NON-TECTONIC SYSTEMS: THE MODEL OF BUILDING. BUILDING AS A GUTENBERG-PRINCIPLED TECHNOLOGY

M. PÁRKÁNYI

Institute of Building Constructions and Equipments,
Technical University, H-1521 Budapest

Received July 15, 1988
Presented by Prof. Dr. O. László

Abstract

The non-tectonic systems actually organize the industrialization of building on a new basis, that is on a new model of building, on the basis of the well-known Gutenberg-principle.

Similarly to the letters of the phonetic alphabet, or more accurately: similarly to the types of the printed alphabet, which in themselves have no meaning, yet they allow any kind of texts to be printed;

the surface elements of the non-tectonic system — the so-called "non-tectonic bricks" — are not structures themselves, yet they permit to assemble any kind of building. The non-tectonic bricks are actually nothing else but letters of a structural system.

Our study gives a detailed elaboration of the theory behind the adaptation of the non-tectonic systems.

Introduction

Theme and objectives of the study

The theme of the study* is the creation of a new comprehensive general model extended universally over the *whole* of building, that is over the whole of both traditional and industrialized building. Thus, the theme of this study organically fits into the scientific endeavours of our age aiming at revealing the technological laws of motion of building (architecture). From this technological law of motion there arises a necessity according to which in the industrialized building the present, mechanically-principled building passes its place to a qualitatively higher level of building based on *automation*. This necessity is of technological character, thus, it can not be identified with fatality. Technology

* This study — giving a detailed elaboration of the theory behind the non-tectonic systems — is actually a chapter of the author's doctoral (D. Sc.) thesis presented to the Hungarian Academy of Sciences in 1971.** Since then all the necessary tests and experimentations have been completed on laboratory or semi-workshop level, the whole system of the non-tectonic building methods have been elaborated, etc. and now, finally, in the close future we are looking forward to the adaptation of the non-tectonic systems on industrial level. This is why we found it opportune to restate the theory and to have it published in English for the first time in printed form. Here, we repeat the original text practically without any essential alteration.

** See: References.

spells systematical knowledge and action so, beyond technical elements it includes the human factor as well, consequently it means a conscious human participation in the historical process raising the mechanically-principled building to the higher level of automation as required by social development. Human activity is one of the elements through which this necessity becomes realized.

Actually it is such a human activity in the field of building science when we try to call into being the comprehensive *new model* of building through which this whole branch of science can be laid on new foundations, since *the discipline-model of the present mechanically principled industrialized building has become in a short time an obstacle to development.* A very significant part of the ever increasing body of knowledge of building-science and architecture can not be unambiguously explained any more in its totality, so revision, modification, or perhaps total giving up of the old theorems will sooner or later become opportune in the field of building science.

This study has a *double objective.* On the one hand it aims at *further developing the image of the objective world of building (architectured)*, on the other hand, it aims at *rendering the manufacture an open process*, since without changing over to manufaturing *open* systems automation in building would simply mean the avoidance of the *architectural* essence of the problem.

Some remarks on the significance of the creation of model in science in general, and in building-science (architecture) in particular

It is well known that the creation of models particularly in the field of natural sciences always had a very significant role. The scientific model-creation explains the empirical phenomenon in such a way that it expounds the theory concerning the phenomenon in the form of some model or analogy. It is widely known that science regards the models created in this way not only as psychologically helpful tools for discovering newer phenomenon, but also as easily misleading sources of error. It is not our task here to analyse this question in detail. The rich international literature on problems of models and analogies in science may release us from this obligation. We can not avoid, however, making some general remarks which may cast light upon our views applied for the creation of the model.

In our studies we never considered the construction of a model as helpful tool for the creation of a theory. The model, for us, means far more than this. The model is a part of the theory, a very important part without would be simply impossible to apply the theory for the most important purpose, for forecasting the field of new phenomena. We do not state at all, thereby, that the use of the model leads to irrefutable theory, but we firmly believe that the properly constructed model does have an *inspiring* effect on the creation of the theory (that is — in case of building-science — not only on the design of structures, but also on their manufacture and assembly).

For us model spells any such system — be it constructable, mechanizable or transferable — which has the characteristic feature of making the theory forecasting, which gives such a *new* interpretation of theoretical notions by means of which the usual, everyday references and correspondences become observable in a *new* way.

The limits, possibilities and methods of extrapolation in building-science (architecture) in particular

If scientific model-crearion in general is expected to *forecast* the field of new phenomena, then it is obvious that the calling into being a new model of building will also — *eo ipso* — raise questions of scientific *extrapolation* in the specific field of building science. The difficulties of this problem are extremely well shown by the fact that even such circumspectly cautious authors like for example DENNIS GABOR, or particularly A. C. CLARKE (who restrict the area of extrapolation to technique, that is a single trait of future, keeping thus far away from the society built upon this technique) simply leave out architecture form the world of technique, whereas such less cautious architect-authors like for example the japanese metabolists or PAOLO SOLERI — to mention only the most extreme cases — simply leave out man from the sketchy Utopian world of future architecture.

Analysing this conspicuous phenomenon, the author, in one of his previous works has already pointed out that in the field of architecture and urbanism experience shows that every *utopism*, every *concrete* drawing up of future turns out to be barren since it can not properly count with the *change*. Thus, it is not the *future city*, nor the *future form of dwelling* that is to be searched for, since every society in its own time, in its own place, in the light of its own circumstances will draw it up much better, more precisely and concretely than we can ever do it today, but, resting on foundations of architectural and urbanistic rationalism and relying upon technology, the most mobile form of motion of the architecture of our age we have to search for the *future brick*, or if you are agreed, the *future building method* which can in due time, flexibly follow the *constantly changing* requirements.

Prediction of the future of building, thus, is a barren enterprise and any such attempt is inevitably doomed to failure in a short time. This study in its objectives is basically more exacting and for more practical. It does not want to foretell, but to determine the frames in which the possible futures of building can be situated. The *frames*, namely, can really be *extrapolated* with scientific exaction. If we look at the future architecture as at a hitherto unmapped continent, then — in accordance with CLARKE — the first and most important thing that we may try to do is to measure the frontiers of this continent to get somehow information on its extension. The detailed geography of its interior will obviously remain unknown — as long as we do not reach it.

The three ways of extrapolation in building:

For a scientifically well-founded extrapolation of the frames there open three possible ways:

The positive extrapolation

The first way — designated by us by the name of *positive extrapolation* — draws its conclusions on the mature of the future industrialized building in such a way that it determines all those fundamental characteristic features of the present-day building, which — according to the present knowledge of building-science — will inevitably be contained by the future industrialized building. In our days we can verify only one such axiomatic characteristic feature with unconditional certainty, namely, that as opposed to the process of *traditional bilding* always composed of *two phases*, that is the phases of design and building, the *industrialized* building — irrespective whether it is based on *mechanization* as it is today, or connected with *automation*, as in the future — will inevitably characterized by the *three phases* of design—manufacture—assembly. But then, wherein does the trend of evolution — leading from present-day mechanization towards future building based on automation — manifest itself? Clear answer may be given to this question as well.

Early in this century, at the dawn of modern architecture based mostly on *traditional* building the wish of the architects was concisely formulated by the demand **form follows function** and three generations' architectural and industrial endeavours made this requirement first a target and then a reality of architecture.

In the *mechanization* based building satisfying requirements of function becomes a question of manufacture and thereby the already classic slogan of "plastic" (formable) architecture is changed and substituted for **form follows manufacture.** Design and production are integrated; form becomes a function of manufacture.

Automation based building relies upon denying the principle of "form follows manufacture", for this purpose it separates, disintegrates design and production forecasting thereby the architectural future of "plastic" design, since its fundamental aim is to make form independent from manufature. Now by the early '80s, at the dawn of automation based building, the scientifically extrapolatable, unambiguous desire of the architecture to come could be concisely formulated as **manufacture follows form.** It seems important to remark here that the future realization of this present wish not only depends on technique, but also on us, on the human participation.

The negative extrapolation

The other way — the way of *negative extrapolation* — draws conclusions on the nature of future industrialized building in such a way, that it determines all those fundamental characteristic features of the present-day building, which — according to the present knowledge of building-science — *can not be maintained any more* in the future automation-based industrialized building.

