materials requires that these characteristics be the basis of design decisions. Concrete begins as a liquid and should therefore be poured into continuous forms. Steel is stiff and strong and can be used in light thin members. Clarity of purpose is achieved when the elements of the building describe the function they perform. The frame is the supporting element of the structure, allowing the walls to act as a skin. Craftsmanship is a pursuit and a necessity of this type of architecture. If the manufactured parts of these structures are not precisely produced, building assembly will be slowed, eliminating the benefits of factory production.

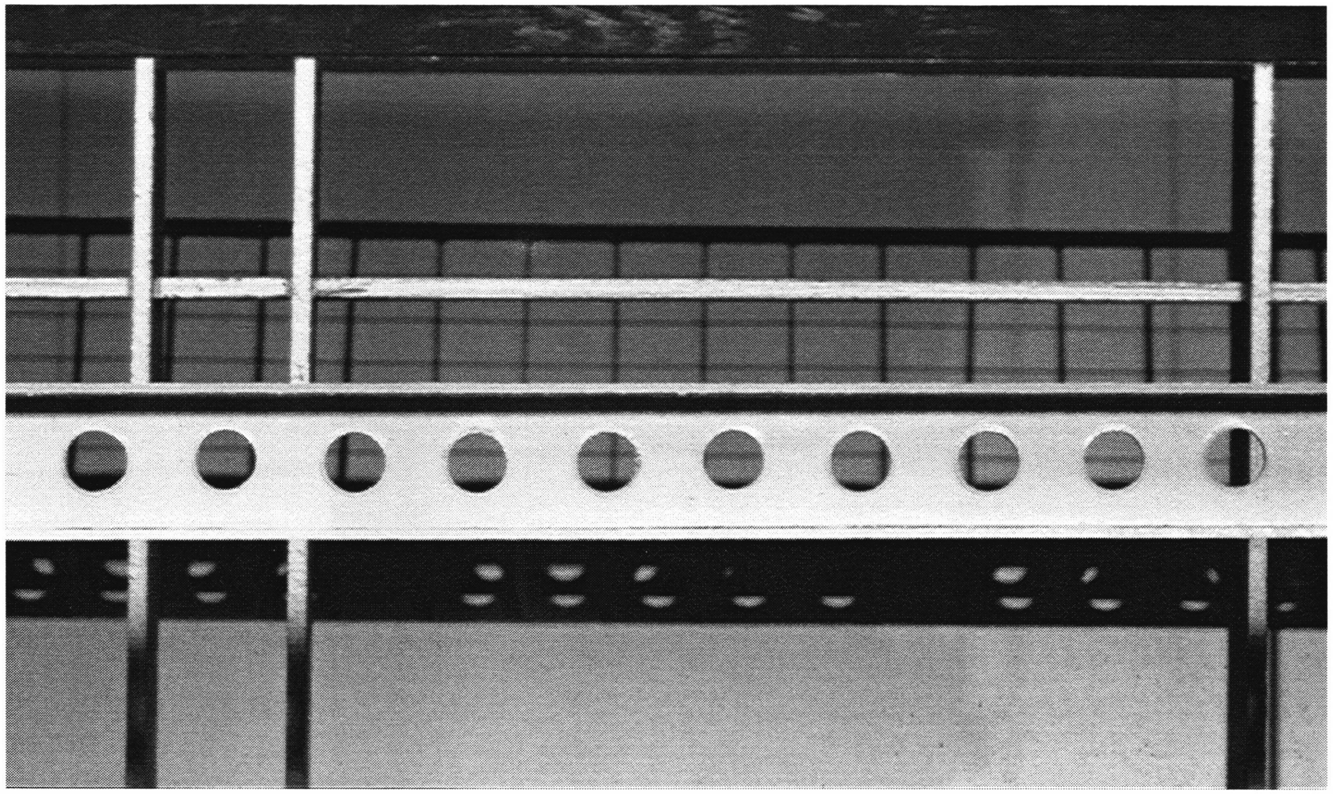
"Buildings are made of machined pieces and machines are but modern tools. It is not the machine that destroys the craftsmanship inherent in all good buildings; it is the lack of love and understanding of the machine by those whose responsibility it is to invent, design and control the buildings - primarily the architect" Richard Rogers

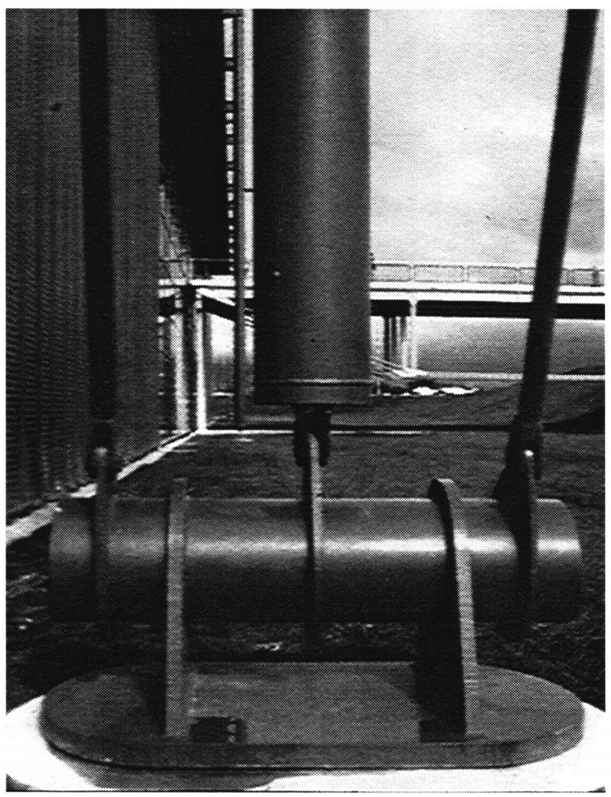




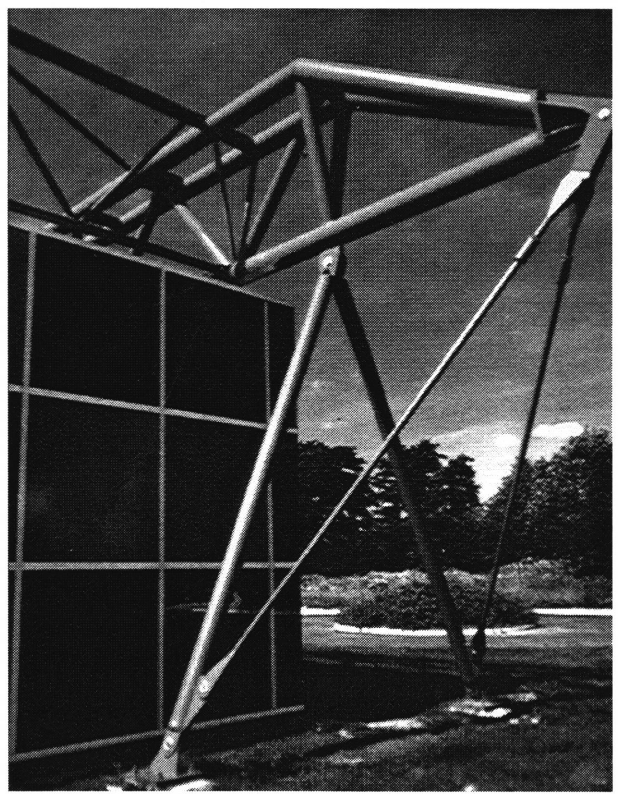

Clockwise from top left: Crystal Palace, Pompidou Center, Renault Distribution Center, Lloyd's of London.

HISTORY

Four buildings which embody these principle architectural pursuits are; The Crystal Palace by Joseph Paxton, Pompidou Center by Renzo Piano and Richard Rogers, The Renault Distribution Center by Norman Foster and Lloyd's of London by Richard Rogers. The Crystal Palace was one of the first structures to combine metal with the concepts of mass production, to create an open adaptable structure. The Pompidou Center uses a more modern metal, steel, for its kit of parts. Its parts were designed using two distinctly different design theories. Piano used cast steel to create one set of parts while Rogers modified standard steel stock in creating another set of parts. The Renault Distribution Center employs standard steel stock and mechanical connections visibly within the frame to describe the flow of forces. Lloyd's of London relies on craftsmanship in construction. Its many elements must each be manufactured precisely to ensure proper on-site assembly.





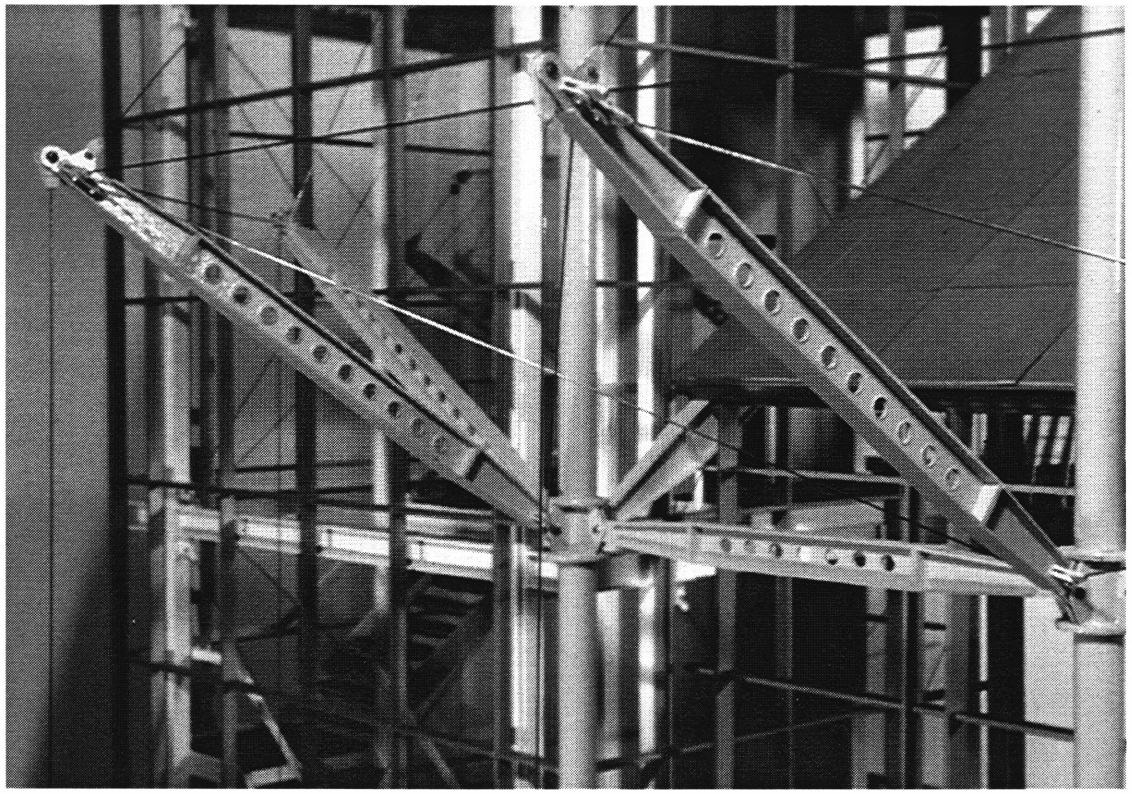


Clockwise from top: Porsche Dealership, Inmos Microprocessor Factory, Center Commercial St. Herblain.

