

**Conceptualisations** |————



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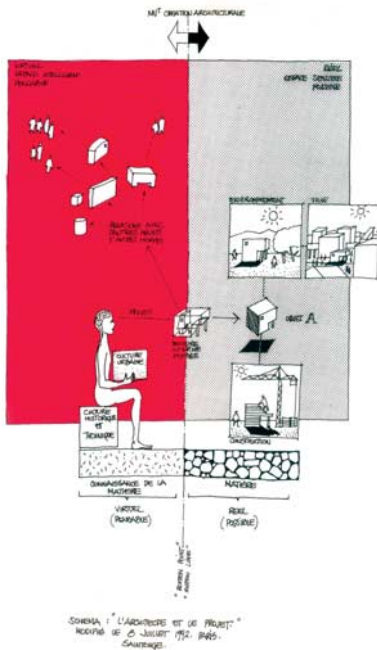
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*\* The keynote speakers appear with the order they intervened.*

# Construction, Experimentation and the Design Process

Pascal ROLLET



I will be speaking to you today from three different professional perspectives. In fact I refer to them as wearing three different hats. The first is as an architect with a private practice, which I will refer to with examples, to illustrate some of the points I wish to make.

The second is that of a teacher of architecture, who teaches studio work in architecture, but not construction, even though I am very interested in how matter is used and put into place or how you assemble and create from scratch. In other words, I am interested in construction, and it is for this reason that I work in cooperation with others at Grenoble, who are involved in the teaching of construction. So, as a team, we aim at creating pedagogic opportunities for students to come in contact with matter and the grounds of Grands Ateliers.

The third and, perhaps not the easiest of the positions I am speaking to you from today, is that of architect of this building in charge of showing you around and receiving your professional feedback.

To begin with, I would like to go back to the basics of how this building was conceptualised in relation to its function today. Despite the seemingly tedious nature of this exercise, I think it is important that we discuss this process, at this point, before I outline my views on architecture and how I try to practise it.

The first picture represents a diagram that I drew ten years ago in trying to explain to students and myself how things work when attempting to do a project. The diagram shows an architect sitting on a piece of historical/technical culture. His feet are resting on the ground made of matter – knowledge of matter. A skill of utmost importance for students to learn on entering the field of architecture is how to project, that is, to throw a projection or idea from one field to another. That is, from the field of the mental and virtual to that of the probable, real, matter and transformation. This activity is a very intellectual one, requiring concentration, thus the



sedentary position. The task is to project an idea of a structure or object that does not exist. This activity can be characterised as a "moving" process, which is very difficult to learn. It involves thinking about how this idea or object is going to exist, what it will consist of, be made of, how functional it will be for its users and the relationship that it will have to its surroundings, besides considering landscape and how it will be built or actualized.

Each of these are very different things, forming a complex patchwork of unrelated elements. The role of the architect is to sort out and assemble these factors. Students must realize that a balance must be achieved between creativity and pragmatics. The ideas flow in one direction, but the pattern is not linear in movement and it is constantly being reshaped as it is influenced by the realities outside. In fact, we can say that it is an alternative movement of thinking and rethinking in an effort to accommodate the natural feedback one receives in the process of building or realising a project. Learning architecture is about learning how to master this movement.

Metaphorically speaking the activity can be compared to learning to strengthen a muscle, except that in the case of architecture, it's mental agility.

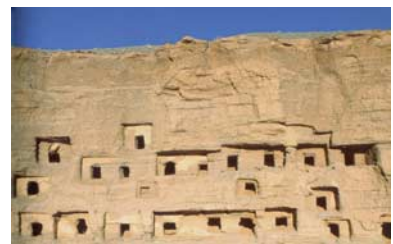
As far as construction is concerned, the parts highlighted in orange on the drawing are the most essential corresponding to matter and knowledge of matter. We, then, talk about very basic materials, such as stone or wood, which are actually not very sophisticated. We often refer to high tech in the field of construction, but in fact, it is quite low tech since we deal with old, even ancient materials, such as stone that we learn to square, wood that we assemble and stone and steel that we fill a particular space with. This field of knowledge of matter can be done in a very scientific way.

For instance, learning about resistance of materials or their chemical components.

However, as an architect one needs to learn what this knowledge means in the cultural sense. Joseph Boyce, a well-known artist, is a good reference for me about how to think about matter in a cultural way. This refers to the notion that materials tend to evoke certain characteristics in people other than the consideration of their mere function. By focusing on what people have to do to put matter together, we enter the world of construction process as opposed to construction systems.