In our days — in accordance with the three phases of up-to-date industrialized building, that is design—manufacture—assembly, we can undertake three such, almost axiomatic negative extrapolations:

In the field of *design* we can state with unconditional certainty that in the age of the future industrialized building the traditional method of *graphical representation* of building can not be maintained any more universally and characteristically. Some kind of mathematical or informational language will simply become indispensable as an alternative to *Monge's* projective geometry, and *pictorial* representation will have to be translated into the language of some *coding* system as required by the computer. The information (that is the design) arising as a result of this translation will not be immediately and directly visually perceptible (as a drawing) but only intermediately, through transmissions; that is why we called this method for making designs briefly: *blind design.*

In the field of *manufacture* we have to do away with the anomalies of *co-ordination* and construction since mass-production based on automation is incompatible with the present systems of the so-called *dimensional co-ordination* where the *elements* produced are bound to *determined final products* consequently, from the very beginning, they are constructed to unambiguously *determined dimensions* and that is why the structural systems to be applied in the future will be, in the last analysis, totally *open* and establish a *triple co-ordination* (that is co-ordination in the sense of building—machine—and time).

In the field of *assembly*, that is in site work, the marking of dimensions, more precisely: building based on *numerically marked dimensions* must cease to exist. In the age of mass production open structures, namely, the task of measuring changes, its function very often becomes redundant since it can be replaced by the manufactured elements themselves (which can also be treated as etalon), the location and moving of the elements (on the basis of the sequence of operations on the building site) will be determined by some grid system. This altogether means that the numerical marking of the dimensions on the "drawings" sent to the building site will have to become as unnecessary as the pictorial representation in the design.

The intermediate extrapolation

The third way — the way of *intermediate extrapolation* — conceives building as a part of the universal world of technique and it draws its conclusions on the nature of the future industrial building not immediately — that is not from the building technology itself — but *intermediately* that is in such a way it first determines all those fundamental *common* features of the *different* other technologies, which — according to the present knowledge of science — *will by analogy, inevitably have to rise to the surface in the future industrialized building as well.* The fields of this intermediate extrapolation today are almost undiscovered yet, but the possibilities behind are very promising. Let us mention here two examples. The first such intermediate extrapolation is so obvious that it can even be derived with a simple logical deduction. If in our days, namely, one of the most fundamental common feature of the other industries is exactly the tendency towards automation, then, it calls for not proof that sooner or later this will have to assert itself in the future building as well, since building — in the last analysis — is an industry. The second example is not so obvious, but perhaps even more thought-provoking. It is known — at least it is shown almost by the whole history of the development of technologies — that if in the field of any technology a really radically new, that is *qualitative* change takes place, then whatever the circumstances, this launches a process as a result of which the *bearers of the old technology disappear* and their place is taken by the masters of the new technology. With the appearance of the GUTENBERG typography the whole world of the copying monks, the parochialism of the hand-written codices have to disappear. ARKWRIGHT's name and activity not only marks the dawn of textile-industry but also the twilight of the weavers. In the track of BESSEMER'S technology the whole guild system of the master blacksmiths hall-marked by the name of JEAN LAMOUR simply melts into thin air. EDISON'S electric bulb renders the candle-makers unnecessary, etc. We do not add to the examples since even on the basis of the aforesaid one might come to the conclusion that — by analogy — the masons, the bearers of the traditional building for many thousand years, are squeezed out by the industrialized building. Experience, however, does not show this at all.

In trying to find an answer to the reasons of this phenomenon we first analysed in detail the *nature of building* in general and then the *nature of automation in the building industry* in particular, since we cannot create a *new model* of building based on up-to-date scientific foundations if we can not determine exactly the place occupied by the "building industry" in the universe of the "manufacturing industries" from the technological point of view. And this all together, finally, not only decided the *order* of the elaboration of the theme but the *method* of its expounding as well, as we shall see in the following.

The nature of building

1. The two stages of industrialization of building: mechanization and automation

GUNNAR MYRDAL has opened a CIB* Congress in Copenhagen by formulating the challenge of our age to building research and the industry: "We need more and better shelter. This is the challenge of humanity to building technology." Building science actually ought to give a *technological* answer to this challenge; it has to establish a link between the demands of building and our technical possibilities; it had to find to ways which in the sphere of building lead from mechanization towards automation. This is the foundamental task of building science and technology of our age and the theme of our study as well.

Before touching upon the topical questions of the "industrialization of building" it seems most advisable here to consider those characteristics of building which make the *process of building* and the *product of building* different from all other processes or products. If we want to make further process, namely, and raise the level of industry to a higher degree of quality, then we have to move it away from the present phase of *mechanization* towards that of *automation*. The characteristics and the potential of these *two stages of industrialization of building*, however, basically differ from each other.

Introducing automation means establishing *high-volume* techniques maintaining *continuity* and *high speed* in production and thus, it is equivalent to radically changing the *existing structure of building industry*. Without the thorough knowledge of *the nature of building*, however, we simply can not create a *technological basis* for a new approach to industrialization. The progress towards automated building requires an incomparably better understanding of what building means both as a process and as a product.

2. Building as a process: the principle of additivity

Up-to-date industrialized building is characterised by the three phases of design—manufacture—assembly.

Building as a process refers exclusively to *assembly* because it is inseparably connected to the ground on which the final product of the building industry — the building — is erected.

From *technological* point of view this feature is of *basic* significance because it means, that quite apart from any future technical development a certain, irreducible portion of the construction industry will always be mobile, since the end product can only be completed on the spot where it will eventually be used.

* Conseil Internationale du Bâtiment.

Building is an additive process. Irrespective whether we build traditionally or with industrialized methods; whether we concentrate technology in the factory or on the site; whether we use closed systems of prefabrication or open ones, *the building itself, that is the phase of assembly will always remain process corresponding to addition in mathematics. Additivity is a universal principle of assembly.*

Building as a process is based on the principle of additivity.

3. Building as a product: the principle of disintegration

Building as a product is the actual *final result* of the "design—manufacture-assembly" process and as such, it immediately refers to the *whole* of the construction activity.

This definition, however, be it ever so evident, does not take us considerably nearer to the problem because it does not relate yet to the characteristics, which make building different from all other products. Let us examine these features first.

What is really a building as a product?

D. A. Turin's list of adjectives

D. A. TURIN replaces short definition with a long list of adjectives. According to this, a building as a product is characterized by the following features:

A *building* is: *fixed* (because it almost becomes a part of the ground on which it is erected), *unique* (at least partly so because two buildings can not be constructed on the same identical piece of ground and therefore, they are bound to differ), *heavy* (because it is made largely of heavy but relatively cheap materials, which is also indicated by the low value/weight ration of the substructure and superstructure), *bulky* (because the ultimate purpose of the building is to provide space for the performance of human activities), *complex* (on the one hand within the physical boundaries and in relation to the immediate and mediate environment; on the other hand, within its production, because it concerns too many products originating from other industries, etc.), *long to produce* (because even if it is made of a great number of repetitive operations, as a product it is always unique and fixed in space), *expensive* (probably the most expensive durable consumer commoditiy, that can be acquired by an individual during his life-time), finally, there is one essential and probably unique feature of building as a product, which differentiates it from all other current industrial products, that a building is *sold before it is made*, whereas most industrial products are made first and sold afterwards.

Looking back on this long list of adjectives TURIN remarks, that it is possible of course to find other human artefacts, which possess perhaps one or two of these features, but none which shares them all and that is why it is so dangerous to draw parallels between the building industry and other manufacturing industries.

The lessons of manufacture

Bearing in mind the old French adage, "comparison is not reason", and being well aware to day, that industrialising is not striving to look like other industries (especially not without knowing what really makes those industries industrial) we certainly do not intend to draw *parallels*. But some technological *conclusions* have to be drawn, however, from these features. Concerning the building, — that is the product of the building process — namely, important lessons can be derived from *manufacture* more accurately said: from the conditions of *factory production* within the building industry. *Although in the age of industrialization building is a product of manufacture, building — as such — can never be the immediate object of manufacture.*

From *technological* point of view, this feature is of *basic* significance, because it means, that no future technical development can ever lead to producing *complete buildings*, stocking them and transporting them to the site, since only *parts*, *components*, *elements*, *units* can be actual objects of manufacture; *building as a product is only a sum total, only a final result of the additive building process.*

Since building — as such — can not be produced therefore the *manufacture of building* can only be based on *disintegration*, that is to say on a sort of breaking the building up into constituent parts. *The principle trends towards industrialization of building are actually a variety of attempts at breaking the building up into parts small enough to remain transportable and complex enough to benefit from factory production conditions.*

Irrespective whether we enforce the principle of *housing factory* (where the factory "sees" the final product) or that of *blind manufacture* (where the factory "does not see" the final product); whether we concentrate technology in the factory or on the site; whether we use closed systems of prefabrication or open ones; the *production, that is the phase of manufacture will always remain a process based on breaking the building up into parts. Disintegration is a universal principle of manufacture.*

Building as a product is based on the principle of disintegration.