STEEL AND HIGH TECH ARCHITECTURE

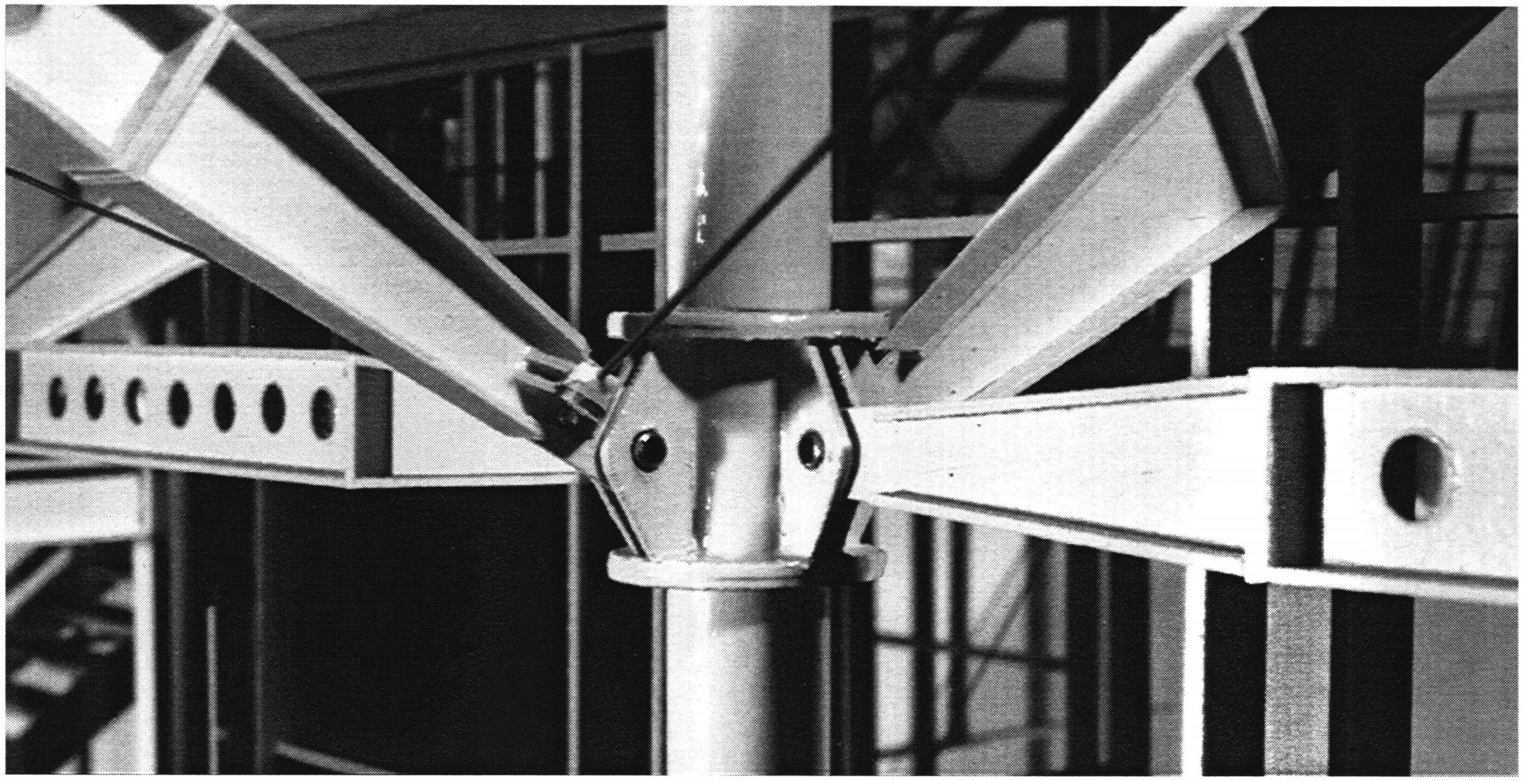
High Tech Architecture is an architecture which allows the viewer to experience and understand the structural integrity of a building. High Tech Architecture is achieved through modern materials and manufacturing methods. The use of robotics in mass production and the potential accuracy and versatility of steel give the basis for this architecture. Steel is inexpensive, stiff, strong and can be machined precisely. While steel could be cast, its most significant attribute is that it can be cut and welded with no loss of strength. High Tech Architecture relies on this attribute in its use of the material. Steel is also accessible in most parts of the world in standard forms; plates, flanged sections, tubes and rods.

In the design of a High Tech building, standard forms of steel are cut down into pieces. Pieces are welded together to form parts. Parts are bolted or pinned together to form assemblies. Assemblies are connected into units which, in turn, are attached to form the frame.

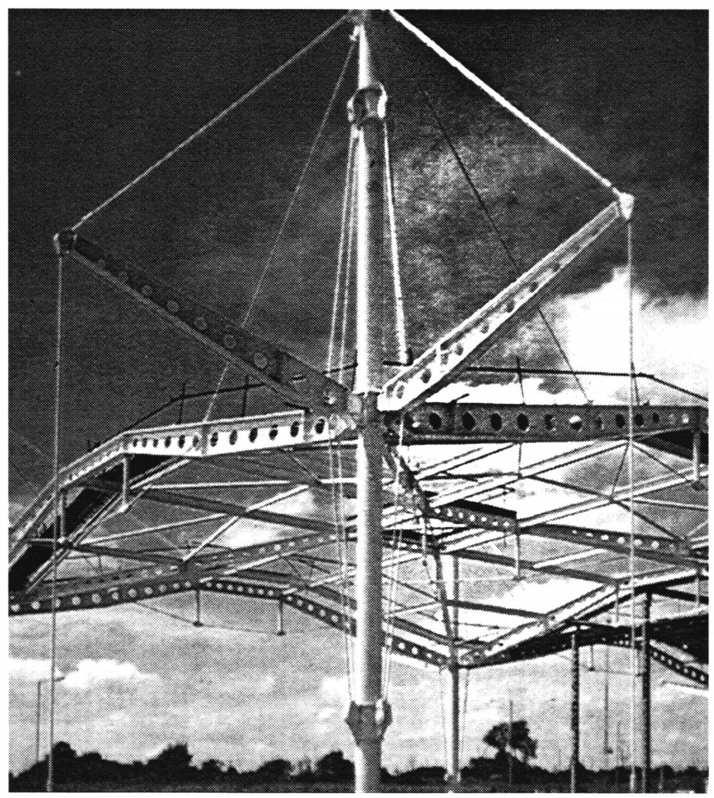


From top: Porsche Dealership, PA Technology Center.

The frame of a High Tech building is designed to be readable. Tasks are separated so that each piece of the frame performs one clearly stated function. Beams are used to collect loads from floors and ceilings and carry it to columns or cables. Columns transfer forces to the ground. Complicated tasks are divided into more easily discernible jobs. A frame should be stiffened using long rods for cross bracing, rather than an awkward moment joint. The number of elements used for each task describes how the frame is performing its function. There is obviously a heavier load where several cables are used to support a part of a beam, and a lighter load where there are fewer cables. Every joint and element used in the frame contributes to the readability of the structure.

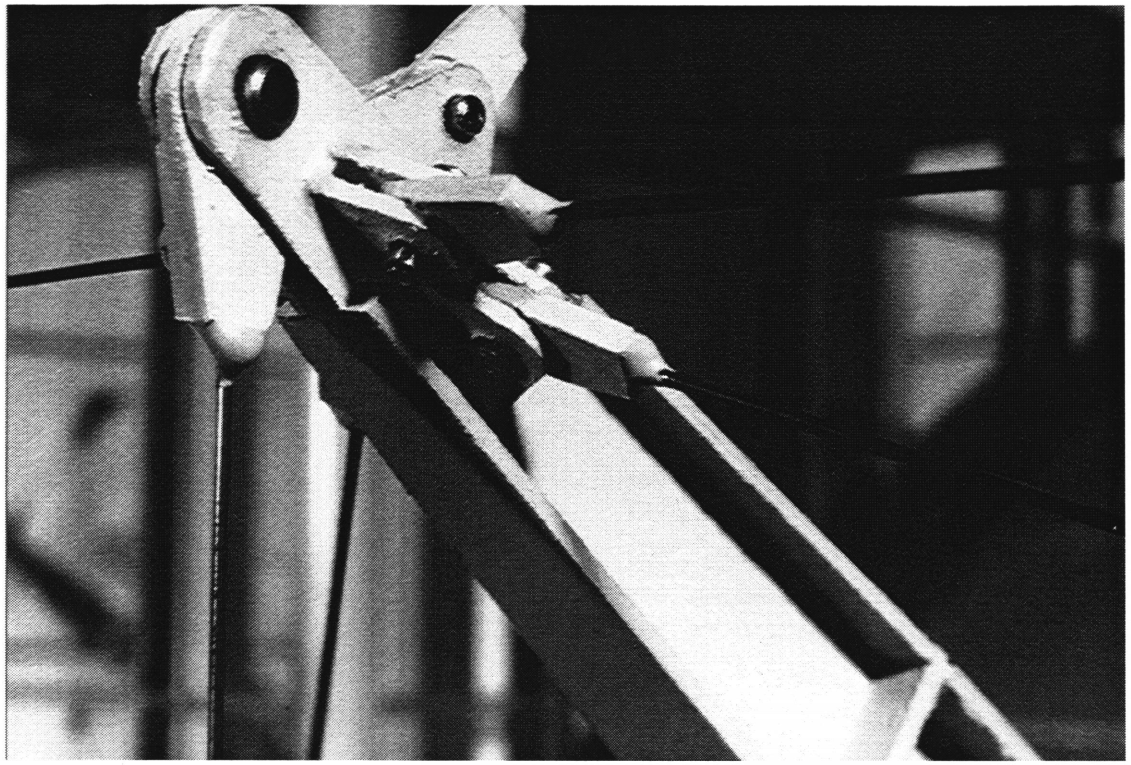


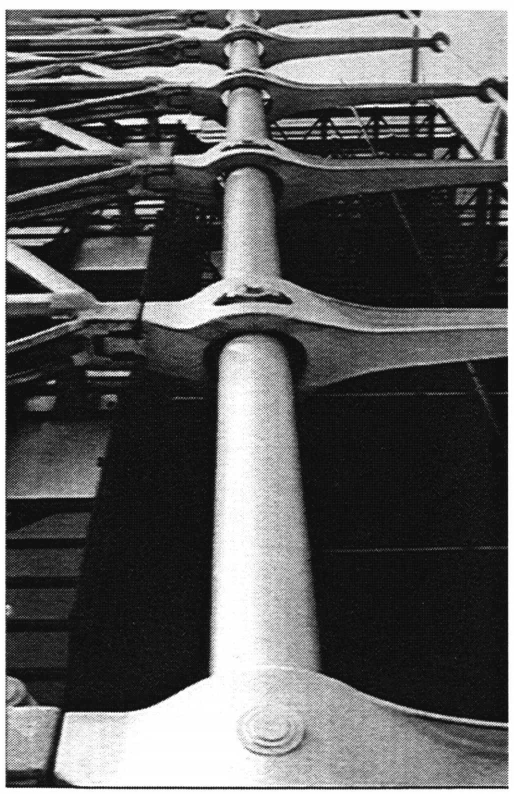
There are three primary joints used in these structures; pinned, bolted and welded. Pinned joints are the most specialized and are used when connecting different types of elements or where there is a change in the force flow. A pinned joint can not resist a moment force and will therefore not transfer the force through the joint. When it is necessary to resist a moment force a bolted connection is used. Bolts are used between similar elements such as column sections. A bolted joint allows secondary elements to be attached easily, for example when connecting secondary roof beams into the primary frame. The third type of joint is the welded joint. Welded joints do resist moments and will transfer any type of force through the joint. Welding is used to connect pieces into parts and is the most common of the three joints.

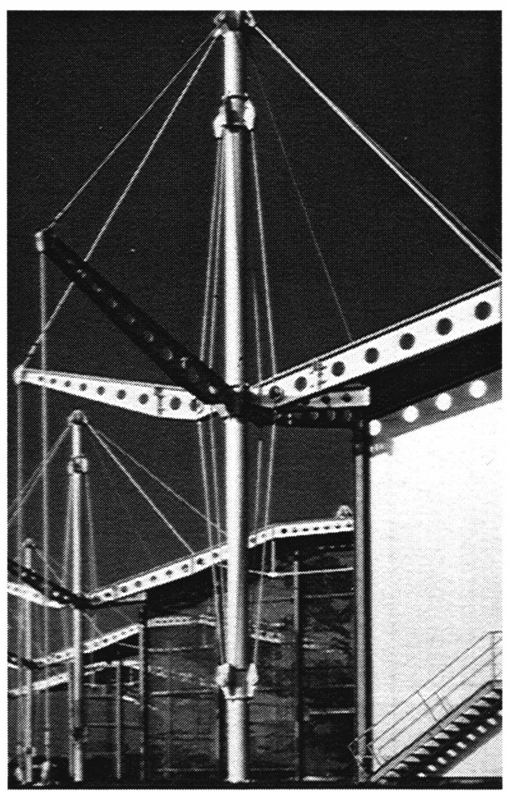


Clockwise from top: Porsche Dealership, Renault Distribution Center, Inmos Microprocessor Factory.