If we examine the origin of the word construction, we see that it comes from the Latin *construere* which means piling up, layer by layer, in order to erect or make a level. Therefore, construction is elevation, raising matter from the ground and making it float somewhere, somehow. It can be done in a very harsh and painstaking manner, such as this (referring to picture), by piling things together to cover a space with an arch, or it can be done more elegantly by trying to make people think that gravity is not a problem. We can even go further and test limits, by venturing in more speculative territory.

At this point I would like to go back to discuss an issue which Denis Grèzes has already mentioned. That is, how to make our students understand how to manipulate and assemble matter. At the Grenoble School of





Architecture we often use the idea of a scale going from construction using mass to construction using structure, which are limited to two archetypes. On the one hand, the cave and, on the other hand, the tent, which represents the most radical way of creating a space in the middle of materia prima, the earth / soil itself, the world of maximum protection and density. This is the world of the agricultural community that lives in one place permanently. This is the culture of stability and masonry that allows you to build very protective walls in order to build a new world inside protected from the outside. Nowadays, architects build in this way as illustrated by the project of Peter Zumthor in Switzerland, which is basically a piece of stone that is carved or layered slate stones with big holes wherever you need space. On the other hand of the scale, there is the idea of using very light materials that are moveable and easily assembled, reflecting the world of nomads and mobility, which is a more idealistic way of building. For example, the idea of a tent is far more intellectual because it involves a deconstructing and re-constructing process, along with an awareness of how things are connected and function, as opposed to using mass and digging with hands and body. A classical example of this is a series of portals in Japan.

Today, I would like to illustrate this idea of the tent and construction with elements with this well-known picture of the Phoenix house in the USA at the end of World War II. I will also demonstrate the work of Glen Murcett, which is a very good example of tent-like architecture. In addition, I wish to stress the relationship between this design process and way of thinking with experimentation.

If we go back to the picture of the architect who is contemplating while sitting and consider the static effect that the picture produces, one wonders how he can learn about transforming matter without moving. Indeed this is the crux of the matter! One cannot learn about matter through mental activity. Surely, one must learn with body first, so experimentation is crucial to learning construction. There are several examples of people who do this and I will present only three of them for the sake of our discussion. In France, it is difficult to talk about experimentation without referring to Jacques Prouve, who has practised with experimentation more than anyone else, particularly in his huge ateliers in Maxville, Nancy.

He has produced things like furniture and small buildings. However, what some of us at the Grands Ateliers are impressed with is the close relationship he has and short distance that exists between his drafting table and construction sites.

Another person worth mentioning, a friend of Prouvé, is Renzo Piano, who designed the IBM Building approximately ten years ago. Finally, two other important people, in my opinion, are Charlie and Ray Eames, who have expanded all their work on the basis of experimentation from the time of WW2 with the production of the famous legsplint plywood. They invented and developed a machine to mould plywood from which all the furniture they later designed was made. It was in their own factory that that they developed design and production ideas that were closely linked.

I will now present two more examples from my own practice to explain the importance of experimenting not only in the teaching environment,

but in the workplace in the process of producing architecture on a daily basis. These are only two examples of projects where very modest experimentation have proven valuable in the design process.

The first is a dance centre in Montpellier, which had to fit in with an old building in the city center. The building would function as a centre for contemporary dance and a place for experimenting on choreography, stage set and lighting effect simultaneously.

At that time, France had no place where a dance company could both rehearse and produce a stage set, as well as experiment with lighting effects all in one place. Therefore, the Dance Company decided to build a specially-designed place to accommodate these specific needs. A building with such facilities was something of a novelty in France, at the time, since only in the Netherlands did a structure of this type exist.

The project was just a big black box embedded in an existing building. We will focus on the façade since it is relevant to our discussion, today. Behind this façade, the main studio would have been a traditional dance-rehearsal studio which could be transformed into a small theatre in order to achieve the flexibility demanded by the company for its purposes. However, as far as the façade was concerned, we encountered an administrative problem, quite common in France. The building had been classified as an historical site. Therefore, we had to find a way of making the façade fit the architectural requirements stipulated by the Architectural Committee of Historical Monuments, whose seal of approval we would eventually need. Consequently, we produced a lot of drawings and reports explaining our plans, using the geometry of the existing site, including various designs with louvers, light filters, ventilation and other appropriate systems. However these drawings failed to convince those concerned. We argued relentlessly for days and conflicting opinions were aired. For example some suggested that the louvers should be of stone, others argued they should be of steel, but painted the colour of stone whereas some insisted they should be made of wood, etc. However, all this interaction did not manage to produce a satisfactory solution. Meanwhile, as the construction was going on, we finally decided to build a real model on a small scale, 1/5 of a piece of the façade simply because we thought that the contact with matter would be more effective and evident than a numeric or visual image.