4. The architectural and the technological efficacy

The architectural efficacy is a combinatorial quality of the structural system

The essence of the problem in *architecture* is, whether from standardized units we can assemble *buildings* which though *structurally unified*, are *different in plan, in function and aesthetic appearance.*

Since the factory made elements—components themselves can not be shaped therefore the shaping of the building can only be based on the additivity of the manufactured elements. Thus, when evaluating the available structural systems the architect can only scale their efficacy from an *architectural* point of view on the possibilities offered by the system to create various assemblies. Hence it follows that:
the architectural efficacy of the system can most suitably be scaled by the number of architectural variations possible, which in turn is an immediate function of the combinatorial qualities of the structural system.

The technological efficacy is a combinatorial quality of the means of production

The essence of the problem in *building industry* is, whether from standardized *machines* we can mass-produce *elements*, which though *technologically unified*, are *different* in *increments*, *sizes* and *ranges of sizes.*

Since the manufacturing apparatus of the technology itself can not be shaped, the *shaping of the manufactured elements* can only be based on the *convertibility of the manufacturing apparatus.* Thus, when evaluating of the available technological systems, the architect can only scale their efficacy from technological point of view on the possibilities offered by the system to create various ranges of sizes for the manufactured elements. Consequently:
the technological efficacy of the system can most suitably be scaled by the number of technological variations possible, which in turn is an immediate function of the combinatorial qualities of the means of production.

The nature of automation in the building industry

Some theoretical and practical aspects of applying computational methods to building industry

1. The nature of automation in general and in the domain of building

The distinguishing feature of *automation* is, that human control is exercised upon machines, which control other machines.

In the early stages of automation this control was described as corresponding to four types of operations traditional to manufacuring. These are as follows: materials handling; routine judgements in connection with machine adjustments; machine setting; and data processing.

For these operations to be done by machine it was necessary to view them as a continuum or process, that is as an *integrated system* having a preestablished order or logic, and possessing self-regulatory, or feedback mechanisms.

In the light of these requirements *automation* emerged as a *system of process-control. Automation* gathered significant impetus in the late 1950's with the spreading of the *computational methods* through the appearance of the modern general purpose digital computers with internally stored programs.

Driven by the twin forces of higher speed and lower cost *process control* is developing now along two lines — *process-mechanization and situation interpretation* — thus it treats the different operations as *integrated systems* and aims at translation across *boundaries*, that is crossing the frontiers of individually closed operations in order to be able to treat the interlocking processes of manufacture, assembly etc. with *homogeneous* methods.

The spreading of the computational methods has led to two characteristic results in the field scientific research. On the one hand a number of sciences previously deemed as homogeneous have split up into different disciplines, on the other hand a number of sciences previously deemed as belonging to different disciplines fused into a single, homogeneous science.

Theoretically one might come to the conclusion that the computational methods applied to the domain of *building* will — by analogy — advance towards this latter direction, that is towards fusing into a single, homogeneous science, since the fundamental significance of the computational methods is that they can analyse physically different phenomena with homogeneous methods, and building-science, in turn, is a "par excellence" composite science.

International experience, however, proves the very opposite since it clearly shows that the computational methods applied to building industry stayed *within* the individual branches of building industry (building science), that is to say — for the time being — it is far from crossing the *frontiers* between the individual *branches*, more accurately: the frontiers between design—manufacture—assembly.

In our opinion this conspicuous phenomenon is in close connection with the specific nature of building industry, which can not be compared to that of any other industry. In the following — in very broad lines — we try to sketch out the reasons for this phenomenon.

2. Building industry and automation

Translating the process of design—manufacture—assembly into mathematical language

Up-to-date building industry — as we have seen — is characterized by the three phases of design—manufacture—assembly.

When applying computational methods for problem-solving, the first step of programming is to produce the different problems in mathematical form, in other words, to translate the problems into the language of mathematics. Thus, when analysing the correlations between building industry and computer science it will be most advisable to know what the individual phases of building industry correspond to in mathematics, since the computer technology applied to building has to bear on all three phases of the industry *universally*.

We have already pointed out that assembly — that is the very process of *building* — is based on the principle of additivity, thus mathematically it corresponds to *addition*.

We have also mentioned that manufacture as a process is based on the principle of disintegration, since building — as such — can not be produced in itself and consequently manufacture in building industry can only be based on breaking up the building into constituent parts. This, however, means that *manufacture* as a process corresponds to *division* in mathematics.

Design should be judged from quite another standpoint. Design, namely, is a *humanoid* process the result of which — the design — is a product of man's intellectual capacity, brainwork. Design as a process is closely connected with invention and so its translation into mathematical language would raise enormous problems anyway.

The essence of the problem in building industry, however, goes far beyond this. It is not the simple question of substituting the traditional thinking activities during the design process for various — mathematical, computational or mechanical — techniques, but the problem is *how to transform radically the very process of design in such a way that the designs* — which can even be produced with the application of the computer — *should reach the phase of assembly through a process of automated manufacture.*

We have to bear in mind, namely, that up-to-date building is characterized by three phases. Design, thus, is only a part of the building process.

The building-process and the automation

We have to consider now the *technological* position of the "building"-industry in the universe of the "manufacturing"-industries.

This again is a very complex problem which, on the one hand poses the general problems of production within the building industry, on the other hand touches upon general question of the final product, so — basically — it raises the general questions of technology and architecture.

From the technological point of view it hardly needs any proof that building industry has not passed yet beyond the phase of *mechanization.* Let me quote here again GUNNAR MYRDAL.* "How could it be — asks he in the year 1965 — that in the era of automatic computers and the rockets to the moon the subject of a big international congress like this of technicians in crucial sector of every national economy could be how to proceed towards industrialisation of building?" . . . "How can it be that the problem of building industrialisation has still not been adequately solved even in the most developed countries? Other branches of the industry have been industrialized long ago and are by now approaching, to a larger or lesser extent, the late stage which we refer to as automation. What is then so particular about building ?" . . .

The answers to these questions are several and complex. From technological point of view, however, the main reason for the present situation is that building industry today is still representing the industrial phase of mechanization and, as such, it is unfitted for creating a real basis for automation.

Mechanization is characterized by *fragmentation*, mechanizing production, namely, means dissecting the process of work into its component operations. As opposed to this:

Automation aims at *totality*, it draws together the different interlocking manufacturing processes and thereby it establishes high volume techniques maintaining continuity and high speed in production. And here we come to the point again.

Introducing automation demands the radical transformation to the existing structure of the building industry. This purpose is actually served by the computational methods already applied in the different *branches* of building industry. Yet the results achieved hitherto are fairly underproportionate especially from the point of view of building industry as a *whole. Aiming at a totalitarian — that is automated — technique namely is necessarily doomed to failure*

* Gunnar Myrdal: Needs Versus Capacity. See: Bibliography.

if it can not liquidate fragmentation, that is the industrial principle of mechanization, and substitute it for a completely new principle.

All this, however, involves grave difficulties in building where the humanoid part — the design — has to be connected with manufacture and assembly which obey other laws, whilst manufacture and assembly — composed in themselves of very many components varying in nature and quality — have to be organized in the best possible way in space and in time.

This is the only possible method, namely, which renders it possible for us to cross the frontiers between the individual branches through application of computational methods in building industry.

The building-product and the automation

It calls for no proof that the final products of building industry — or at least a part of them — are not only industrial products, but intellectual productions as well. Thus they not only have to satisfy *technological* (industrial) requirements but *architectural* (artistic) ones as well.