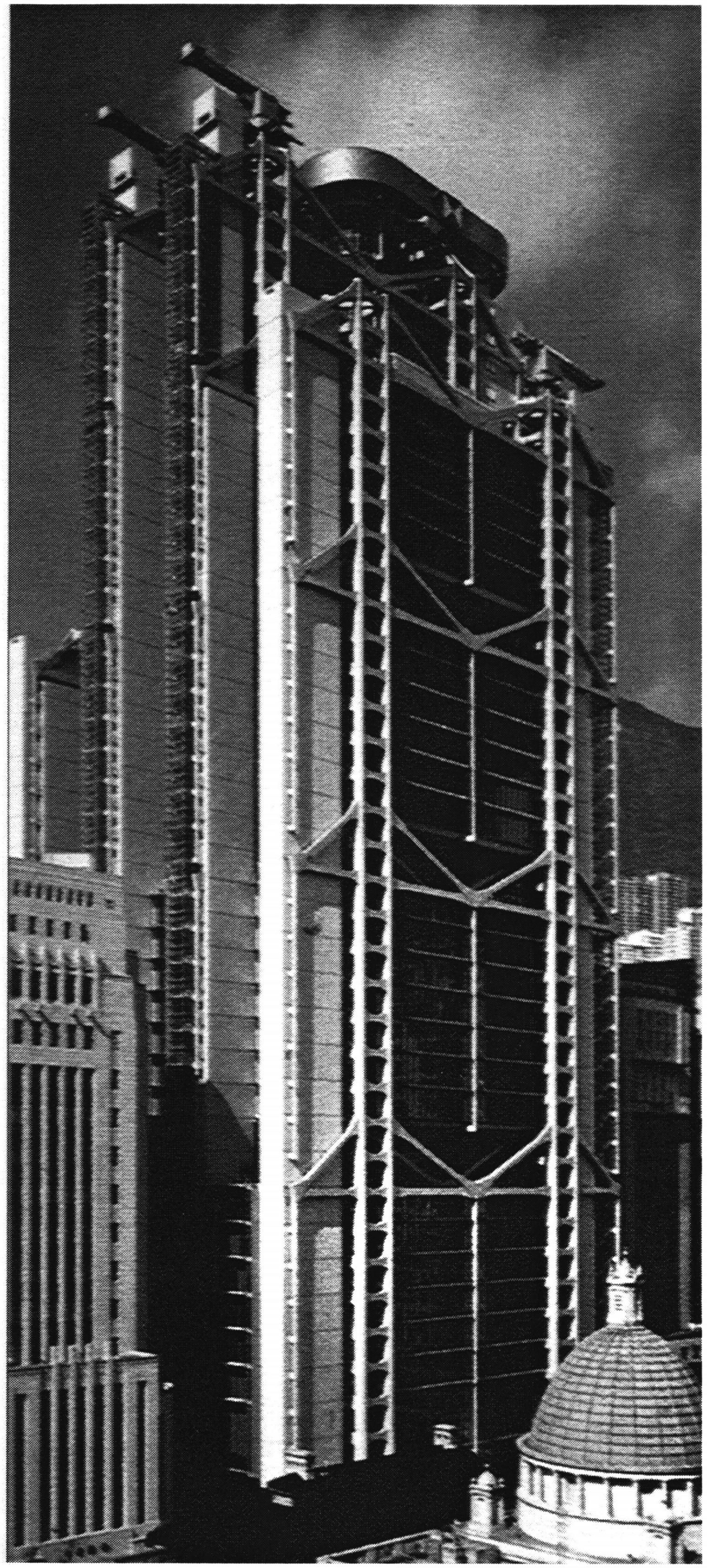
Like the joints, there are three primary elements used in High Tech structures; cables, tubular sections and flanged sections. Cables can carry only axial tension and are always pinned at their ends. Cables are usually used in opposing pairs. A tubular section can carry tension or compression in an axial manner. It is generally used as a column. Other members are pinned to the columns so that no moment is transferred to them. Since tubular sections are completely symmetrical, they only require one connection detail. The final type of element is the flanged section. This section can resist tension and compression in any direction. It is most commonly used as a beam. Any excess material in the web can be cut away to create patterns and cast shadows on the building. The flanges cast shadows onto the member itself adding visual depth to the individual frame members.

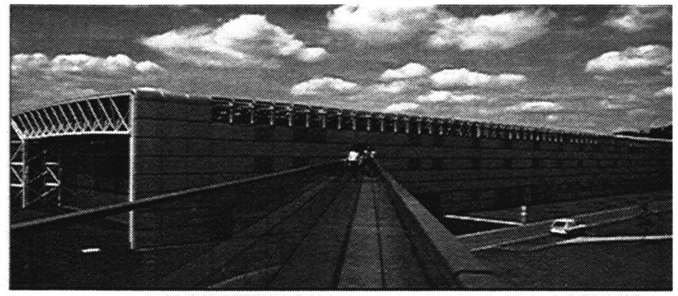


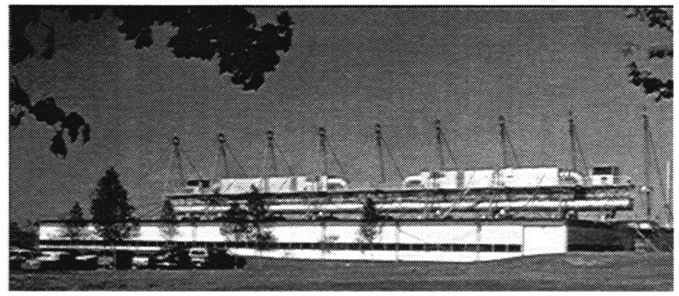


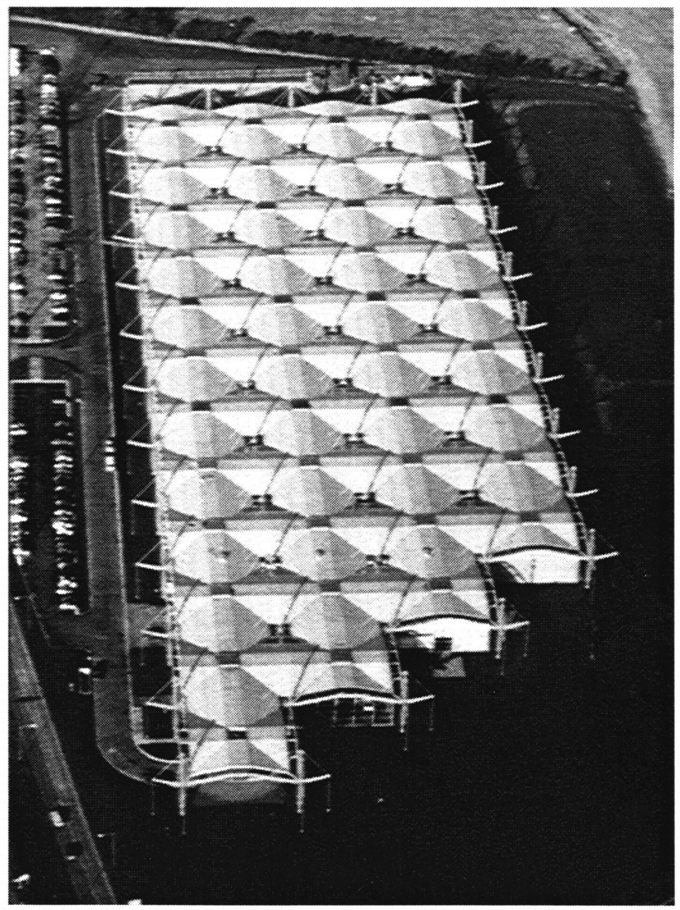


Clockwise from top: Porsche Dealership, Renault Distribution Center, Pompidou Center.