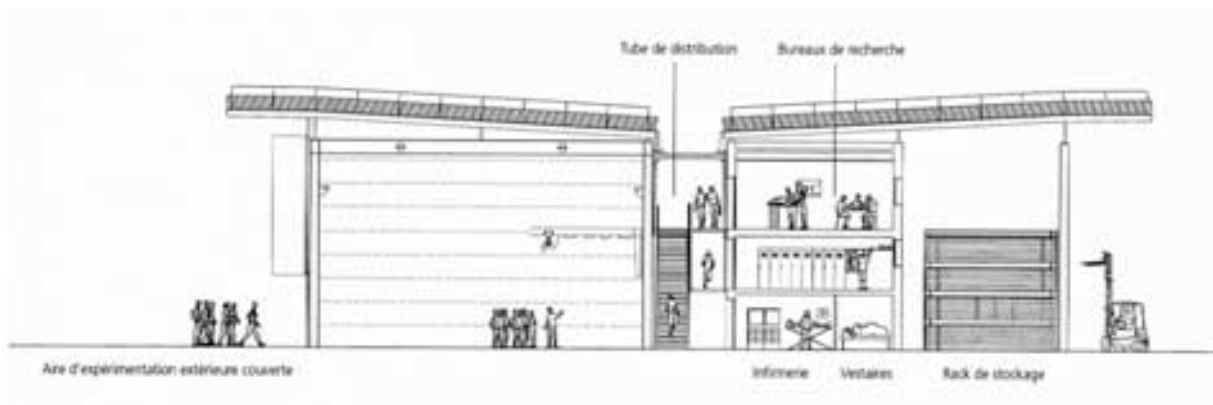


As soon as we finished the model we brought it to a meeting of about 50 people, some of whom remarked, at the entrance, that we would have been better off using computers to save ourselves the trouble of carrying so much weight (60 kilos per piece) from so far. We assured them that we had and placed the model in the middle of the table for them to examine. After a 10-second period of silence had elapsed, the chairman said "Well, gentlemen, I think that the model speaks for itself!" That was it, they had accepted the project. That was a very important moment for me because I realized that objects, matter and experimentation mean far more than ideas when trying to realize projects.

The second example I wish to present is another project we did in Valence in the Southeast of France, not far from here, concerning another façade for the School of Engineering. The project was close to a very noisy highway, so, part of our task was to find a way of protecting the classrooms from noise. Also, people wanted to open windows, so there was no question of ventilation systems. Moreover, it faced west, which meant that there would be a lot of sunlight in the afternoon. An additional problem was that it was a very long façade (90 metres long), creating a billboard identity of the school on the highway, with the name of the school appearing on it..

We decided to build a glass façade (6th screen). We assigned a French graphic designer of Swiss origin, Rodi Bors to design a pattern, which would provide shade from the west and make it possible for people to see through it from the inside. The façade would measure 90 metres in length and carry the name of the school on it.(Reference to a picture) This part consists of studios, classrooms and laboratories on this side of the campus as well as offices and a big nave in the middle with "boxes on legs", providing technical platforms with a lot of computers.

The procedure was the same as any other project. We designed the structure, talked with the engineers and proposed different geometries. The people concerned were not against the plans. In fact, they had found them rather appealing. Nevertheless, we had to find a way of convincing them and ourselves that the design would work. As a result we built a prototype and tested some pieces of glass. We worked with the engineers of the school on the numeric basis of 0 and 1 to produce the pattern, as well as collaborating on the mathematical tool which they created on small software to produce a random pattern. Once again, this process is



a very important feature in the course of designing and realising a project. I hope that these examples have illustrated what I mean by experimentation.

All this practical experience provides valuable insights and feedback for my own teaching practice. My colleagues and I have clearly understood that it is of vital importance to have a place where students can come in contact with matter and learn through their bodies. It was with teachers of various other disciplines that the idea of the Grands Ateliers come from. As Myriam Olivier has just explained, it wasn't the notion of a new school of architecture that we had conceptualized, but rather a place which would enable students to make and do things, manipulate mass, articulate structures and the numerous other things that they would be expected to do in cooperation with engineers and artists. Therefore, the idea for the project, Grands Ateliers, represents the principles behind what we have just talked about.

There will be a tour for those who wish to learn more about the plan and function of the building today. First of all, I should mention that the building, which is more like an aircraft carrier, is a platform, a ground. When carrying heavy weight, in order to be able to move and be flexible, you need to be on very solid flat land. Technically it required special cranes to carry water, filter water, electric plugs and anchors for different weights. Therefore the first "movement" in the project was to settle or place the platform at the site.