The automation in the building industry can not put an end to the nature of architecture. It is unreasonable to insist on the fallacy of the parallel between automobile and building industry. It can be easily shown that in the production of an automobile it is always the final product which is standardized whereas the components are mostly specially made and practically never interchangeable. Exactly the opposite applies to building. *Even in the phase of automation the ideal programme of building industry is to couple the mass-production of the structural-systems (components) with leaving the possibilities for creation (the final product) open.*

The problems of manufacture and co-ordination in the building industry are, thus, definitely not analogous with those of the mechanical industries but they are far more complicated and composite.

If we want to move away the industrialization of building from the present phase of mechanization raising its level to the higher degree of quality of automation, then we have to keep in view the simultaneous satisfying of two basic requirements: we have to increase the *architectural efficacy* of the manufactured structural systems and at the same time we have to increase the *technological efficacy* of the manufacturing apparatuses as well.

Workability of structure and convertibility of machine: these are the two characteristic, fundamental requirements of automation in the building industry.

The essence of the problem in *architecture*, namely, is to ensure the *variability of the final product*, that is to establish the preconditions of *planning for change;* whereas: the essence of the problem in *building industry* is to ensure the *flexibility of the manufacturing apparatus*, that is to say, to establish the preconditions of *producing for change.*

3. Architectural design and automation

Human and mechanical aspects of the creative process

Design is a *creative* process. Irrespective whether we design buildings or machines, keep in view aesthetic or structural considerations, struggle with functional or mechanical problems, all creative designers are involved in a similar process. This *design-process* unfolds some how like this: at the beginning of the design-process — be its object an automobile or a building — the designer does not have a very clear notion of what he wants to do. He has only a vague concept, or none at all, of how he will go about accomplishing his task.

In this sense, the design process is a *learning process* during which the designer must learn what the problem is and how to solve it. Within this process of learning there are certain exciting aspects of discovery. But these *intuitive* moments are interspersed with tedious periods of *rote* behaviour — sheer, unadulterated, dull work — noncreative but necessary. It is appropriate to have computers to do this noncreative work so as to leave the designer free for the activities human beings are especially good at: *innovation*.

Intuition and analysis

The typically human aspect of the design process is invention, the grasping of schemes that are at the beginning vague, tenuous and solidifying them into something tangible that can be looked at, explored qualitatively and evaluated quantitively. In the process of design-work discovery spells intuition, presentiment, flash: light through, whereas analytical procedures spell orientation, sense of certainty: light on. It is the analytical procedures that reveal for the designer the totality of the possible choices, the bases for comparisons, the methods of selection that is all the criterions of technical judgement.

Analytical procedures, in general, are mechanical, they are characterized by reliability based on repetition, automatism and control. While all activities during the *design* process up to the application of analytical procedures are *humanoid*, the *analytical* procedures are essentially *non-humanoid*.

Analysis is the real domain of applying computational methods to the design process.

The classic world of the design is actually bound to the traditional building. In the period of mass-construction, however, this world — as a consequence of inserting the phase of manufacture — qualitatively changes.

The *industrialization of building*, namely, opens two possible ways for the *design* depending on the character and product of manufacture; the one is based on mechanization, whereas the other on automation.

Design in building industry based on mechanization

The first way is building industry based on *mechanization.* Its symptomatic tendency is the *integration of design and production.* This way links the essential requirements of design, its possibilities and limits to those of factory production and closes the process of design when production starts. According to this:

Design in the *integrated industry* is a complex, integrated, closed process. It is a:

complex process because it bears on all three phases of industrialized building;

integrated process because it designs no building in the classic sense of the word but creates a system of buildings, the variability of which is determined by manufacture and the assembly of which is individually closed;

closed process because its work comes to an end when manufacture starts since the manufacture aimed at determined products and the closed assembly aimed at determined individual buildings renders its further contribution unnecessary: design becomes system-design within the frame of which the design of the individual buildings actually becomes adaptation.

The axiom of mechanized building

In the building industry based on mechanization the sequence of the three phases is design—manufacture — assembly. In the building industry based on mechanization *form follows manufacture.*

This is the axiom of mechanized building.

Design in building industry based on automation

The other way is building industry based on *automation.* Its characteristic tendency is the *disintegration of design and production.* This way links the essential requirements of design, its possibilities and limits not to the production of a particular factory — be it organized on any high level — but to a system of requirements demanded by the automated manufacture and related immediately to the whole of the industry. This way does not close the process of design when production starts, on the contrary, it opens it, since through the apparatus of the industry it has actually called into being the technical preconditions of planning for change. According to this:

Design in the *disintegrated industry* is a complex, disintegrated, open process. It is a:

complex process because it bears on all three phases of industrialized building;

disintegrated process because the assembly of the buildings determined by the automated manufacture is open, consequently manufacture — on a higher level of quality — reinstates design again;

open process because its work does not come to an end when manufacture starts but, on the contrary, it rises to a new level of quality since, there is really no obstacle any more to design the building — in harmony with the ever changing requirements — architecturally freely.

The axiom of automated building

In the building industry based on automation the sequence of the three phases is: *manufacture—design—assembly.*

In the building industry based on automation *manufacture follows form.*

This is the axiom of automated building.

From technological point of view the above axiom is of vital importance since it means that in the automated building *manufacture precedes the process of design*, that is in mathematical language: the process of *design is derived from a manufacture.*

The freedom of design and automation

The characteristic feature, namely, which distinguishes the building industry based on automation from the one based on mechanization is that it can build into its manufacturing apparatus the analytical, that is mechanizable procedures of design and thereby it really frees the human activities of the design process since it concentrates the energies of the designer on intuition.

Automation in the building industry raises the freedom of design to the highest of quality of industry because it calls into being the freedom of design translatable into the language of the machine, that is the freedom really based on the "recognized necessity" of our era.

Architecture and the computer

The inexorable approach of the computer age into the life of the architect has certain emotive characteristics. It is a feeling well known from history. So too, in their day, did the advent of the steam engine, the aeroplane and even Gutenberg's movable types, evoke similar pangs of disquietude about what appeared to be an ominously changing future.

Concern among architects about computerization of design there may be but doubts as to its inevitability there should be none. After all the age of scientific — technological revolution has its own objective laws too.

The use of computers in design is still in its infancy.* But the tool is already existing and architects should not shrink from welcoming and fostering its development. *The computer, namely, is a tool which can separate the logistic and functional factors of architectural design from those of art and intuition.*

From the point of view of architecture this feature of the computer is of epoch-making importance, for it is not design by computer that is intended but design aided by computer. And this is our intention, too.

4. Co-ordination in the building industry based on mechanization and on automation

The role of co-ordination

Co-ordination is a method for relating industrial techniques to the building process. Co-ordination spells systematization according to certain principles so it belongs to the analytical procedures, and, as such, it is extremely suitable for taking up computational methods.

Thus it is not without any grounds if we assert that one of the ways of spreading computational methods universally in building industry definitely leads through co-ordination.

The possible methods of co-ordination

The industrialization of building is inconceivable without manufacture, whereas manufacture can not exist without co-ordination.

The industrialization of building, however, can apply many different possible methods of co-ordination. If systematization is only connected with some kind of manufacturing operation then we normally speak about *standardization.* If the standardizing operation is only related to the dimensions of the manufactured elements then we deal with *dimensional co-ordination.* If the standardizing operation does not stop at co-ordinating the dimensions of the elements, but relates these dimensions to each other through inserting the international module grid — where the distance between the gridlines is the basic module = 10 cm — then this is *modular co-ordination* which gets a decisive role first of all in the determination of the fundamental structural parameters (spans, heights, etc.). The *double co-ordination* does not stop at the modular structural parameters but goes beyond this and also includes into the systematization the different submodular structural thicknesses as well and thereby it not only establishes mutual and unambiguous reference between the elements and the modular grids but also between the grids and the apparatuses manufacturing

* See footnote on page 103.

these elements. The *triple co-ordination*, finally, draws into the systematization the time factor as well, that is the moving of the elements, the sequence of their location in space, etc. and thereby it establishes a systematization relating already to building — machine — time as well.

The mechanization based building industry and modular co-ordination

The *industrialization of building* opens two possible ways for *co-ordination* depending on the nature of the industry.

The one is the building industry based on *mechanization*. This way, as we have already mentioned, leads to the *integration of the design and production* and is connected first with *dimensional co-ordination*, then — in its most advanced period — with *modular co-ordination*.