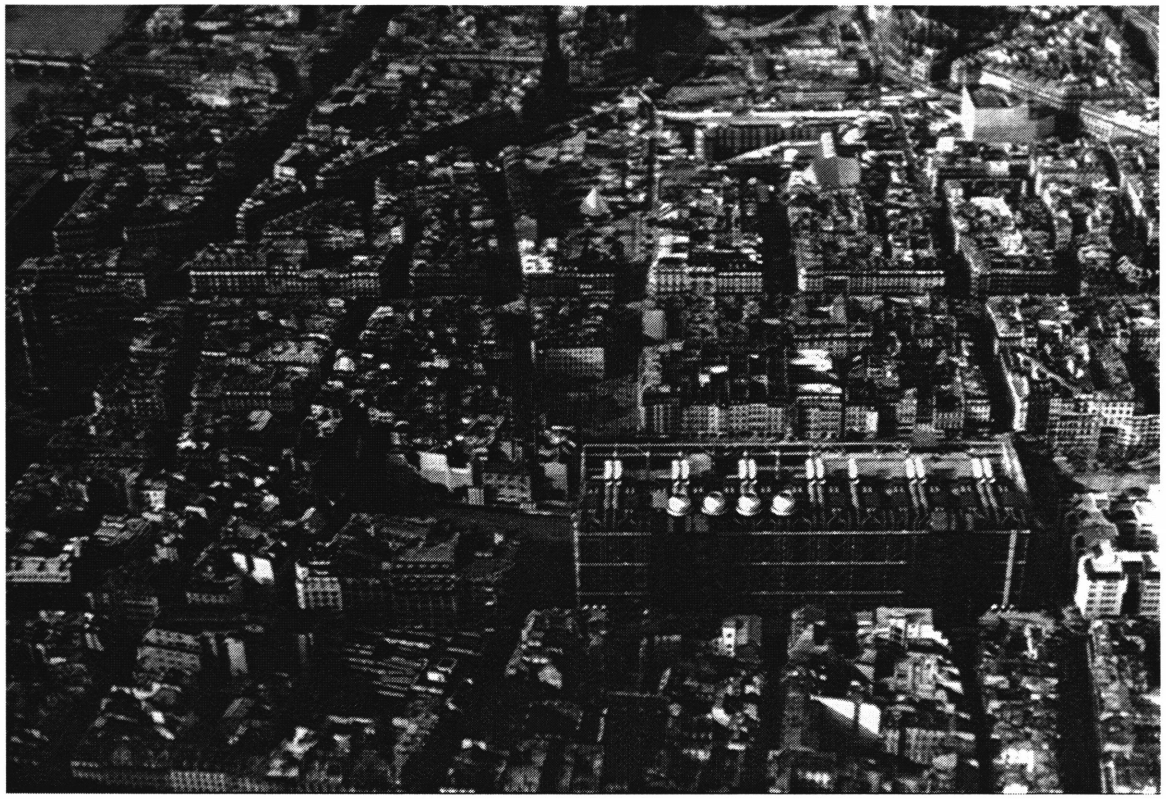


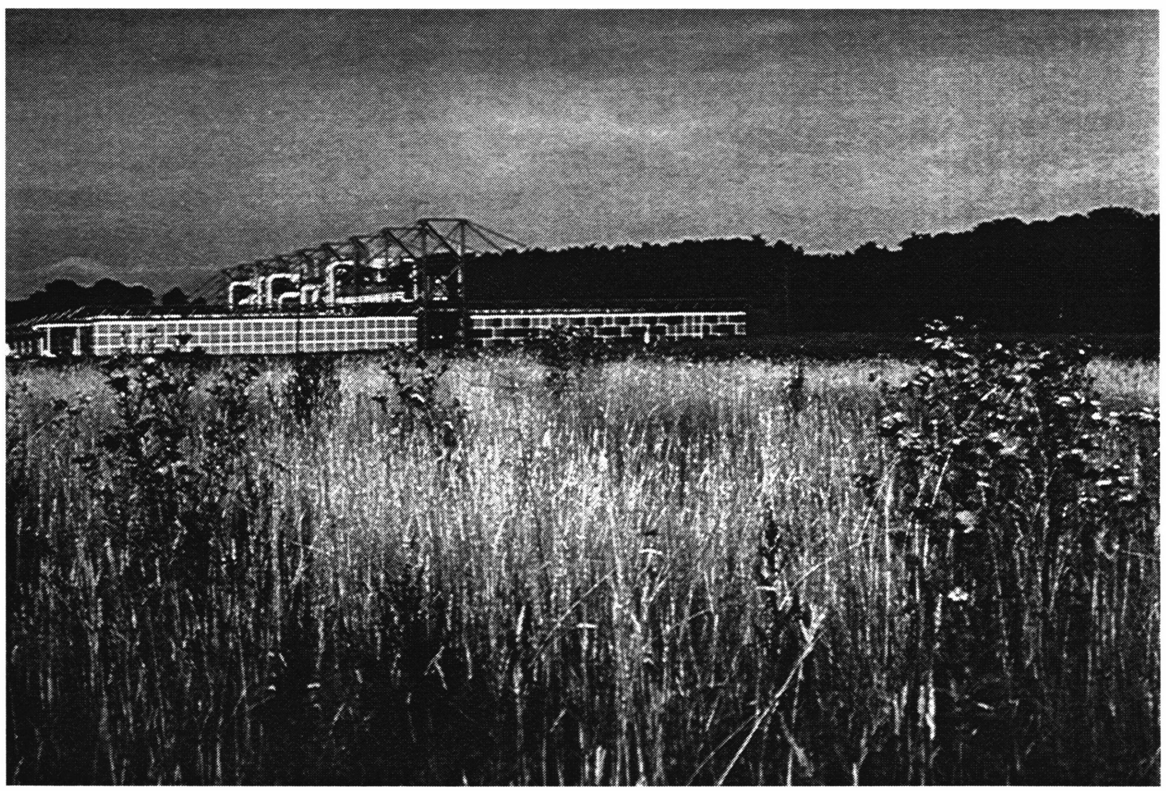




Clockwise from left: Hongkong Shanghai Bank, Sainsbury Center, PA Technology Center, Renault Distribution Center.

The primary architectural elements are connected into frames of three forms: a linear structure, a two dimensional planar structure and a three dimensional structure. In one dimensional, linear buildings the width is limited by the spanning abilities of the assemblies being used. In some linear buildings, the forces are distributed to the edges of the structure resulting in a single, large, open interior with nothing to arrange the space. Other linear buildings direct forces to columns at the center of the structure. The columns give a place to collect utilities and help organize the interior spaces. Two dimensional buildings are able to cover large areas and are generally used as warehouses. The interior columns arrange interior spaces while the perimeter columns visually dissipate the mass of the structure into the open surroundings. The most frequent example of a three dimensional structure is the American glass box skyscraper. In contrast to their simple facade, the High Tech buildings push their framework to the outside of the building and collect their utilities in lines along the exterior of the structure. This opens the interior so that natural light is available throughout the entire building.

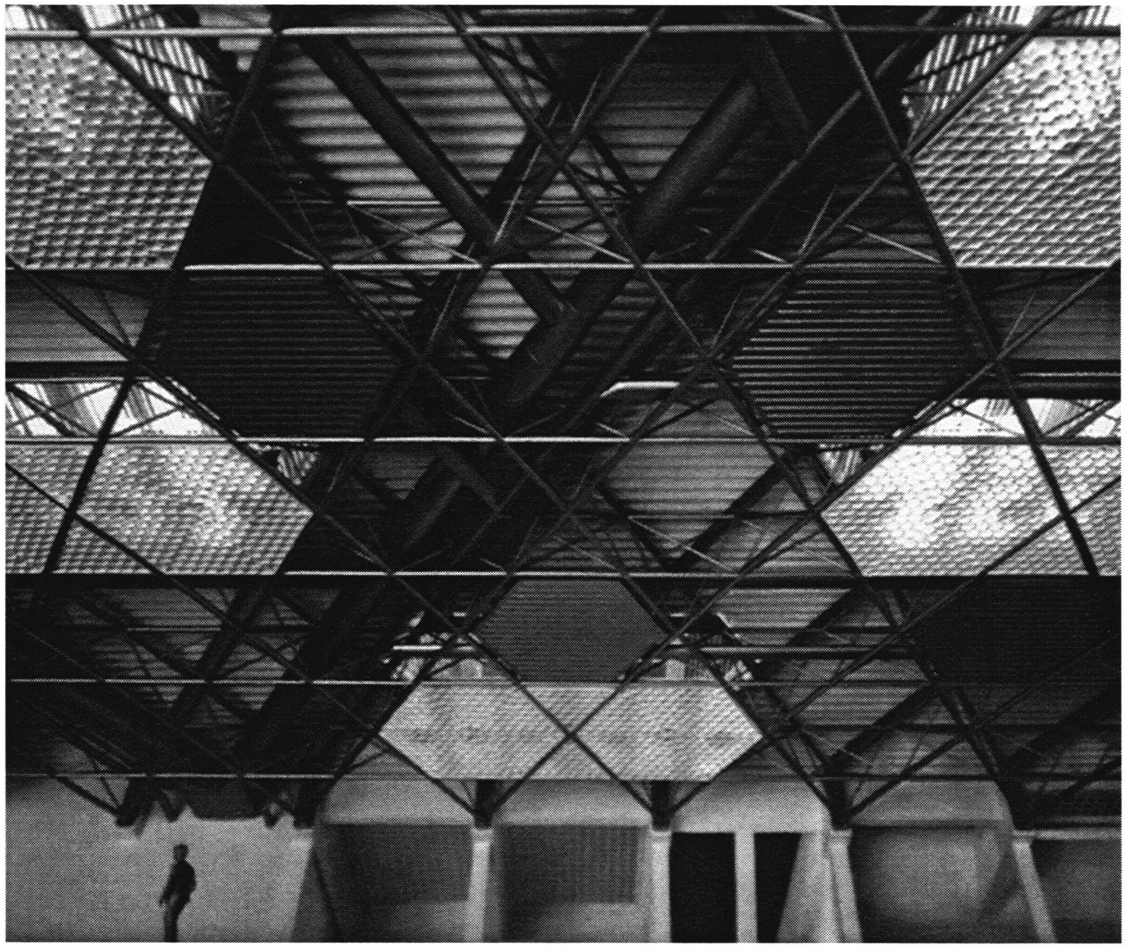


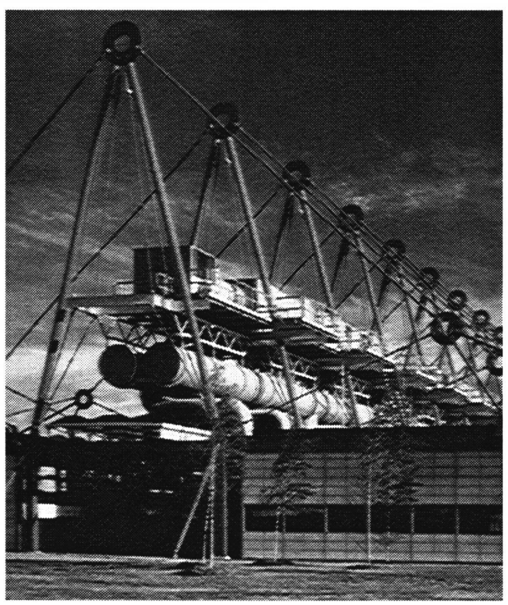


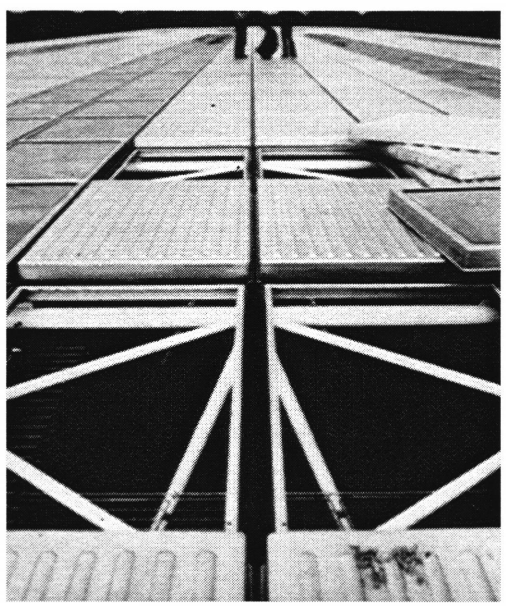
From top: Pompidou Center, Inmos Microprocessor Factory.

High Tech buildings in urban settings are usually three dimensional structures. In these settings, neighboring structures define the High Tech building's place. These High Tech buildings keep their framework close to their skin since there is no room for it to reach out and anchor itself. High Tech buildings in rural settings, however, expand into the surrounding open space. The building, through its frame, must create its own place. If it fails it could end up floating in a sea of grass.

These buildings draw little from their site. The only way to know where one is, is to know where the building is. The uniqueness of the structure does not come from regional architecture, but from the building's own architectural elements.