The second "movement" was to create a large roof, which is quite an old story in architecture, especially if we consider that the Chinese start off building a house with the roof, which is quite clever! We wanted the roof to be transparent so as to give the impression of being outdoors. Also, the roof is made of polycarbonate, a cheap material, because we were limited by a tight budget. We decided to give it a U shape in order for it to collect rainwater at the center (above this gallery). The water is collected in a big tank and used for the needs of this building. We must bear in mind that this is quite useful in a building of this nature devoted to experimentation, which is actually a construction site. Indeed, it is a permanent construction site where plenty of water is normally used for various purposes.

Therefore, collecting rainwater was an important design consideration.

Under the large roof, which is like a very light tent, we have different boxes or elements all playing a role in the building industry. The heavy box we are in now is a massive concrete structure that has workshops and insulated places, but which can produce sound. We have also given it the luxury of options, just like a car. For example, containers for materials on this side, a small exhibition hall at the entrance, including the main hall of the remaining space, used for experimentation. Also there is portable material or carrying equipment, such as rolling cranes, forklifts. The huge doors of the structure allow the space to open up entirely, transforming it into an outdoor construction site in summer. On the other hand, it is also a shelter for the winter months.

The most important drawings in this building are the sections because they show how things relate and function within the building. What was considered a priority in the design phase was the activities that people



in the building would be involved in, so as to render the building functional. Therefore we had to assimilate the potential activities and think about what it is that we have to when putting a piece of timber through a machine to slice it, or to weld something or carry a two-ton stone.

These tasks defined how things would be put together and function in a building.

In this section you can see the experimentation hall, the full-scale construction site with a rolling crane. On this side you have the workshops with the machines and all the containers with materials. The materials are cut, transformed and assembled here; it's a very linear process, just like any industry or workplace. Above it you have a place where one can think, write and confer with others, like the studio we are in today.

Besides the pedagogic scope, the idea behind the Grands Ateliers had to have another dimension, that is, that it would also serve as a research centre, where we could test different parts of a building, for example. In France there are many places where materials, a chunk of matter or a piece of a system are tested, but not a full scale building. As far as I know, the only place that has facilities where parts of buildings are built and tested (e.g. set on fire) is an insurance company in the USA. However, their objective is to determine the value of a premium on fire insurance for buildings.

Research orientation and association with industry are special features of the Grands Ateliers.

A further dimension is that it would also be a cultural resource center. More specifically, it was meant to be a cradle for culture, a place where culture would be produced through building and construction and how the world could be transformed with matter. Moreover, we proposed to equip the building with a series of equipment which would allow one to shoot a film or display a stage set around a prototype; perhaps, even have a movie production, if necessary. In addition, as it is essential in our profession to display our work, the place was made to be easily transformed into a large exhibition hall.

Comfort was also taken into consideration in the designing phase. People's needs and activities in relation to the building, along with such factors as ambience, climate / temperature, sound and movement were all taken into account.

Basically, we had to build a shelter and create various ambiances / environments within it. For example, here, it's like being in an office, while upstairs it's like a factory whereas in the main hall it's just like a construction site. The plan is very simple, but what is difficult to understand is the limits of the building (internal and external). The gray area represents the main technical platform (the horizontal floor) while the light gray is the roof. The white area is all the enclosed space, which can be transformed by opening these large doors. The building also provides facilities for people to change, cater to the injured and administer etc. with corresponding office space.

I would like to end this presentation on a more academic note by presenting a few of the projects my students have done at Grenoble. In the 5<sup>th</sup> year, the final year of their degree programme, we have a course dealing strictly with Grands Ateliers and experimentation. The idea is that a group of about thirty students goes through a series of workshops on

different themes, according to different materials. They work with Gilles Perneaux on stone, a team from the school on wood, a team from Croatia on earth and concrete and with me on steel. Throughout the four weeks that a workshop is run, the students work exclusively on their workshop-related activities. That means that during this period, they are not expected to attend any other course. However, they do resume their regular classes and fulfill other course requirements immediately after the workshop ends and before another session begins. This rhythm is adapted to the pace of experimentation, which requires a minimum of at least ten days in a row to be completed, unless one is merely dealing with manipulations. This time factor is important for those who wish to come here and should think in terms of long periods of at least a week.

The workshop I conduct is on steel and it lasts four weeks. Teaching construction, architecture and design process cannot be possible without referring to the cultural environment of the materials one works with. Therefore, what counts is not just knowing the material in terms of its physical capacity, but the cultural and social environment around it, that is, who uses it, what architectural references are available or what it means to build with steel, for example. As a result, the first week of the workshop is devoted to visits. We go to places where steel is produced, worked and transformed. Finally we examine the type of architecture that can be produced with steel. (Reference to a picture) The first visit is usually at a steel stock where one can find all kinds of steel. This is a good experience for students because they suddenly realize that steel is heavy, that it takes up space, that it cannot be moved by hand, but only on rolling cranes, that it makes noise, smells, etc. Finally, they realize the logic in the way it is made (it comes in bars, tubes, H-shaped, etc. So, the first phase is familiarization and understanding of the material.