This integrated industry accordingly makes *manufacture a closed process* since it *renders the technological cycles complete within the factory*, which necessarily means *enforcing co-ordination on the factory level.*

Under these circumstances the *application of computational methods* can not become universal, that is to say it cannot bear on all three phases of building, consequently it *can not cross the frontiers of the individual domains.*

The automation based building industry and double coordination

The other one is the building industry based on *automation*. This way as we have already mentioned, leads to the *disintegration of design and production* and is connected in the beginning to *double co-ordination* and on its highest level to *triple co-ordination.*

This disintegrated industry accordingly makes *manufacture an open process* since — instead of rendering the technological cycles complete within the factory — it *renders the technological cycles complete within the industry*, which necessarily means *enforcing co-ordination on the industrial level.*

Under these circumstances the application of computational methods may really become universal since in the automation based disintegrated industry co-ordination is realized on the industrial level, all three phases of building are open processes in themselves, and so the *application of computational methods can cross the frontiers of the individual domains.*

The theoretical bases of the adaptation of the Gutenberg-principle to building industry

About the notion of technology, in general

Technology means systematical knowledge and action. In everyday usage the notion is mainly connected with *industrial* processes. In the broadest sense of the word, however, any recurrent activity spells technology. We use the notion here in this latter sense.

The explicitness of technology

As *systematical* knowledge every technology is also a *method* at the same time, through the intervention of which, we can *translate* one kind of knowledge into another mode.

Thus, technology is *explicitness* and translation basically means *spelling.*

Building as a technology

Building as systematical knowledge and action is one of the *technologies,* and, as such, it is also a *method through which, worked, or unworked-, natural, or artificial materials (that is one kind of knowledge) through the intervention of assembly (that is the method of additivity) can be translated into the language of spaces (that is another mode of knowledge).*

Building is an ancient technology. At the dawn of mankind in the neolithic age it was the heaping up of natural materials with the use of human force and skills (that is in an artifical way) that heralded the appearance of the technology by which man was able to let go of his environment, the virgin nature, the caves, in order to grasp it in a new way, that is an artifical way. *The building namely is an artificial nature.*

The explicitness of building

Through building man appeals to the *hand* and translates nature, because by the heaping up of elementary pieces he tames the ancient, natural tectonics into a human additive process. *In the technology of building, additivity — that is the heaping up — means the explicitness and disintegration — that is the decomposition into elements — corresponds to spelling out.*

The constant and variable factors of history of building

In the principles of *additivity* and *disintegration* the *axioms* of building technology are put into shape. Thus, in the history of many thousand years of building these mean the *constant* factors.

Variable on the other hand is the *method of additivity and disintegration: so — from a technological point of view — the individual periods of the history of building can only be distinguished on the basis of how the building is broken up into elementary parts and how these elementary parts are put together.*

The two fundamental technological periods of history of building

According to the aforesaid, history of architecture classified into so many periods of styles can only be divided into two fundamental periods from *technological* points of view. These are the periods of *traditional* and *industrialized building.*

The process of *traditional building* is based on the additivity of individually workable elements and its period still goes on in the overwhelming majority of the countries of our world.

The process of *industrialized building* is based on the additivity of factory-made, thus, subsequently unworkable tectonic elements and its period hardly goes back to more than some decades even in the most advanced countries.

The continuous technological revolution of our age extremely accelerates the development of building technologies as well, and renders it a reasonable question for us to overpass mechanization — the previous stage of industrialized building — by stepping over to the more advanced period of automation.

The need for devising a new model

Llewelyn Davies has been quoted as saying that in the development of our knowledge of the process followed in creating the built environment, we have reached a *pre-Newtonian* stage in the sense that a considerable amount of knowledge has been accumulated and digested, but no clear pattern or *model* has been devised yet to fit these separate components into a *system.*

In our view we simply cannot avoid the devising of a new comprehensive model, which concerns the *whole* of the building-process since switching over from mechanization to automation remains a bare illusion if we fail to organize building industry on the basis of a *new model.* Therefore we must not allow that the real difficulties of solving such a problem should serve as a pretext for shirking the question.

We have to try out the "Newtonian approach" and so, make an attempt at formulating the "simplifying hypothesis", that is to say, we have to define the general model into which our existing and future knowledge would fit in beauty and order.

The universal model of building

The nature and quality of building

The *nature* ("genus proximum") *of building* has never been a subject of contestation. Building as systematical knowledge always was and remains *technology*.

This does not apply to the *quality* ("differentia specifica") *of building*, that is the characteristic features, which distinguish building technology from all the other technologies.

Nevertheless, as long as we were in the age of *traditional building*, this meant no problem either. Everybody knew that building was a *composite handicraft technology* including a number of skills (masonry, carpentry, etc.). Ever since we have stepped over to the age of *industrialized building*, however, and it became evident that building meant industrial techniques, it became very important for us to know how to interpret the situation of building as a *composite industrial technology* within the universe of technologies.

The need for situation — interpretation on industrial level

It calls perhaps for no explanation that here we are basically confronted with a very special case of situation interpretation on industrial level, in so far as it is not the task here to analyse individually closed processes with homogeneous methods, but to cross the frontiers between the individually closed industries and to analyse interlocking technologies with homogeneous methods.

Thus, the question is *to determine the situation of building-technology in the totality of technologies* so as to be able to treat building technology — on the basis of this situation-interpretation — as an *integrated system.*

The model as a tool for situation-interpretation

The model of building is a tool for situation interpretation. It is obvious that we cannot get a correct general survey, unless the model hypothetically devised is really adequate, that is to say:

a) if the model is universal i.e., it really spans the *whole* of the building process;

b) if it treats the three phases of up-to-date building — that is the process of design — manufacture — assembly — as a *coherent system;* finally

c) if it suceeds in establishing these three very heterogeneous processes on sound foundations of a *unified industrial conception.*

The basis of the model: the simplifying hypothesis

The basis of the model is a simplifying hypothesis, in our case the assumption that the three component operations of industrialized building constitute an integrated system, consequently computational methods may be comprehensively applied to building as a whole.

There are two possible ways for devising a model like this. In both cases we have to start out from the *product* of building — since it is only ***the building*** that embodies all three component operations in the form of *final result* — and arrive at the model on the *way back.* The two ways hide two different conceptions of *co-ordination:*

— the one treats the building as a result of *additivity of processes,* thus it conceives the final result of the building-process as a *sum total of elementary movements;*

— the other one treats the building as a result of *additivity of products,* thus it conceives the final result of the building-process as a *sum total of elementary parts.*

The two methods, of course, are overlapping each other. Since, however, building is an additive process, its seems expedient to choose this latter method for devising the model and therefore in our study *we conceived the building* — that is the final result of the building process — *as a sum total of elementary parts.*

Thus our task is to devise the model of building as an integrated system and thereby, open the way for the application of computational methods on industrial level.

Building as an integrated system

Building as a *whole* can only be treated as an *integrated system* if — technologically — we succeed in translating its three very *heterogeneous* component operations into a common language. Therefore:

— first of all, we have to examine the technology the *essential* features of which stand closest to building, which therefore — technologically —may serve as a *model* for automated building;

— then, we have to examine how to translate the three component operations of building into the language of this *analogous technology;*

— finally: we have to devise a *universal model* of building in such a way, that we translate the three component operations — through the medium of the analogous technology that we have chosen as a basis for the model — into mathematical language.

Building as a Gutenberg-principled technology

About analogy, analogical conclusion and analogical model, in general

By way of introduction let us say a few words about analogous valuation in general.

By *analogy* we usually mean similarity, parallelism.

The notion of *analogical conclusion* is not identical with that of analogy. By analogical conclusion we mean inference drawn from essential features of two different phenomena in certain particular respect pertaining to the similarity between the phenomena.

The analogical conclusion is a tool for scientific foresight, so it plays an important role in the process of systematic research. From scientific point of view analogical conclusion — in itself — is of no proving value.

The notion of *analogical model* is not identical with that of analogical conclusion. The analogical model basically is a metaphor, that is a pictorial statement, which draws an all-embracing picture of the essential characteristics of a certain phenomenon by expressing similarity through some kind of identification.

Thus the analogical model is not a conclusion but a translation, through the intervention of which, we can fit a new kind of knowledge into our exciting knowledge.

The analogy formulated in the model is a tool for identification (i.e.: scientific understanding) therefore it is almost indispensable, when a new notion is to be explained with known ones. A model may give an inspiration, it may serve as a basis for a new hypothesis, or theory, in itself, however, it is of no proving value.