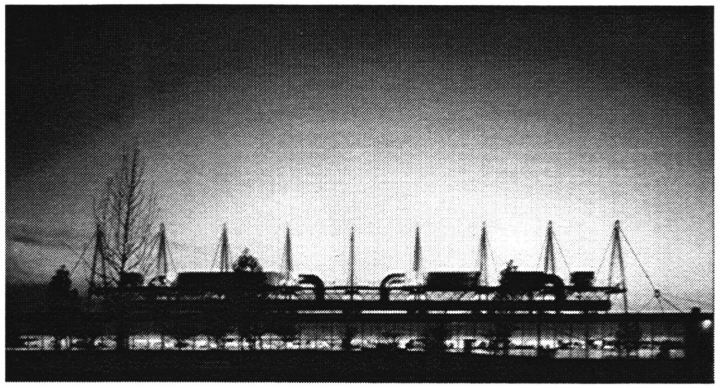


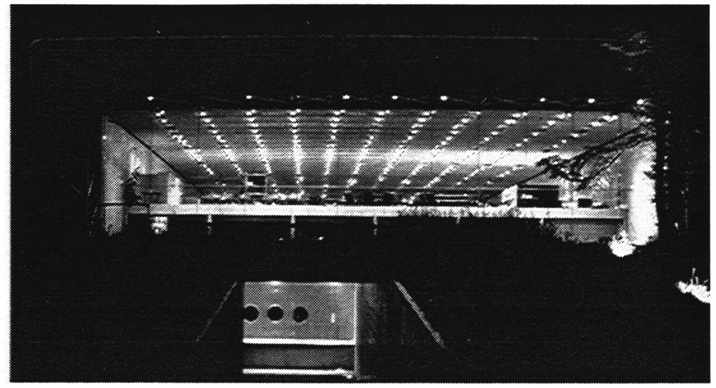


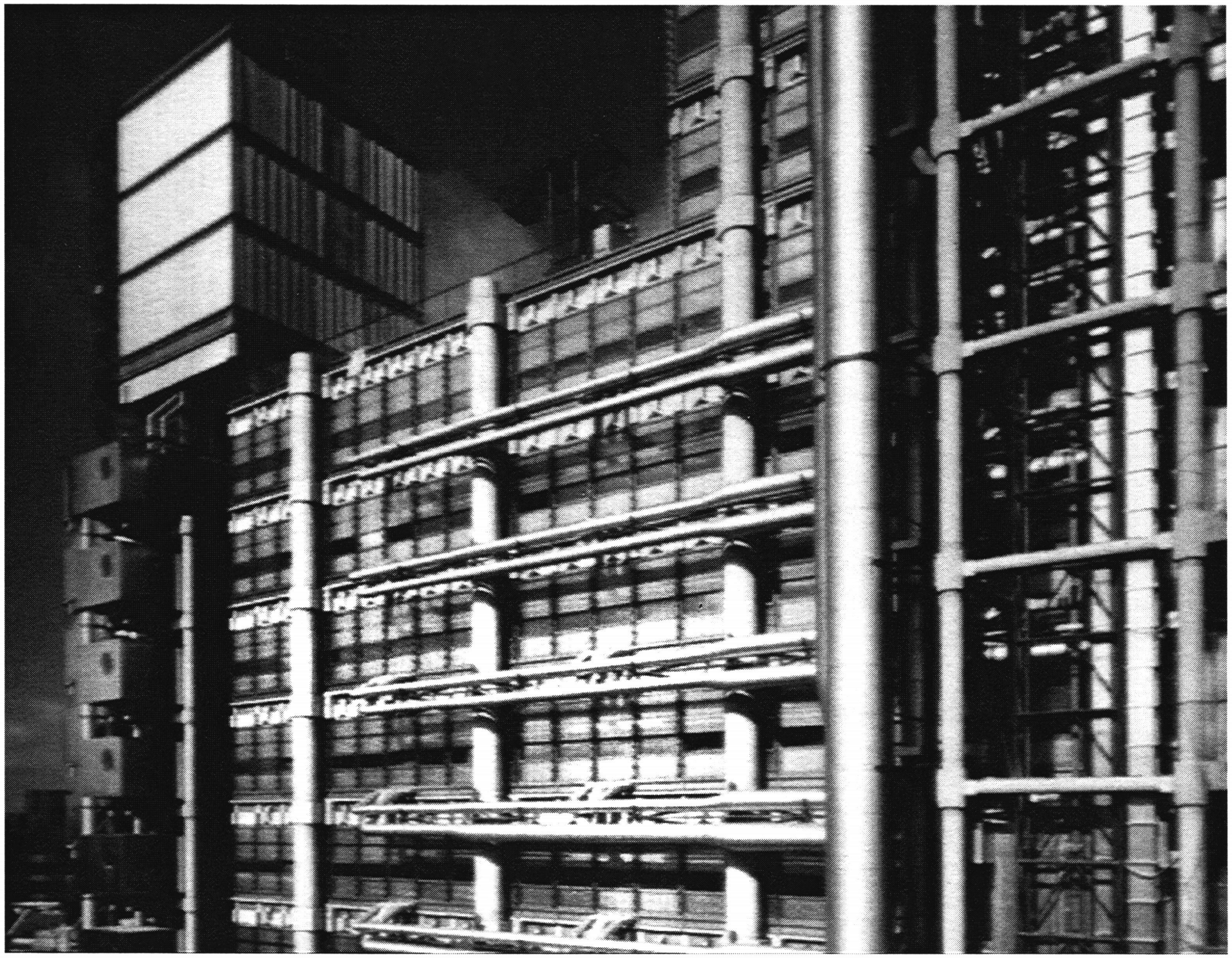
Clockwise from top: National Indoor Athletics Stadium, Sainsbury Center, PA Technology Center.

The most prominent element in a High Tech building is its primary frame. The frame sets the base rhythm for the entire structure. This rhythm is derived from the spanning abilities of the assemblies. Any change in the elements of the frame results in a change to the rhythm of the building. When designing these elements, both size and weight must be considered, so that the resulting elements are easy to transport and erect.

The frame assembly creates a three dimensional canvas on which other systems and their functions exist. The skin has an obligation to reiterate the frame's pattern, while the utilities and other elements must conform to it. The frame never makes an exception for them, they work within the frame's constraints. In the National Indoor Athletics Stadium the HVAC ducts weave through the frame, light diffusers duplicate the pattern of the frame, and the corrugated roof decking emphasizes the linearity of the building.

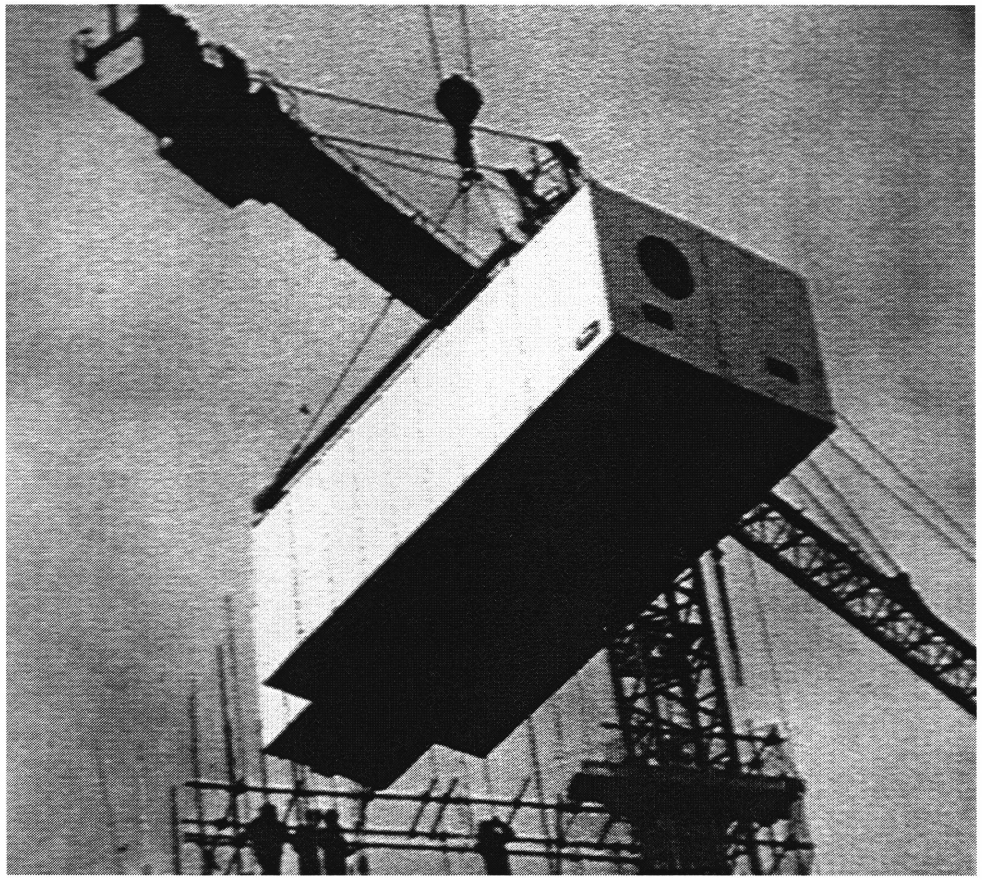


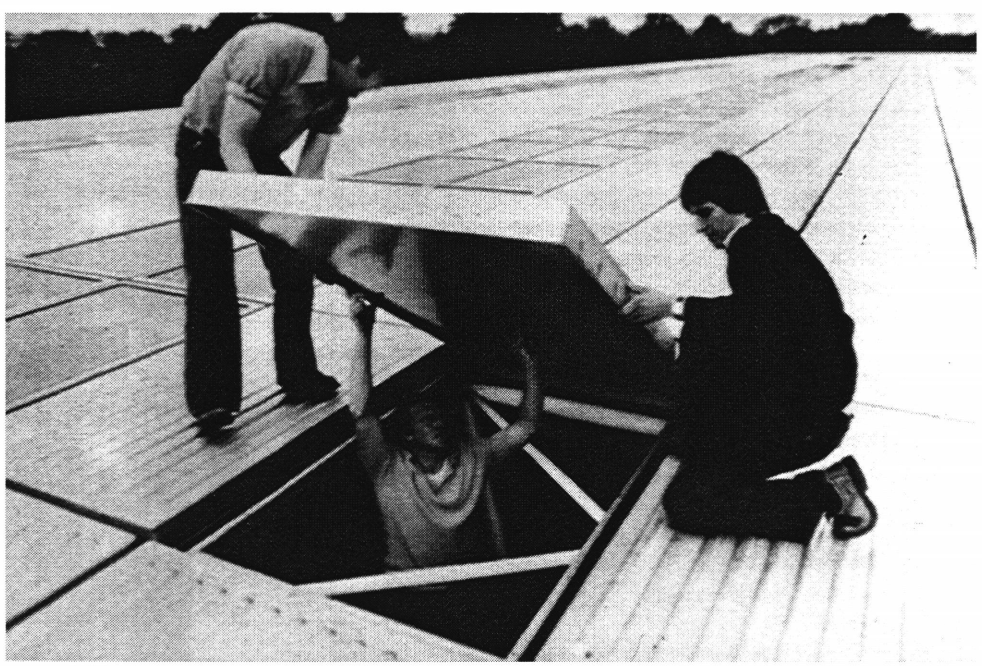




Clockwise from top left: PA Technology Center, Sainsbury Center, Lloyd's of London.

There are three primary ways of designing utility systems in High Tech buildings; around points, along lines and across planes. When utilities are collected at points they are easy to service. This design strategy requires long duct runs to get the utilities where they are needed. The ducts then emphasize other assemblies in the building. The main HVAC ducts at Lloyd's emphasize the verticality of the utility towers while the secondary ducts delineate each floor. When arranging utilities along lines, they are still collected into a small area where they can be easily serviced, however less ducting is required. This technique is most often used in linear buildings, such as the PA Technology building. Here, the main supply duct emphasizes the linearity of the building. The third way in which utilities can be arranged is across planes, such as in the Sainsbury Center. Here, utilities are distributed evenly throughout the space frame. Utilities fill the interior of the frame, adding to its visual complexity. With this arrangement of utilities, no ducting is needed since small units are placed wherever they are needed.



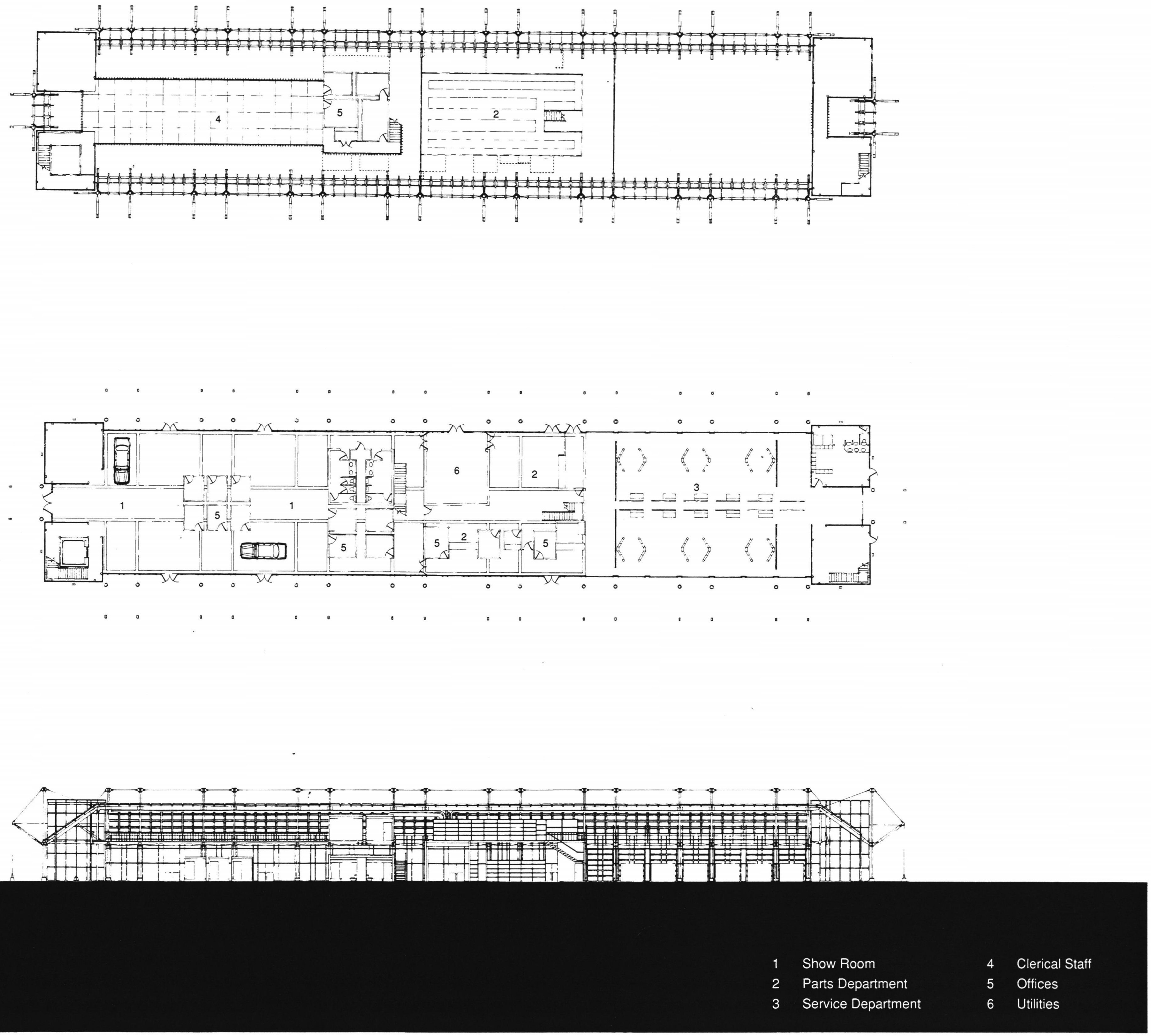


From top: Lloyd's of London, Sainsbury Center.