The next step is to visit a foundry in order to see the important relationship between steel and fire. In the final phase they see steel transformed into simple bungalows. The aim is for them to see the process from the idea (architect's drawings) down to the workshop and the person who cuts the pieces and makes the holes. Interaction with all these people is important in order for students to gain an awareness of the difference in the way architects think, which is abstract, based on vague / blurry ideas, and that of other in the profession that deal with very precise figures.

After the first four days of going around observing things, they visit places with architecture made of steel in order to learn its use and application, the way it is designed and calculated. They also interact with the engineers who have actually built the projects. For instance this is a picture of the ice rink in Grenoble, designed by architects Yves Vernaux and Isabelle Leroy and the engineer Marc Marinovski.

Usually we call in the actual engineers to explain how they did their calculations and worked out the details with the aid of a computer. We also engage in discussions about various details, such as how to draw connections between two pieces, etc. Moreover, we visit historic places because it is important to examine how steel has been used throughout time, for example, the great hole made by Tony Garnier in Lyon. Besides, there is plenty of good architecture around there to admire, so that the trip becomes worthwhile.

On the fourth day, we come to the Grands Ateliers where they start to use machines for construction, available free of charge. This is an important step for students learning to build. There are external people who come in to show the students even the most basic tools, such as a saw or welding tools. Students are not always confident about using tools, so this is a good start. Moreover, they learn to respect and appreciate blue-collar workers for the kind of skills they, themselves, lack.

On the fifth day, we come back to the studio where we start to the back and forth moving process earlier described. The particular assignment on experimentation that students had was to produce and build, themselves, at the Grands Ateliers' site, in a week or less than ten days, a section of a student residence building. In this process we all usually get involved in a kind of game where we all assume certain roles as follows. Since, in the first year, we had a group of students working on this part of the project (the mass plan), the second year students worked on the unit-making project. We then picked one of these projects and gave it to the team of this year.

As a result they acted as entrepreneurs and contractors whereas we played the role of architects. Therefore, we had twenty-five students and five contracts: one in charge of structure, one responsible for the roof, another for interior design, one for wood paneling and one in charge of coordination. This role play begins with small drawings in connection with the real structure. They begin a kinesthetic up and down process between the workshop and studio. In the beginning, at their drawing table, they have lots of questions regarding how to draw the design or details (e.g. what size bolt to use, etc.). They are normally sent down to choose one they think is fitting and, on coming up to the studio again, they often complain about having forgotten a piece of steel, etc. Thus the procedure is slow and awkward at first, but it becomes quicker and more efficient in time. We tend to facilitate and speed up the process by giving them materials, perforated bars, etc.

From an educational perspective, they really need to think about how to build and consider such factors as pricing and stability. It is important for them to invent connections and think about the materials they plan to use (e.g. perforated bars that can be reused for future projects). In the beginning there is hesitation, but gradually things start to take shape. There is also a great deal of discussion, making them realize how much coordination and effort is required in dealing with very precise elements. By the end of the third or fourth day of experimentation, the students are very proud of their achievements. They work eight or nine hours a day, without a problem, and get used to working with tools. Also, they live very near the Ateliers or in a nearby town, just like ordinary workers employed on a construction site do. By the end of the fourth day, the roof is usually placed and on the fifth or sixth day the structure is completed.

This is the moment of truth for students because they have to verify that their calculations are accurate. They are not allowed to drill another hole at this point. Everything has to be in place and if everything does not fit in, then they know that they have miscalculated, which means that they have to start all over again. During the entire process we hold daily meetings, at the end of the day, just like at any construction site. On the seventh day there is a final meeting, a debriefing, to assess exactly what

has / hasn't worked, the strengths and weaknesses of the project, what was learned and insights gained in the process. The final phase, which is an important one is for them to take pictures of or film their projects for display purposes and in order for them to be used with students the following year.

# The Role of Construction and Technology in Architecture and its Teaching

Jean- François BLASSEL

The aim of this presentation is to first discuss the relationship between technology and architecture and, secondly, to show some images that represent just one example of an unconventional exercise that we do at the Ecole d'Architecture de Marne-la-Vallée as part of a course entitled "Introduction to Technology and Building" with first-year Architecture students.

Of primary importance is for students to understand the relationship between architecture and technological / scientific thought. A major consideration for those with an engineering background, as in my case, who wish to go into architecture would be to recognize the very unique position of architecture as being at the crossroads; that is, an intersection between many areas of thinking, many disciplines and activities, which make it both an art and technology, both an intellectual activity and an industry. So, it is precisely this overlapping that results in the unique culture, derived from this mixture, which is particularly interesting.