According to its function the analogical model may range from a simple graph to complicated mechanisms. Norbert WIENER'S famous model — the "moth", which steers itself automatically into a light — is basically a metaphor, which translates the analogies between the feedback apparatuses and the human nervous system into the language of the mechanism. The tool for identification — the model — is sketchy and from the mathematical point of view it is not even precise. But, *the pictorial statement is all-embracing* and therein lies the reason of the analogical model.

After these preliminary remarks let us finally mention that there is a very specific analogical model through the intervention of which, we elaborated the integrated system of building based on a unified conception.

The problems of selection of the model-analog technology

If we analyse the technologies in order to decide which of them might serve as the most suitable *transmission* for constructing the universal model of building, then we have to start out most expediently from the constant and variable factors of the building-process.

In building, independently of the age and the technology applied

the *constant factor* is represented by the *principle* of additivity and disintegration;

the *variable factor* is represented by the *method* of additivity and disintegration.

It is very important to know that the requirements of the *model-analog* technology can exclusively be satisfied by those technologies which include all the above mentioned *essential* characteristics of building *without deduction.* It is pertinent to consider N. WIENER'S warning: "it is equally dangerous to accept an unproven analogy as it is to refuse its possibilities from the start" or, — this being our own supplement — not to draw a proper conclusion from a recognized analogy.

These criteria are of vital importance because they protect us from the *false* analogies that led us into so many complications in course of the last decades. They unambiguously exclude for example from the range of possible technologies the mechanical industries, more accurately said: the manufacturing technologies as possible models.

In building technologies the final product is variable

— in *manufacturing technologies,* namely, it is always the method of additivity and disintegration that keeps constant, since the *final product* completed in the factory — the machine-tool, tractor, automobile, etc. — is always *the same;* whereas

— in *building technologies* exactly the opposite is necessary since the process of production is not completed in the factory but on the site and it is the *variability* that we expect from the *final product.*

In building technologies the elementary parts are universal

There is in addition another (and not less important) point of view that, from the very first, renders the manufacturing technologies absolutely unfitted for serving as a model for the whole of the building process, namely:

— in *manufacturing technologies* the *components* — that is the additive elementary parts — are mostly *specially made* since it is the final product which is standardized; that is determined from the very first;

— in *building technologies*, however, the real purpose is to avoid standardization, that is determination of the final product from the very first, therefore, *in the manufacture of the elementary parts we aim at universality.*

Building is not a mechanically principled technology

This is a very important conclusion, since — as opposed to previous suppositions — it cleary proves that building as a technology basically differs from the manufacturing technology, consequently the model of building based on automation can not be founded on the analogy of the mechanical industries either. **Building is not a mechanically principled technology.**

But then, what kind of technology is building, finally?

We have to go on with the analysis. We have to bear in mind that technology as "systematical knowledge and action" includes *every* kind of recurrent activities, consequently technology is a *broader* notion than that of industrial operation. *Technology is the highest category of recurrent activities.*

The extension of the scope of research for model-analog technologies into areas hitherto unexamined is, thus, justifiable both from industrial and scientific points of view; so we carried on the analysis in this direction.

Unfortunately the limited extent of this study does not render it possible to expound this analysis *in extenso*. We had to be content with publishing the final conclusion and of course, with the proving of this conclusion.

Building as Gutenberg-principled technology

Here again we started out from the constant and variable factors of the building-process and again conceived the building as a total of elementary parts.

This time, however, we considerably *modified the method of disintegration* in such a way that instead of breaking up the building into semantically meaningful, that is non-neutral elementary "parts", we broke up the building into semantically meaningless that is neutral elementary "particles". Through the "infinitesimal" reduction of the limits of disintegration the building — instead of falling into "parts" — fell into "particles" that can even be called "molecules". And this is which finally led us to the drawing up of a new conception of building. In the universe of technologies, namely, building based on the additivity of molecules does have an adequate model-analog technology: **building is a Gutenberg-principled technology.**

The modelability of building

This sentence written with capitals and still waiting to be proved, expresses that *building based on the additivity of molecules can be technologically translated* into the language of any technology in which explicitness is literally based on some kind of spelling out, that is: on some kind of carrying *disintegration* (decomposition) right through to the elementary particles, and then on some kind of *integration* (assembly, additivity) of these elementary particles.

The role of the additivity of molecules

The modelability of building based on the additivity of molecules is a very important circumstance for us because it may open new, hitherto unknown ways towards the automation in building.

— The *speech* in which semantically meaningless *sounds* add up to meaningful, outspoken words, sentences;

— the *writing* in which semantically meaningless *letters* add up to a meaningful, visual code;

— the *print* in which semantically meanigless movable *types* add up to meaningful mass-produced texts, are all *model-analog* technologies of building.

The new conception of building

We founded the new conception of building on the recognition that technologically, building composed of the three phases of design, manufacture and assembly can be adequately modelled through the transmission of speech, writing and printing.

Since that fundamental model-analog technologies of building — the speech (the verbal code for understanding) and the writing (the visual code for speech) — was first translated by GUTENBERG into the language of mechanized production (that is mechanical repeatability), therefore — availing ourselves with a metaphor — *we called building a Gutenberg-principled technology.*

The model analog technologies of building

The determination of the model-analog technologies of building means only a first step in solving the problem. We still have to prove that the choice was correct, consequently — on the basis of these technologies — building can really be treated as an integrated system. For this purpose, as a second step, let us examine here how the three component operations of building can be translated into the language of these analogue technologies. Before this, however, we have to get acquainted with these model-analog technologies themselves.

The speech

The *speach* — the spoken word — was the first technology by which man was able to let go of his *environment* in order to grasp it in a new way. It is the speech that enables the human intellect to detach itself from the wider reality, and to denominate nature with articulated words. The spoken word namely is a named nature.

The spoken word: the verbal retrieval of the world

Through speech man *appeals to the ear* and *translates* nature because, by means of linking up *sounds* the entire world can be evoked and retrieved and so the process of conciousness becomes *verbal* too.

Language not only translates one kind of knowledge into another mode but is also stores experience: in the oral world information "flies from mouth to mouth", thus its nature becomes *subjective* because it is bound to man, and *dynamic* since it *changes* with the flight of time.

The speech as the model-analog technology of design

The design: the graphical representation means that technological phase of building in course of which the thought, the architectural idea is formulated in the adequate form of a pictorial statement. The *graphically represented design* namely, is a *visually denominated building.*

The graphical representation: the pictorial reproduction of the building

Through the "speech" of the design the architect appeals to the *eye* because by means of *drawings* he renders his verbally inconceivable ideas reproducible, and thereby he makes the *pictorial* factor the most important in the process of consciousness.

Design not only translates one kind of knowledge into another mode but it also stores experience; in the world of drawings based on *Monge's* projective geometry information becomes visual. Model-analogically speaking: *the architectural design corresponds to graphical speech.*

The writing

The *writing* — the written world — was the first technology by which man was able to let go of speech in order to grasp the oral — that is verbally reproduced — world in a new way. It was the writing that enabled the human intellect to escape from the jail of oral tradition. The written word, namely, *visually* fixes the "flying" words of the live speech.

The written word: visual reproduction of the oral word

Through the writing man *appeals to the eye* and translates nature because by means of symbols he renders the "sounding" oral world reproducible and thereby, he makes the *visual factor* the most important in the process of consciousness.

The writing not only translates one kind of knowledge into another mode but it also stores experience. In the world of manuscripts information becomes visual, thus its nature becomes *objective* because it is bound to material (clay-slate, stone, papyrus, etc.), and *static* since its message *does not change* with the flight of time.

It is not our task here to point out the extremely interesting relations that exist between the writing and the material to which it is bound. It is all the more important, however, to turn our attention to the lessons that can be drawn for architecture from the different *forms* of writing from a model-analogical point of view.