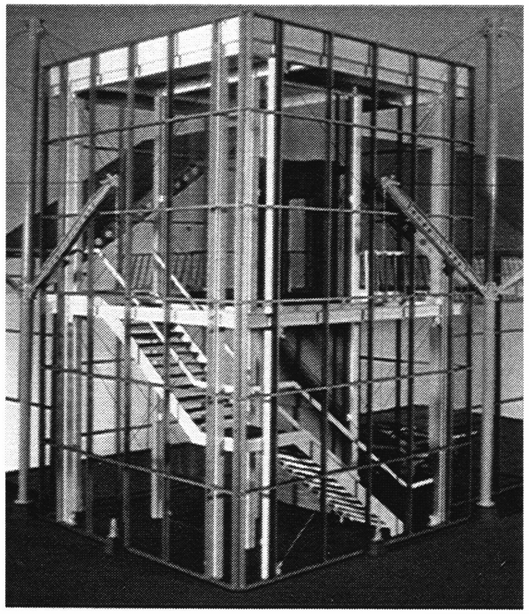
All of these High Tech structures employ factory produced parts, from the small roof panels at The Sainsbury Center to the complex bathroom modules at Lloyd's. There are several benefits to factory production. Factories provide better working conditions for employees. When workers are kept warm and dry they do a better job. Additionally, control over the machines and materials allows for a more precisely crafted product. Since parts are made off-site, they must be easily transportable. Parts must be made accurately so that when they arrive on site, they will not need reworking. Everything from the foundation to the hand rails must be precise. Finally there must be enough of each part to offset the cost of creating the tools which are needed to produce them.

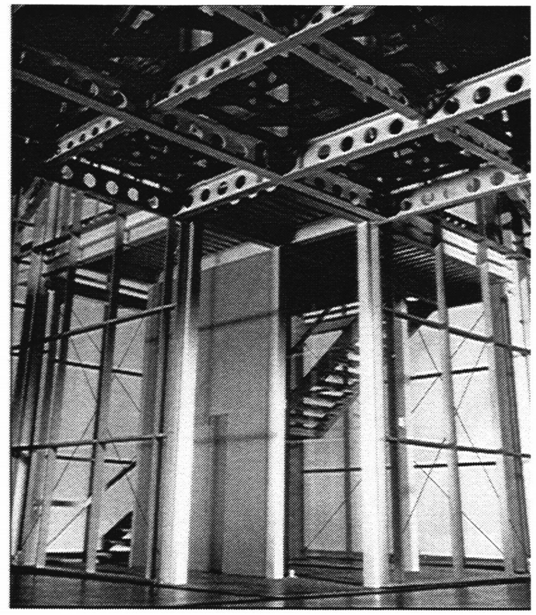
Porsche Dealership, clockwise from top: Skylight, Elevator Tower Frame Joint, Second Floor, Elevator Tower Frame Joint.

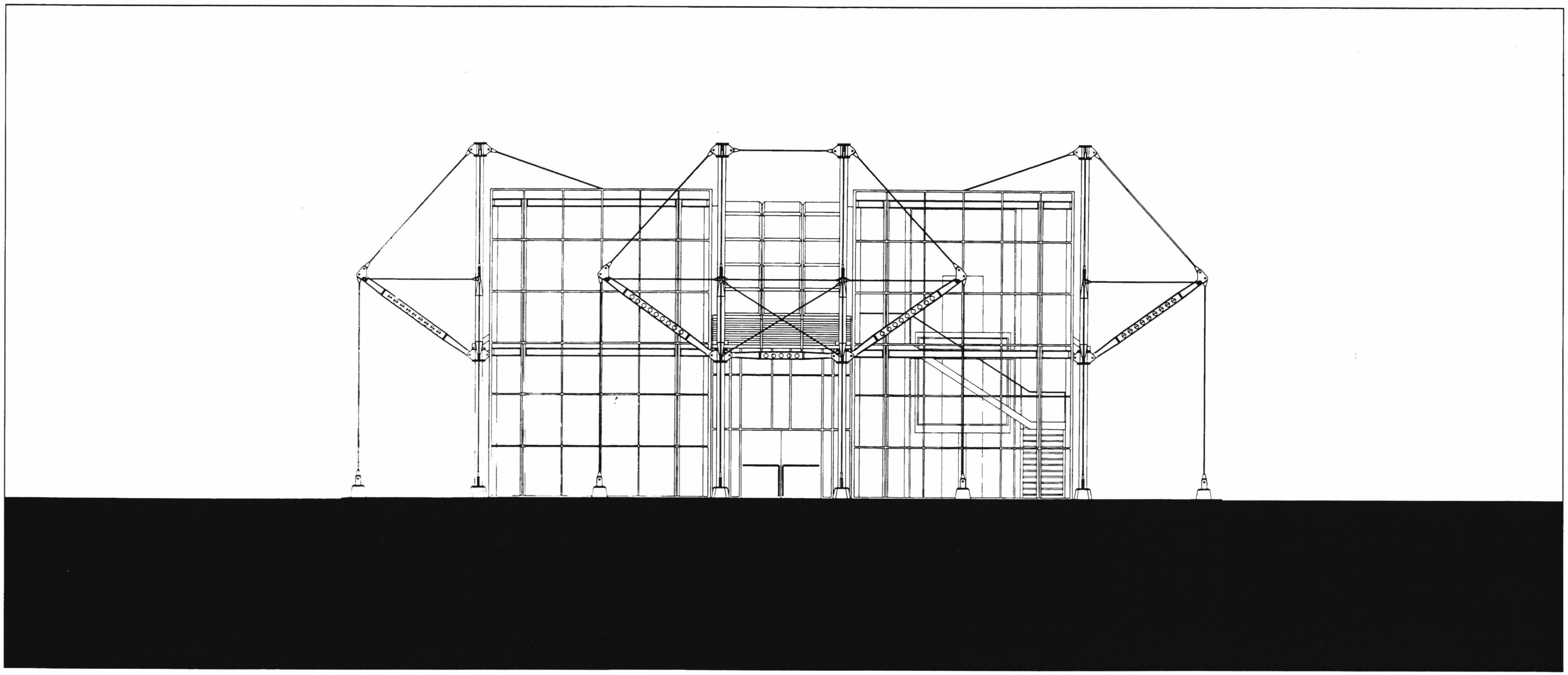
The project for this thesis is an automobile dealership. It is a dealership for high quality automobiles. The building has been designed in the way that the vehicles are designed. It is composed of many well designed parts creating a complete object. The three primary pursuits of architecture have been achieved in this design. Steel is used in ways which describe and exploit its natural characteristics. Long thin members are bolted and pinned together, clearly showing how each performs its individual task. The construction of this building relies on craftsmanship and precision. If the foundations are inaccurate, the frame members will be misaligned and none of the panels or plates will fit. This is a linear building in which the primary frame sets the base rhythm for the entire structure. The roof panels reduce this rhythm to a human scale. Utilities are collected around a point in the center of the building and are distributed linearly along the length of the structure.



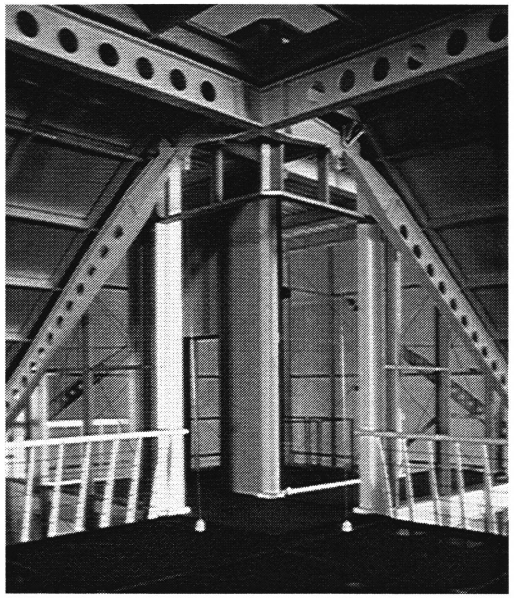
Porsche Dealership, from top: Second Floor Plan, First Floor Plan, Longitudinal Section.