We all know the definition of architecture, perhaps the first, given by Vitruvius, which describes architecture by its utility as well as its solidity. Surely, the role of technology in architecture extends far beyond the pragmatics of solidity. Buildings have to be able to stand and withstand. They have to be built from real, natural materials and must interact with the physical world, as they are part of the natural environment. However, if one limits one's approach to this kind of thinking, then one misses the point that technology is, in fact, the medium of architecture. Architecture is all about doing, making and building, so technology represents the medium of architecture, just like paint, oil and pigments are the medium of a painter. Therefore, this medium acts as an intermediary between the ideas, intentions and emotions that are the start of an architectural project. At first, the project is something private, belonging only to the designer, but eventually it actualizes and transforms into something physical, concrete and public. Therefore, an architectural project, as marvelous as it may be, has no value, unless it has the potential of existing physically. Similarly, something that is technically competent has no value in architecture if it is not fed with ideas, intentions and emotions. So, I perceive technology in architecture as a unique characteristic, which designers give to the public and, which, in turn, the public sees as a concrete structure made of steel, stone, glass or wood. However, the emotions that one receives from architecture come from assembling these very simple, basic materials. Construction, therefore, is not an accessory to architecture or something that happens afterwards. It is at the very core or essence of architectural thought.

As a result, when considering the teaching discipline, we should aim at teaching a mixed culture. Our objective is not to teach or produce second- level engineers nor are we interested in making builders or

contractors out of our students. We are interested in developing this mixed culture, the combined culture of construction and architecture. The question is what type of knowledge or skills should students develop during their training in order for them to go into the profession capable of using and understanding the means and all those elements that make a building physical. The concreteness of a building implies that it basically intervenes with the forces of materials, energy, air, etc. in reference to its overall physical existence not only from the point of view of gravity, but from other perspectives that one needs to seriously consider, particularly nowadays. So, what architects need to know and have is not the very specialized skill of the engineer, which has to do with the ability to predict through the use of numbers the "behaviour" of a building. Neither is it the knowledge of the craftsman, which is acquired through very long training, having the dimension of an initiation. What they need to have is the capacity to synthesize, to define systems and to find a unique response or solution. Building is a unique response to a set of complex, divergent or contradictory questions. There isn't only one answer or solution, but a multitude of factors to consider. Therefore, what counts is the ability to manipulate and assemble these factors. Students need to acquire an understanding of physical phenomena affecting buildings and what techniques are at their disposal. Moreover, understanding the environment of a building includes all of its dimensions, the natural as well as the socio-economic one.

After all, we don't build in the same way as 200 years ago simply because society has changed. In conclusion, the overall objective of the course on technology or science in building is to give students the means, desire and pleasure of building, since there is something extremely joyful in building. All these elements are vital so that the process does not become frustrating – a kind of punishment, as it may seem in some cases. They should be able to use all available means and engage in meaningful discussion with all relevant specialists as well as dealing with the entire building industry in a confident and creative or at least responsible manner. There are many ways of acquiring these skills and knowledge and it is recommended that all modes be used, not just an eclectic one. Students come from various backgrounds with varied intellectual abilities, therefore, we must use a wide range of modes and methods to achieve satisfactory results.

I would like to suggest four main modes. One is experimental. I don't know if it's the case in all European architectural schools, but, in France, a lot of students who come to us don't have a comfortable relationship with science and technology. Either they come from secondary schools where these subjects did not prove very satisfactory, so they go into architecture because they think it's more humanistic or liberal-arts oriented. There are also cases who were good at science, but did not feel like becoming engineers. What we also see are many students who come into architecture dissatisfied, "angry" with their science and technology experience at school and who have no desire to continue on a scientific route. Therefore, working with direct experimentation is very helpful in that it creates a kind of reconciliation between invention / creation and the world of science and technology, which is, in fact, the key for this

type of undertaking. However, it is common practice that in the schooling they have been through, students were deprived of this creative dimension, leaving them with a schoolish mathematical approach, without having experienced the exciting side of science and technology.

The second mode is mathematical. Obviously, even if students are not going to use it professionally, they need to know the power of numbers and algebra. Also, they need to understand and manipulate the physical dimensions of a building, such as stresses, temperature and movement. Moreover, they need to understand what a natural law is and how it works. They need to be able to look at a formula and unfold it as well as understand what matters in a particular phenomenon.

The third method is historical and cultural. The technology we have today is not arbitrary. It is the result of a very long process of work, intelligence, discovery as well as building on what others did before us. So understanding that the emergence and evolution of technology is not something removed from culture, but at the heart of culture is very important. Technology in itself has no meaning for architecture unless it is an integral part of it. That is, technology has to operate in relation to projects, urban planning, infrastructure, etc in order for these areas to profoundly advance. In conclusion, it is essential that students make this link between technology and architecture.