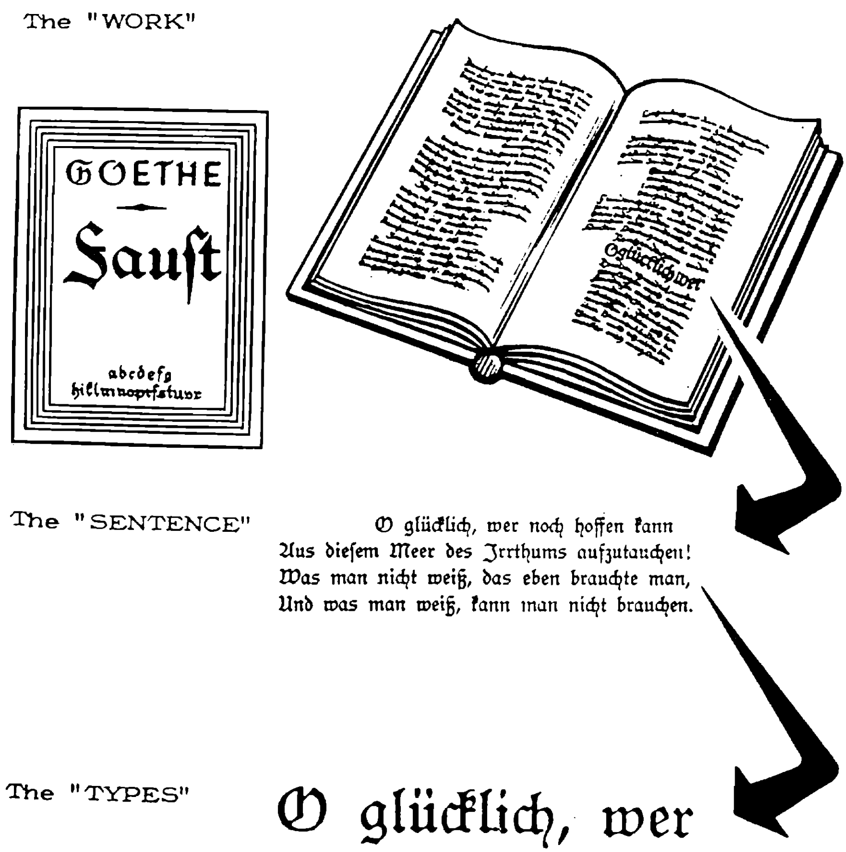
Ideography and phonetics

For us, writing is equivalent to phonetics, though this is not the only form of writing and not even the most ancient one. From the point of view of spreading literacy, however, it turned out to be the most efficient and it was phonetics that created the real foundations of European culture both in the field of the Humanities and Techniques.

As opposed to *ideography*, which with its innumerable *signs* was difficult to master; *phonetics* did not necessitate the acquisition of so extensive a knowledge and so complex a skill since the alphabet could be learned in a few hours.

The phonetic alphabet as technology

The phonetic alphabet, namely, is a unique technology. There have been many kinds of writing, pictographic and syllabic, but there is only one phonetic alphabet in which semantically meaningless letters are used to correspond to semantically meaningless sounds. To quote *M. McLuhan:* the phonetic alphabet translates the sound into a visual code. Model-analogically speaking: *the phonetic alphabet is a kind of technology which disintegrates the live speech into elementary particles (sounds), then translates these particles into a visual code* *(letters) and reassembles writing (meaning) from these semantically meaningless particles, as illustrated by figure below:*



The writing as the model-analog technology of manufacture

The *manufacture* — the breaking up of the building into constituent parts — means that technological phase of up-to-date building in which we translate the architectural idea formulated in the designs into the language of the manufacturing apparatus.

The principle of disintegration in manufacture and in writing

Through the *disintegration* the architect appeals to the *industry* because he breaks up the "ouvre", that is the *whole* into elements, that is constituent *parts* in order to have these parts *manufactured*, and thereby he renders the industrial factor the most important in the process of realization. Model — analogically speaking: the *determination of the manufactured elements in building corresponds to the determination of symbols in writing.*

The fact, that the determination of the manufactured elements in building is nothing else than the determination of symbols inwriting is an extremely important statement because it helps us in proving that *the two fundamental stages of industrialized building — the mechanization and the automation — correspond to two different forms of writing from a model-analogical point of view.*

The mechanically principled tectonic building and the ideography

The mechanically principled building breaks up the building — the completed whole — into semantically meaningful, finally shaped and load-bearing "parts", into such parts, namely, from which the whole — the building — can be immediately and unambiguously recognized. This is well exemplified by the well-known mechanization principled large-panel building method where the characteristic element of manufacture is a semantically meaningful large-sized element of parameter size in two directions, that is a *tectonic large-panel, which as a symbol corresponds to an* ideogram.

Since in the mechanically principled building the basic manufactured tectonic elements are semantically meaningful therefore from a model-analogical point of view *the mechanically principled manufacture corresponds to the ideogrammatic form of writing.*

The automation principled building and the phonetic alphabet

The automation principled building — as opposed to this — breaks up the building — the completed whole — into semantically meaningless, finally shaped "particles", into such elementary parts, namely, from which the whole — the building — can not be recognized. In this *Gutenberg*-principled building the characteristic element of manufacture is semantically meaningless, which means that *the element as a symbol corresponds to a letter.*

Since in the *Gutenberg*-principled building the basic manufactured elementary particles are semantically meaningless, therefore from a model-analogical point of view *the automation principled manufacture corresponds to the phonetic form of writing.*

The print

The *print* — the printed word — was the first technology by which man was able to let go of *handwriting* in order to grasp the same in a new way. It was the print that enabled the human intellect to escape from the jail of parochialism, the world of codices. The print introduced the means of *mechanizing* the ancient handicraft of handwriting, and thereby it became the archetype of every mechanization to come.

The printed word: the mechanical reproduction of the written world

Through the print man *appeals to the machine* and translates nature because he renders the written world precisely and infinitely repeateble and thereby he makes the *mechanical factor* the most important in the process of consciousness.

The print not only stores experience but multiplies it in the strictest sense of the word because the world of typography renders the visual information mechanizable and thereby it extends information psychically and socially, in space and time.

Fragmentation and typography

Precision and repeatability: this is the core of every *mechanization,* this is the real message of the *Gutenberg* typography, the printing from movable types. It was the typography that introduced *fragmentation,* the method of mechanizing any handicraft.

Typography is no more an addition to the handwriting as an aeroplane is an addition to the bird. The *Gutenberg*-technology teaches us how to do *the same thing in a different way,* how to translate a kind of knowledge into the language of mechanical production by the process of *fragmenting* an originally *integral* action.

Gutenberg's uniform, continuous, and indefinitely repeatable bits inspired the concept of the infinitesimal calculus by which it became possible to determine any tricky, irregular space though the integration of elementary parts. Precision and repeatability: this was also, later on, the message of the industrial assembly line.

It was the adaptation of the Gutenberg-principle to building industry that finally inspired us to formulate the new conception of building.

The printing as the model-analog technology of assembly

The assembly — the in-situ operation of the building-process — means that technological phase in which the architectural idea, formulated in the designs, is realised through the proper addition of the manufactured elements.

Model-analogically speaking: *the assembly of the manufactured elements in building corresponds to the type-setting in printing.*

The principle of variation in building and printing

The statement above is extremely important because on the basis of this model-analogy it can be easily proved that *variability means two completely different problems in the mechanically principled and Gutenberg-principled building.*

In the *mechanically principled* large-panel building the smallest "settable" unit is an *ideogram*, that is an architecturally meaningful *large-size tectonic element*, the model-analogical content of which is not a semantically meaningless letter but a semantically meaningful part of a printed text: a *word*, a *notion*, a *sentence*, etc.

Since in the mechanization-principled building the smallest repeatable unit is architecturally meaningful, consequently *in the mechanically principled building variation can only be established between the elements.*

In the mechanically principled, tectonic building variation is a question of relation between the elements, the rational reduction of the number of diverse elements, in turn, is a well-known industrial requirement at the same time.

In the *Gutenberg-principled* building the smallest "settable" unit is a *letter* that is an architecturally meaningless molecule, a non-tectonic elementary particle, the model-analogical content of which corresponds to the *movable type* in printing.

Since in the Gutenberg-principled building the smallest repeatable unit — the molecule, the elementary particle of the building — is architecturally meaningless, consequently *in the Gutenberg-principled building variation can not only be established between the elements but also between the particles.*

In the Gutenberg-principled, non-tectonic building variation becomes a question of relation within the elements (between the particles) thus the reduction of the number of diverse elements becomes theoretically irrelevant.

Summary: the technical universality of the phonetic alphabet and the Gutenberg principle:

The technical universality of the phonetic alphabet and the *Gutenberg* principle lies in the fact that neither the spelling nor the printing is specifically connected to a particular language.