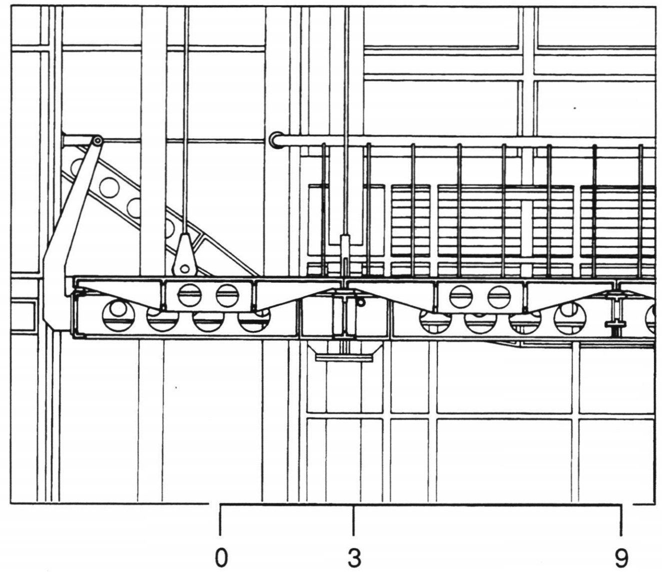


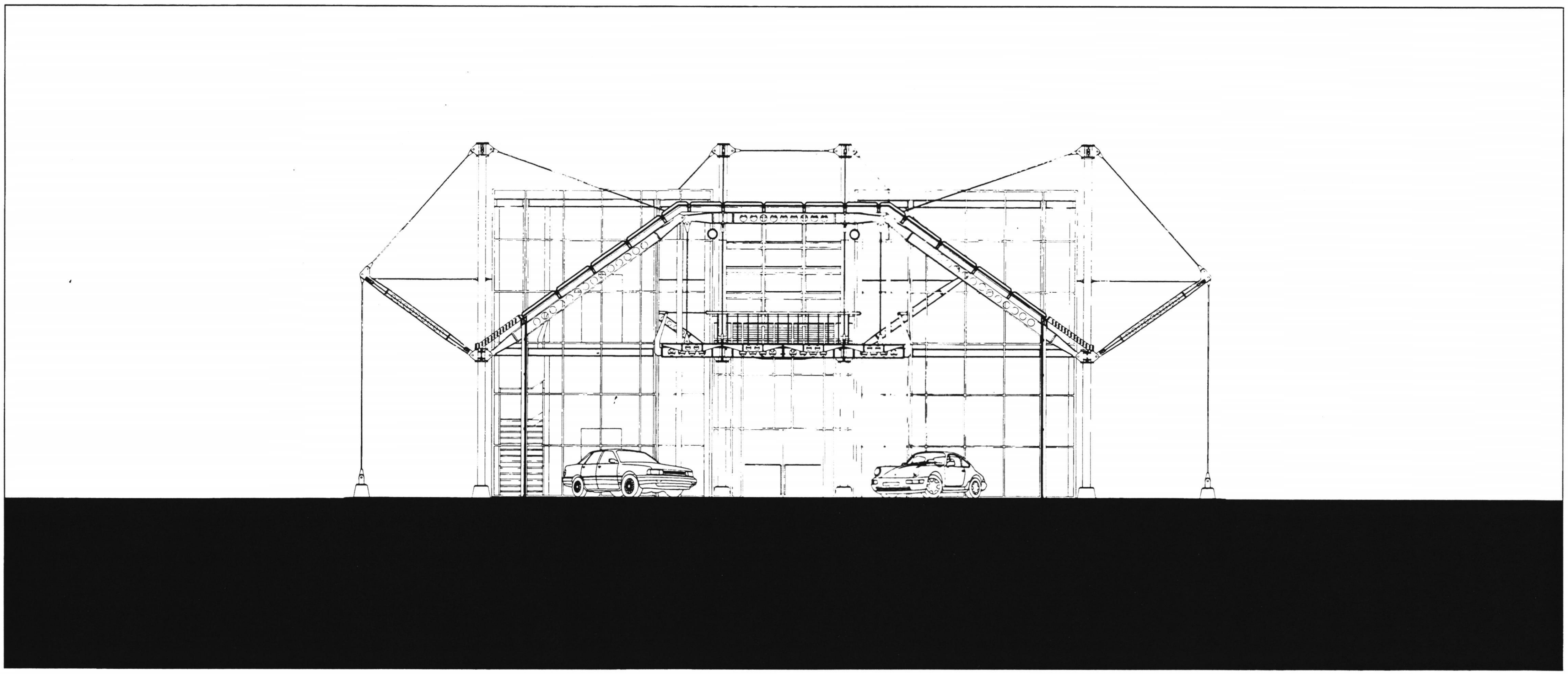




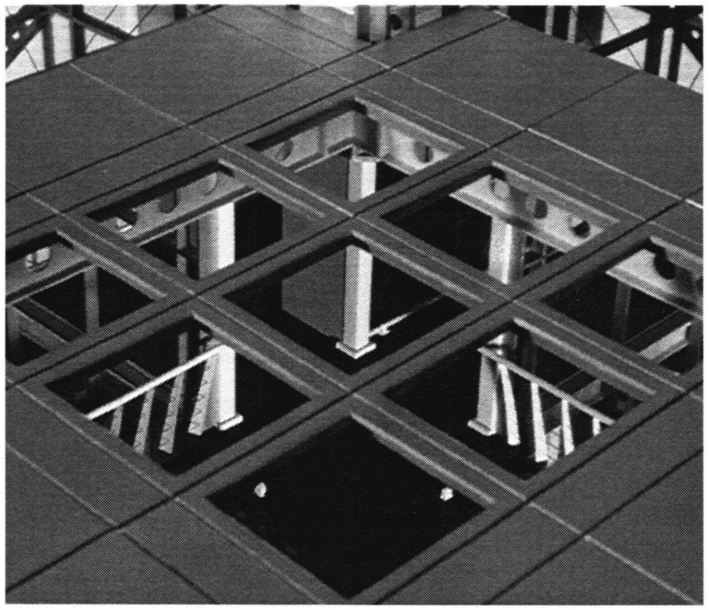
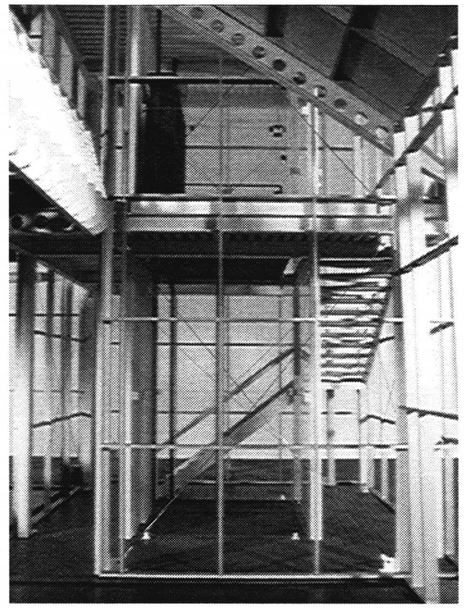
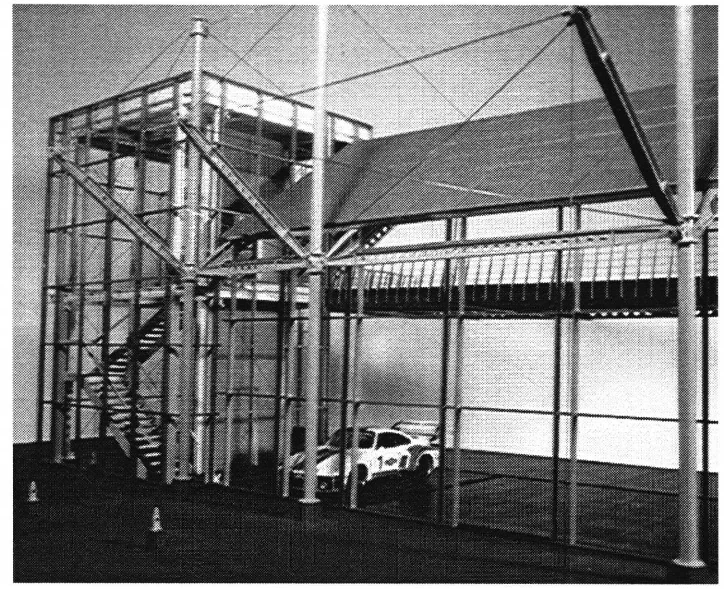
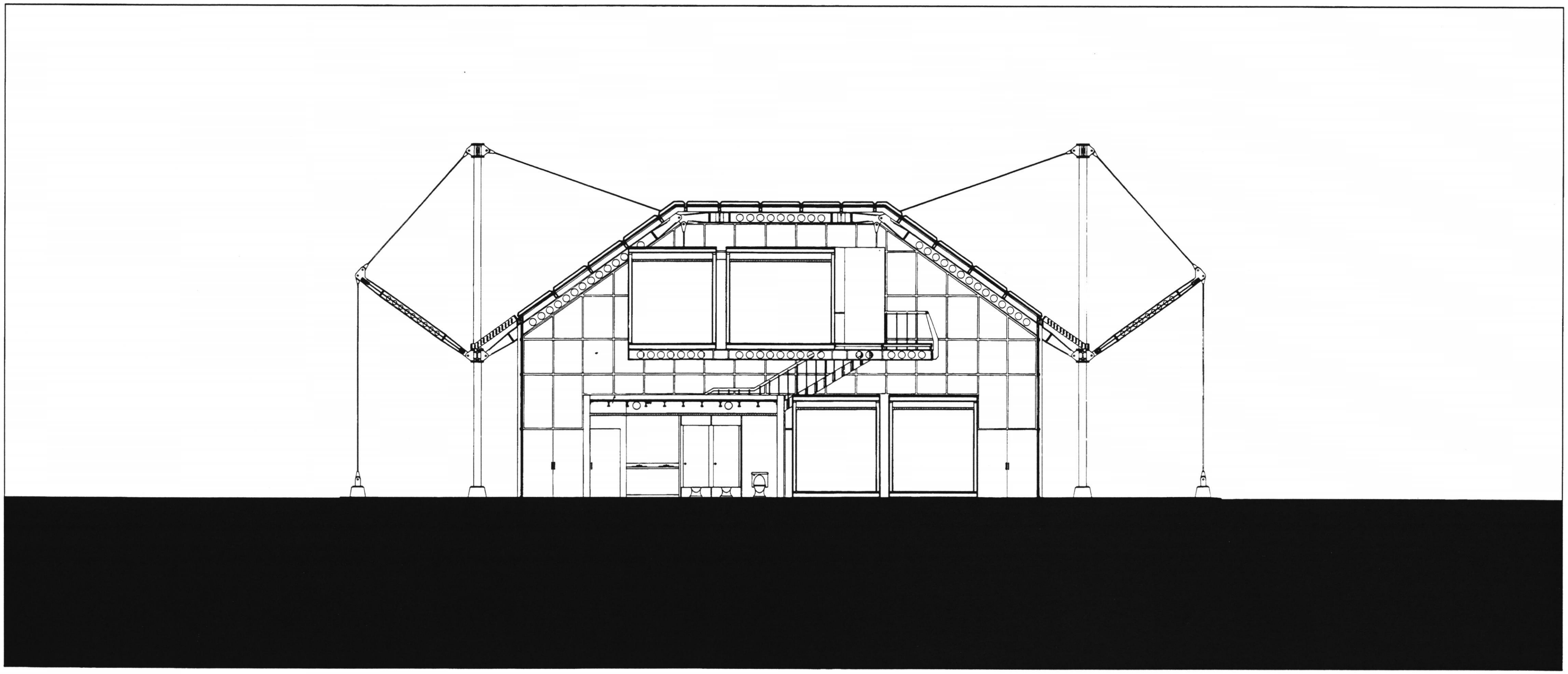
Porsche Dealership, clockwise from top left: South East Corner, Elevator Entrance First Floor, Elevator Tower South Elevation, South Elevation.