After this introduction, perhaps we can look at some images.

To begin with, technology is all about tools and the way they developed has allowed us to transform the relationship that humankind once had with nature. That is from a relationship in which nature was menacing to a present situation where nature is being menaced. The fantastic power and vitality of technology needs to be understood. Technology was compared by Siegfried Giedion in one of his books to a piece of radioactive material or a piece of radium in a glass bottle that acts beyond the glass bottle that it is sealed or contained in. So, the point is that the effects of technology cannot be restrained.

This is an aerial photo of the Chernobyl power plant site between 1984, before the accident and 1994, after the accident, with the *pradopsycho/radopsycho* effect. The red is the vegetation. The fact that the city was abandoned means that there is more vegetation now than there was at the time. This is a reminder and an example of the power and effects of technology which do not affect only nature, but the organization of human societies and cultures as well. Whatever we do or think about whether it is materials, information, communication, birth control or genetic engineering, technology affects and transforms every single aspect of our lives, that is, the way we work, live and love.

In a well-known book on motorcycle maintenance, there is an interesting passage on the relationship people have with technology. This book recounts the story of a group of people traveling on motorcycles across the USA and the narrator describes the anger and apparent indifference of his friends towards technology. He claims that technology is a set of strange, incomprehensible human activities, usually enclosed behind barbwire fences around industrial plants. He adds that technology pollutes and devours their territory and goes on to say that this issue is mentioned

in the book simply because they don't like technology. As a result, they don't maintain their motorcycles and neglect anything that deals with technology, even as far as a leaking faucet. Eventually they suffer from this negligent and hostile attitude toward technology. The writer of the book explains that he disagrees with their attitude, not because he does not empathize with their feelings about technology, but he merely thinks that their resentment and hostility are self-directed. He uses the image of Buddha sitting comfortably in a gearbox or in the circuits of a macro computer placed at the top of a mountain or in the middle of a flower. In essence, he believes that to despise technology is, in fact, despising oneself. These reactions of resistance toward technology are also present in students. So that one of the important things we try to do is to make students use technology as an integral part of their culture and creativity. The aim is to have them work with it.

An interesting aspect of technology is that if you go very far back, some of the specialist in prehistory, such as the French, André Leroi-Gourhan in his book, "Le Geste et la Parole" (Gesture and the Word) explains that the fate of humankind was totally transformed when humans stood up on their hind legs. When we crawl on our hands and feet, we are left with our mouth to carry things. Therefore, the mouth loses its essential function of speaking and communication. There is nothing else for the mouth to do except for its rudimentary function since the whole body is engaged in locomotion. When we stand up everything changes. We can move and carry things with our hands, freeing the mouth for communication.

Gourhan suggests that when going on archaeological excavations (digs) and looking at transitions between animal and mind in the times of the first homo sapiens, you see that tools appear as extensions of the body. Similarly, technology appears as an extension of the body. To paraphrase Gourhan, these tools didn't appear as a sudden inspiration, they appeared to the diggers as if they had emerged from their hands, as extensions of nails, fingers and hands. Therefore, we can use this set of images to make our students understand technology.

Furthermore, another French writer, not relevant to the field of architecture or technology, but an anthropologist, Claude Levi Strauss, who wrote "Le Pensée Sauvage" (Primitive Thought) tried to establish a link between pre-scientific and scientific cultures and how people could conceive making things without science as we know it today. In his wonderful book, he portrays two characters as caricatures. One of them is the engineer and the other the tinker / handyman (bricoleur) who builds with whatever he has at hand. The two characters represent two perspectives. One uses the process which goes from abstract concepts to tools and who basically devices the tools and methods from abstractions. The second, the thinker, who works from finite sets ad-hoc from things he finds and composes the object he wants to build from these random materials. So speaking from experience, engineers are very much tinkers, building from what is available, not always inventing new material for each new project. In Levi Strauss's explanation, the engineer tries to create or force the passage beyond the tinker's limits. One operates with concepts, the other with science. What is extremely valuable is to have our students approach technology from these two angles, that of concepts and

tinkering with an available set of materials that they play and experiment with.

As far as technology and the body are concerned, one of man's dreams is to fly and technology as an extension of the body allows man to fly. Body extension allows us to go much further so as to extend our range. It can allow us to extend our skeleton. We can hook up a machine to the skeleton of a person to increase its strength or make someone run for 24 hours with a 100 lbs on his back. There are prototypes of these. Their real problem is their source of energy, but the relationship of technology as extension of the body is basically found everywhere. This extension is not always so mechanical or sinister. There are milder or softer ways of looking at technology.