The *Gutenberg* technology, which translated the handwriting based on the use of the phonetic alphabet into the language of mechanical production, is exclusively bound to the *constancy of fragmentation. Thus the adaptation of the principle is not bound to any definite language.*

This conclusion is very important because architecturally speaking it means that in the *Gutenberg*-principled non-tectonic building it is only *Gutenberg's principle of fragmentation that is really constant, the typefaces may vary.*

אבגדהוזחטיכלמנסעפצקרשתךםןףץ

ΑΒΓΔΕΖΗΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ

أ ا ب ث ت پ ج چ ح خ د ذ ر ز ش س ض ص ط ظ ع غ ف ق ک گ ل م ن

و ه ى ي ١٢٣٤٥٦٧٨٩٠ ( ) ! ؟

ABCDEFGHIJKLMNOPQRSTUVWXYZ

АБГДЕЖЗИЙКЛМНОПРСТУФХЦЧШЩЪЫ ЬЭЮЯ

ABCDEFGHIJKLMNOPQRSTUVWXYZ

2 לָמָּה יֹאמְרוּ הַגּוֹיִם אַיֵּה־נָא אֱלֹהֵיהֶם :
3 וֵאלֹהֵינוּ בַשָּׁמָיִם כֹּל אֲשֶׁר־חָפֵץ עָשָׂה :
4 עֲצַבֵּיהֶם כֶּסֶף וְזָהָב מַעֲשֵׂה יְדֵי אָדָם :
5 פֶּה־לָהֶם וְלֹא יְדַבֵּרוּ עֵינַיִם לָהֶם וְלֹא
יִרְאוּ : 6 אָזְנַיִם לָהֶם וְלֹא יִשְׁמָעוּ אַף לָהֶם
וְלֹא יְרִיחוּן : 7 יְדֵיהֶם ׀ וְלֹא יְמִישׁוּן
רַגְלֵיהֶם וְלֹא יְהַלֵּכוּ לֹא־יֶהְגּוּ בִּגְרוֹנָם :
8 כְּמוֹהֶם יִהְיוּ עֹשֵׂיהֶם כֹּל אֲשֶׁר־בֹּטֵחַ
בָּהֶם :

Μῆνιν ἄειδε, θεά, Πηληϊάδεω Ἀχιλῆος
οὐλομένην, ἣ μυρί' Ἀχαιοῖς ἄλγε' ἔθηκε,
πολλὰς δ' ἰφθίμους ψυχὰς Ἄϊδι προΐαψεν
ἡρώων, αὐτοὺς δὲ ἑλώρια τεῦχε κύνεσσιν
οἰωνοῖσί τε πᾶσι — Διὸς δ' ἐτελείετο βουλή

سُورَةُ الفَاتِحَةِ (1)
مَكِّيَّةٌ وَآيَاتُهَا سَبْعٌ

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ (١)
الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ (٢) الرَّحْمَٰنِ الرَّحِيمِ (٣)
مَالِكِ يَوْمِ الدِّينِ (٤) إِيَّاكَ نَعْبُدُ وَإِيَّاكَ
نَسْتَعِينُ (٥) اهْدِنَا الصِّرَاطَ الْمُسْتَقِيمَ (٦)
صِرَاطَ الَّذِينَ أَنْعَمْتَ عَلَيْهِمْ غَيْرِ الْمَغْضُوبِ
عَلَيْهِمْ وَلَا الضَّالِّينَ (٧)

Arma virumque cano, Troiae qui primus ab oris
Italiam fato profugus Lavinaque venit
Litora, multum ille et terris iactatus et alto
Vi superûm saevae memorem Iunonis ob iram,
Multa quoque et bello passus, dum conderet urbem
Inferretque deos Latio: genus unde Latinum
Albanique patres atque altae moenia Romae.

Eröffn' ich Räume vielen Millionen,
Nicht sicher zwar, doch thätig frei zu wohnen!
Grün das Gefilde, fruchtbar; Mensch und Heerde
Sogleich behaglich auf der neu'sten Erde,
Gleich angesiedelt an des Hügels Kraft,
Den aufgewälzt kühn emsige Völkerschaft.
Im Innern hier ein paradiesisch Land,
Da rase draußen Fluth bis auf zum Rand,
Und wie sie nascht, gewaltsam einzuschießen,
Gemeindrang eilt, die Lücke zu verschließen.
Ja! diesem Sinne bin ich ganz ergeben,
Das ist der Weisheit letzter Schluß:
Nur Der verdient sich Freiheit wie das Leben,
Der täglich sie erobern muß.

Our Revels now are ended : Theſe our Actors
(As I foretold yon) were all Spirits, and
Are melted into air, into thin air,
And like the baſeleſs Fabrick of their Viſion,
The Cloud capt Towers the gorgeous Palaces,
The ſolemn Temples, the great Globe it ſelf;
Yea, all which it inherit, ſhall diſſolve,
And like this inſubſtantial Pageant faded,
Leave not a rack behind : we are ſuch ſtuff
As dreams are made on : and our little life
Is rounded with a ſleep:

Счастлив, кто в страсти сам себе
Без ужаса признаться смеет;
Кого в неведомой судьбе
Надежда робкая лелеет;
Кого луны туманный луч
Ведет в полночи сладострастной;
Кому тихонько верный ключ
Отворит дверь его прекрасной!

CSAK az olvassa versemet,
ki ismer engem és szeret,
aki a semmiben hajóz
s hogy mi lesz, tudja mint a jós
mert álmaimban megjelent
emberi-formában a csend
s szivében néha elidőz
a tigris és a szelid őz.

The adaptation of the Gutenberg principle to building industry, as we have seen, represents a method of disintegration which breaks up the building — the completed whole — into elementary particles.

In the Gutenberg principled building the smallest unit of manufacture — the elementary particle — is non-tectonic and architecturally meaningless and so as a symbol, it corresponds to a letter.

The adaptation of the principle of fragmentation, thus, does not determine either the size or the form of the elementary particles, the letters, consequently it does not necessitate the identity of the architectural languages either.

The different alphabets of the industrialized building in the future will actually mean only one language in the line of the possible languages of building.

This idea is actually illustrated here by the figure on the preceding page in the model-analogical language of literature.

* * *

References

The publications enumerated below are only those immediately related to the subject matter.

1. ELLUL, JACOUES: The technological society. A. Knopf, New York 1965.
2. ENGELS, FRIEDRICH: Anti-Dühring. Szikra, Budapest 1948.
3. GABOR, DENNIS: Inventing the future. Secker and Warburg, London 1963.
4. GIEDION, SIEGFRIED: Mechanization takes command. Oxford University Press, New York 1948.
5. HESSE, Mary B.: Models and analogies in science. Sheed and Ward, Cambridge 1963.
6. MCLUHAN, MARSHALL: Understanding media. McGraw Hill, New York 1964.
7. MCLUHAN, MARSHALL: The Gutenberg galaxy. Univ of Toronto Press, 1962.
8. MYRDAL, GUNNAR: Needs versus capacity. Toward industrialized building. Contributions at the third CIB Congress, Copenhagen 1965. Elsevier Publishing Company, Amsterdam 1965.
9. MYRDAL, GUNNAR: The challenge of world poverty. Pantheon Books — Random House, New York.
10. PÁRKÁNYI, M.: The theory of blind manufacture. Doctoral (D. Sc.) thesis presented to the Hungarian Academy of Sciences, Budapest 1970. (Vol. I.: Variations on a span-indifferent structural system; Vol. II. The theory of blind design; Vol. III.: The adaptation of the Gutenberg-Principle to building industry.) Manuscript in Hungarian and in English.
11. PÁRKÁNYI, M., GÁBOR, L.: Fundamental questions of theory of non-tectonic building. Akadémiai Kiadó, Budapest 1985. (in Hungarian).
12. OSBEKHAN, HASAN: The future of automation. Science Journal. 1967. október.
13. POPPER, Karl R.: The logic of scientific discovery. Hutchinson, London 1959.
14. RUSSEL, BERTRAND: Science and human life. in: Basic writings of Bertrand Russel. Allen and Unwin, London 1961.
15. TURIN, D. A.: What do we mean by building? The Architect and Building News, 30. March 1966.
16. WIENER, NORBERT: God and Golem Inc. MIT Cambridge. Mass. 1964.

Dr Mihály PÁRKÁNYI H-1521, Budapest