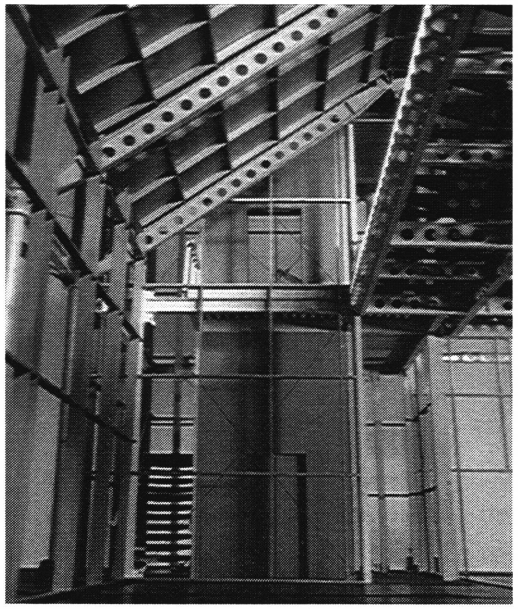


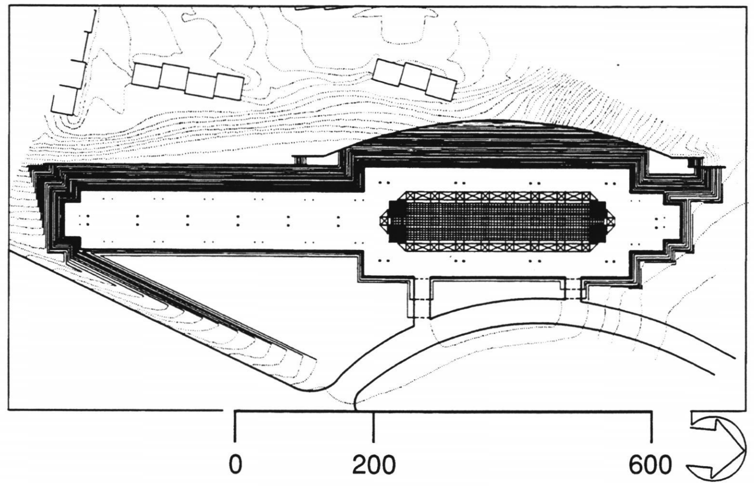


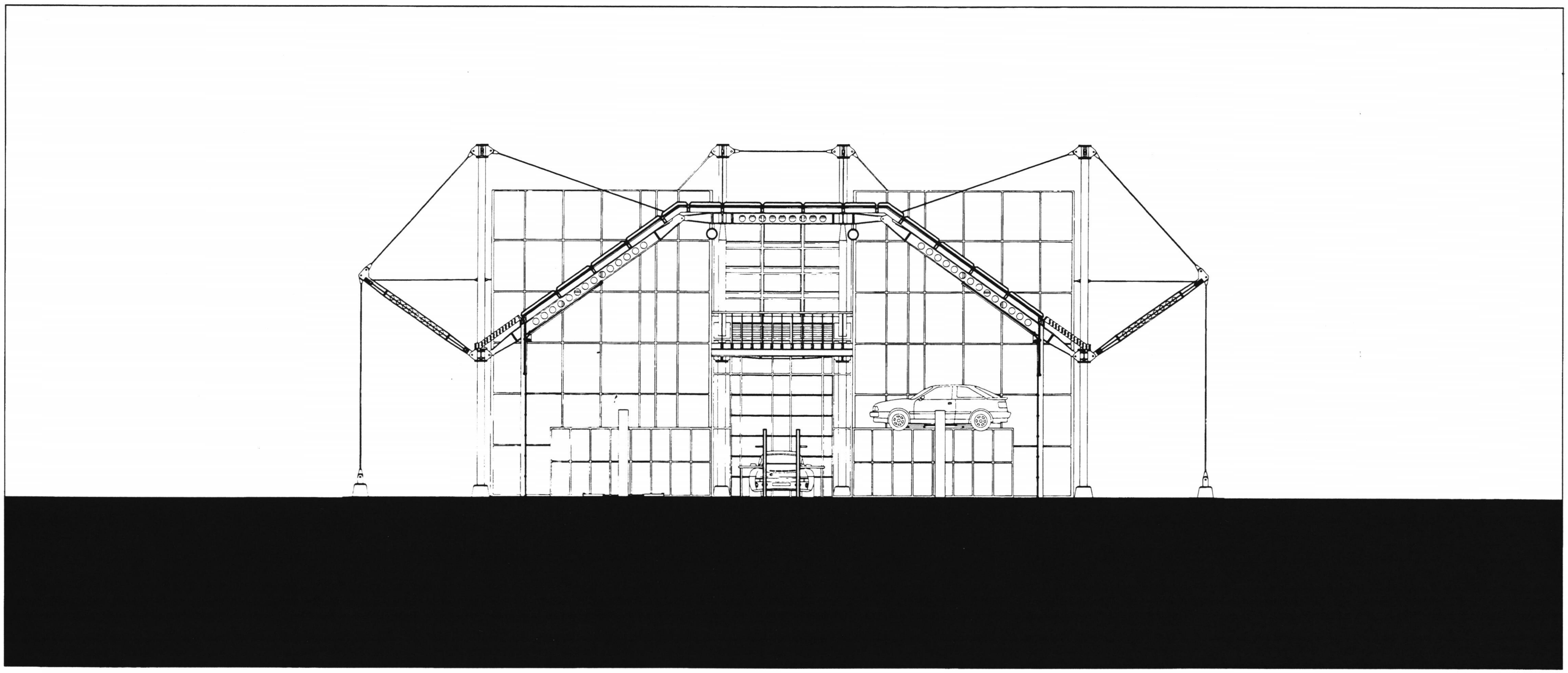
Porsche Dealership, clockwise from top left: Elevator Entrance Second Floor, Detail Section of Second Floor, Bottom of Second Floor, Section Through Show Room.

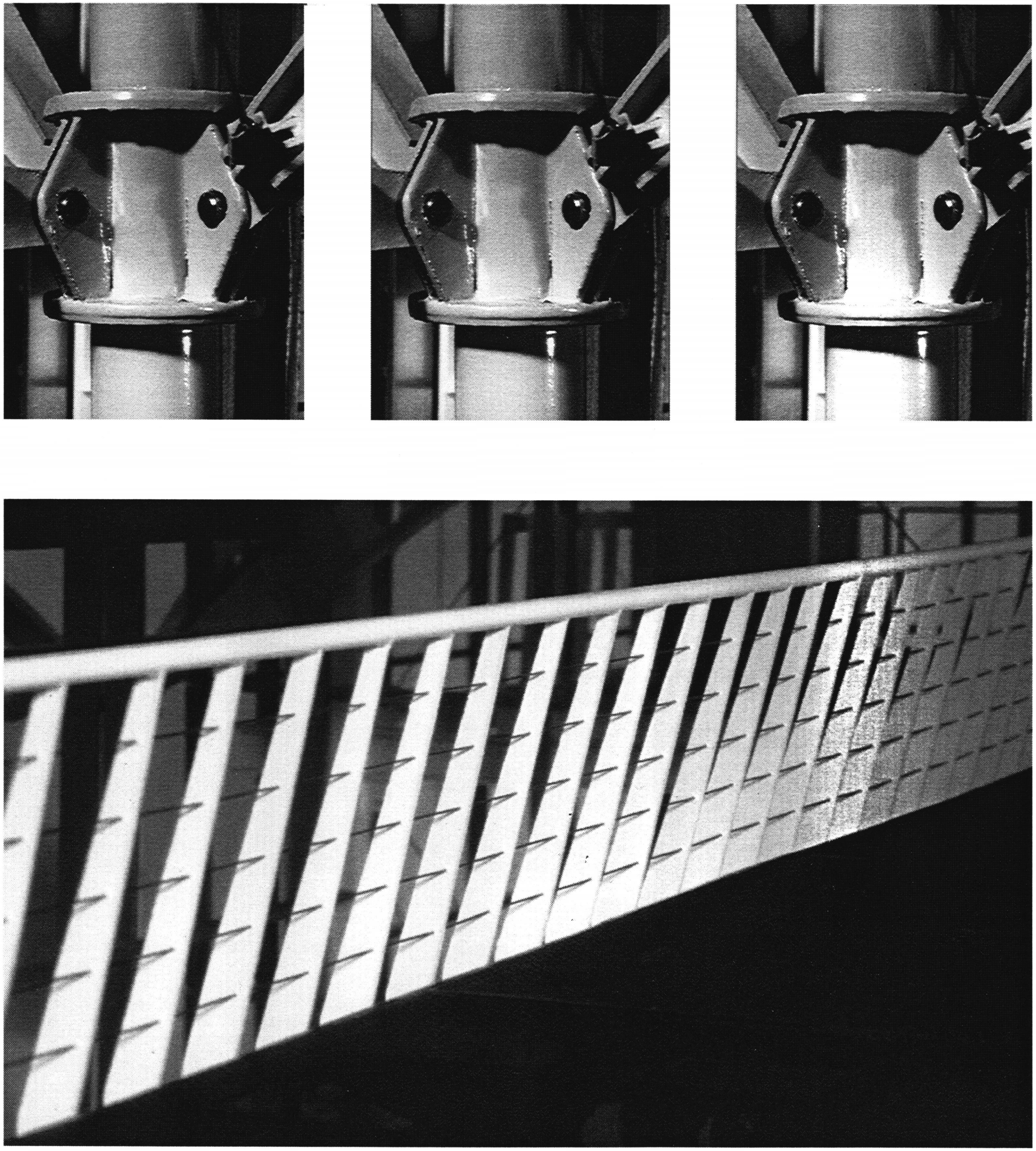
Porsche Dealership, clockwise from top left: Skylight, Elevator Tower, South East Corner, Section Through Office Cubicles.





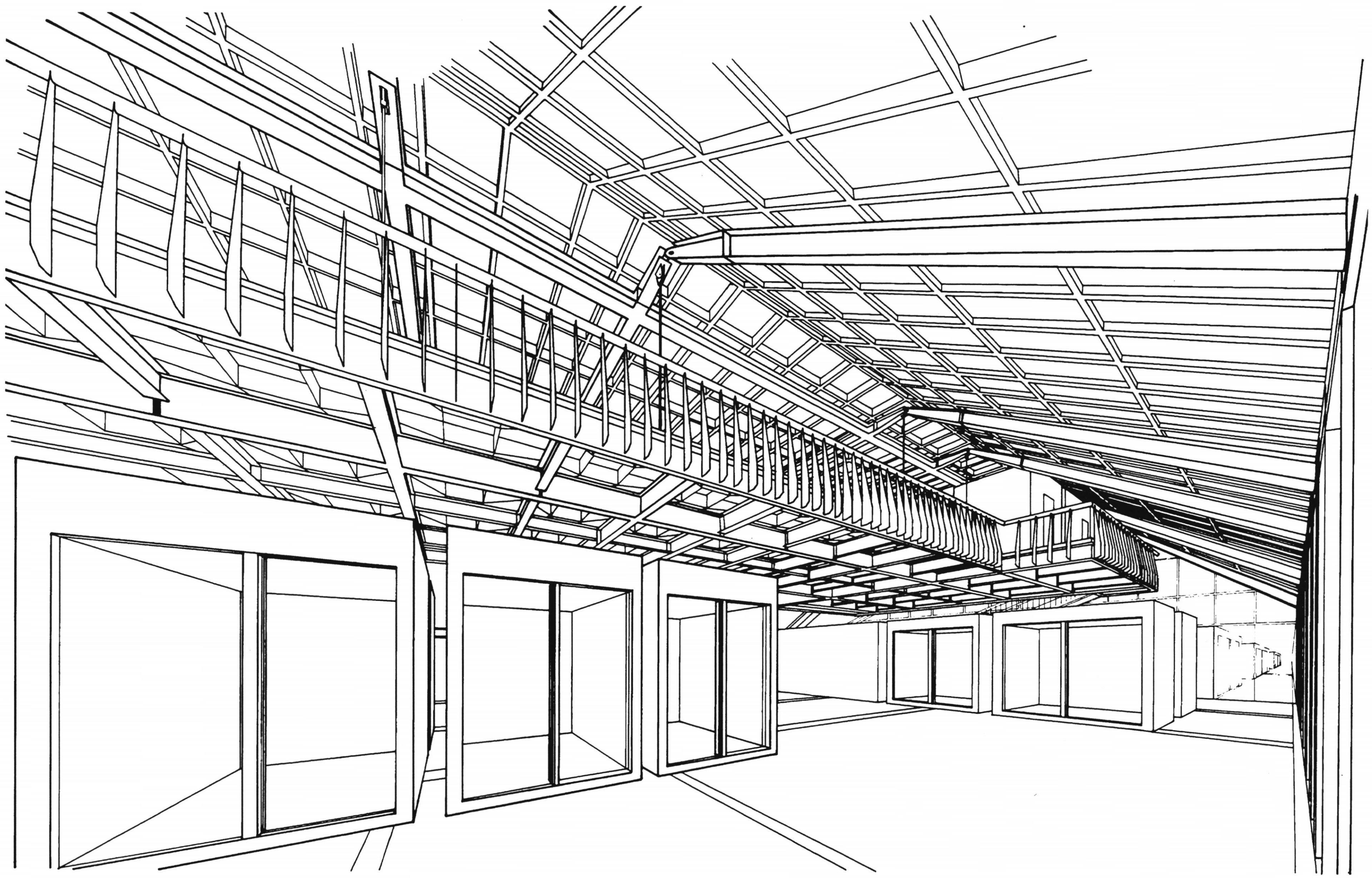


Porsche Dealership, clockwise from top left: Elevator Tower, Site Plan, Elevator Entrance Second Floor, Section Through Service Department.



Porsche Dealership, from top: Column Beam Joint, Second Floor Hand Rail.

All High Tech buildings use mass produced parts in their design. Two factors serve as contributors; the amount and variety of available metals and the growing use of robotics in the production process. Today's machines can produce the same piece repeatedly without error. These factors allow everyone the chance to experience good architecture. If these pieces were produced by hand, fewer would be made. In our society these few elements would be placed where the clients would see them, in the lobbies and showrooms of the buildings. This prevents the dock workers and delivery truck drivers from experiencing pieces of quality design. Mass production provides the opportunity to experience a well designed piece of architecture. Architecture is for everyone, not for the chosen few.



Porsche Dealership, Show Room.

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