Now, what I would like to show you is an exercise that we do with first-year architecture students after about six months they have been in the course. This exercise is done in cooperation with those who teach first-year Technology at Marne-la-Vallée, that is, Marc Mimram and myself, as well as those who teach Architecture, that is, Isabelle Beroux, Jacques Sinclair, Stephanie Sperger and Stephan Montpant.

So, it is an exercise strictly between architects and engineers.

One of the ways to make students understand the issues of construction and building is to start with the experience that they all have when they're between the ages of 18 and 22, that is, their body. They look at the body first and look for ways of extending it. It has been done before based on the Bauhaus dance exercise of the famous Oscar Schlimmer Ballet. Also, we make them look at the body as a structure, tension, compression, tendons, muscles and bones. We begin to introduce concepts related to structure through experience or analysis of their experience.

In this photo\* is their models of bones and tendons and on the right, the famous photo\* showing the difference between tension and compression, which can be physically felt. We can then look at the section of the bone from the wing of the albatross, a large sea bird\*. This is the wall of the bone, so it's like a tube and these little links work like diaphragms to prevent bucking of the wall. Obviously, for the bird, the idea is to optimize the strength and rigidity of mass ratio. So you want a lot of void in the center of the bone and as much mass as possible concentrated on the outside. Then you can try to get the students to do an exercise that starts with this consideration and look for ways of extending the body, which is what I would like to show you now.

This is the booklet that was produced by the students at the end of the studio and as I show you the images, I will comment on them, even though they are self-explanatory.

This is a "marais" on a bridge type movement analysis, which is basically the handout students received for the exercise. The title of the exercise was "A Moving Envelope", supported by the body in movement, including all ideas of not just static, but dynamic movement. We divided the students in groups of three and asked them to build a structure that moves. In order to accomplish their task, they were given a set of materials to choose from (three types of wood, three types of metal rods and three

types of fabric). From a quantity of material available to them, they establish a stock exchange of materials. They then trade between themselves a piece of wood, for example, for a piece of metal, etc. depending on the value of the material and the needs of their particular projects. However, at the outset, they start off with an equal quantity of materials. I should add, that this exercise is also done with those who teach drawing, so there is a lot of sketching of bodies from nude models, providing them with opportunities to look, think and analyse the human body. They mold their body with plaster casts, such as what is used when we break a leg. These casts of body parts are used for study purposes. In addition, there is a part of the exercise, which has actually evolved over the years, in which they have to go out in the community and select various accessories. Although the school is located in a suburb, there are a lot of DIY (do-it-yourself) shops owned by locals or other suppliers. Their task is to build a structure that interacts with the body. The body supports the envelope, which will move with the body. The idea behind it is for them to get the most effect out of the limited amount of materials given to them. This is the notion of economy of means. With the means given they try to be as extensive as possible with the effect. Therefore the structure has to be large, the body and limbs have to be flexible and mobile. Also, there has to be a folding and unfolding (envelope) quality to it. Consequently, there has to be a kind of alchemy between the body movement, structure and envelope. These things are grouped in sets as families of structures.

Finally, the students carry their individual projects and walk around with them, just like a fashion show, demonstrating them around the school.

Here are some pictures\* of models done by the students. As you can see, some worked on the folding/unfolding quality, a lot of them on flexibility. Perhaps next time we should film them because these structures move as the students walk around, so a moving picture would be more effective. The students worked on many ideas, all of which are highly inspiring.

Perhaps the ultimate value of this exercise is that when the students actually build a cantilever that extends on their own spine, they have understood for the rest of their lives what a cantilever is, how it works, what the compression and tension is. The fact that they can actually feel it falling on their hips, or feel the folding and unfolding of the canopy or protection - that's learning through experience! Another interesting factor is that there was also the spirit of competition among them. For example, they would compete for the longest cantilever, just as engineers compete for the longest bridge. Furthermore, these are real projects, subjected to real blows and movements, so they have to work. They can't collapse in the middle of the presentation-walk. They also realize how difficult it is to build the fashionable blobby pieces they see in magazines.

This picture\* on the left has a very elaborate set of pulleys and ropes. The movement of the students as they are walking in the structure represents an up-and-down movement of the bubble above their head, which is quite interesting. Through this exercise they are given a chance to also test the flexibility of materials, the conditions they break / tear and when they hold together.

The one on the right has an elaborate cinematic system, which allows it to open and close according to the details shown. This is a way of putting their ideas into practice and testing their applicability. The one\* on the left was the longest cantilever, 12 mm long, built from bamboo, while the one on the right is based on the idea of pantographs, which are attached to the hinges on the body which allows the structure to open and fold.

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\* Unfortunately despite the numerous efforts made by the editor, the images accompanying this lecture were not provided by the author.