CHARACTERISTIC FEATURES OF THE NON-TECTONIC SYSTEMS (THESES)*

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Abstract

The actual theme of the theses summarizingly denominated as "Characteristic features of the non-tectonic systems" is the mass adaptation of the non-tectonic systems, or rather some fundamental theoretical and practical problems of the adaptation.

The theses are expounded in an expedient rhythm, in so far as they summarize the characteristic features of the non-tectonic systems through grouping them around definite problems.

Theses 1—3 deal with the "status", — i.e.: the proper place — of the non-tectonic systems. Here, first of all, we define the "genus proximum" of the system and then on this basis we start expounding the features, that is the "differencia specifica" of the system.

Thesis 4—6 analyse the architectural efficacy of the non-tectonic systems and point out why and to what degree the specific complementarity hidden within theses systems endow the non-tectonic systems with a particular significance in the industrialized building.

Theses 7—9 give an analysis of the principles of additivity and disintegration, that is the two universal, axiomatic and internative principles of building and prove that the non-tectonic systems by combining the two diagonally opposite principles of construction of industrialized building (that is the principle of component and the principle of coach-work) maintain their characteristic openness at all events (even if availing themselves with a possible closedness, if that is expedient).

Theses 10—12 finally examine the two fundamental and complementary systems of industrialized building — the system of co-ordination and the system of tolerances — from the point of view of non-tectonic building and on this basis — and as a summary of what has been said — determine the basic methods of non-tectonic building and mark out thereby their terrain the industrialized building.

Introduction

Theme, nature and foundation of the theses. . .

The actual *theme* of the theses summarizingly denominated as "Characteristic features of the non-tectonic systems" in the mass adaptation of the non-tectonic systems, or rather some fundamental theoretical and practical problems of the adaptation.

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The *nature* of the theses is extrapolation, or more accurately: positive scientific extrapolation and as such they draw conclusions on the nature of the future mass adaptation of the non-tectonic systems in such a way that they determine all those fundamental features, which — according to our *present* knowledge of the system — will inevitably characterize the future mass adaptation of the non-tectonic systems as well.

The *foundations* of the theses, more accurately: the scientific results embodied in the theses rely upon the more than a decade's research work of the authors as a comprehensive whole.

. . . and the method of expounding

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The theses, also in themselves, add up a coherent text.

1. Status of the non-tectonic systems
Place of the silicate-based, lightweight systems in the industrialized building

The two fundamental ways of building technique

In our age the technique of industrialized building is characterized by two different, contrasting, fundamental ways: the one concentrates production *in the factory*, whereas the other *on the building site* and the two ways have only one common feature, that none of them is able to create, to complete the building in itself on the place of the production, since it is quite evident that the products manufactured in the factory can only be assembled into a building on the building site, whereas it is unimaginable to have a building technology which could manufacture all the required industrial products (e.g.: doors, windows, lavatories etc.) on the very building site.

This statement again expresses the characteristic feature of building, since it basically states that building is not a mechanically principled technology. In the mechanically principled manufacturing technologies, namely, it is always the method of additivity and disintegration that keeps constant since the final product completed in the factory is always the same, whereas in the 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 not repetition but first of all variability that we expect from the final product.

Basic quality of the complementary technologies

The statement above, however, does not exclude at all the possibilities of other technologies of building, since between the two extreme situations necessarily quite a series of transitional — complementary — technologies can be called into being which complete each other to different degrees and which extend over the whole of building on the basis of some structural, technological, or system-building principle. The fundamental feature of these *complementary technologies*, however, always lies therein, that they can come to being exclusively through the mutual application, that is through some combination of the two fundamental ways of industrialization.

The non-tectonic systems are classed with these complementary building technologies. This is the "genus proximum", the nature of the non-tectonic systems, so first of all, let us have a closer look at it.

2. About the complementary building technologies in general

The complementary building methods, as we seen, take their place within the zone marked out by the two fundamental directions of the industrialized building, that is between the building technologies planting manufacture in the factory (which in the overwhelming majority of cases are closed) and the building technologies concentrating manufacture on the building site (which are essentially open), and represent between these two extreme poles on the basis of their structural, technological or system-building principle those building processes which always combine some kind of *factory* production of casing (forming) elements with a kind of *in-situ* building technology based on pouring, and always apply some kind of *auxiliary structural system* to keep the casing (forming) elements in in-situ position until pouring is completed, more accurately: until the *load-bearing structural system* arising as a result of pouring in of concrete is called into being.

Depending on the nature and ratio of the components, however, quite a series of complementary building methods can be created,which — considering their architectural and structural efficacy — can be significantly different from each other, therefore it seems unavoidable here to analyse some relevant questions of the nature of the complementary building method, one after the other.

Products of the complementary building

The first question: in what do the *products* od the complementary building differ from those of the other building technologies representing the two fundamental ways of the industrialized building? The answer is very instructive since it draws up *one of the specific features* of the complementary building

— as opposed to the technologies concentrating manufacture *in the factory* the products of which, the buildings, are *mass-produced mass products* (assembled on the building site in mass volumes, from mass-produced elements and components); and

— as opposed to the technologies concentrating manufacure *on the building site* the products of which, the building, are *individually produced individual products* (erected individually on the building site from constructions manufactured individually underneath the final position and lifted individually);

the products of the *complementary* building are always *individual products produced by mass-production methods* (which, of course, does not mean that they can not be repeated but that they are not driven by the compulsion of repetition).

These buildings are characteristically founded on the use of the *surface as principle of construction;* this means that manufacture does not start out from the final product, nor from its loadbearing structural frame but it starts out from the *surface* of the loadbearing structure, that it always produces the *casing system*, that is the *mould*, necessary for calling into being the primary loadbearing structure through pouring; and finally that this casing system, this mould is always mass-produced — on basis of a required, co-ordinated range of sizes, of course, — as a self-reliant secondary structural system.

Casing system of the complementary technologies:

The other question that seems expedient to analyse here is thus the following: in what do the *casing systems* of the individual complementary technologies differ from each other, in other words: what are the possible *moulds* through which the complementary building can call into being its specially individual products?

In the complementary building the mould can be produced in two ways (with method of mass-production, of course):

The regainable. . .

— first: as a *regainable* casing system, always as product of a factory. This kind of mould is always suitable for solving only one single task, for shaping the structure, namely, and since the architectural efficacy of the system in this case depends exactly on the combinatorial qualities of the casting system, therefore it is quite evident that any tendency towards increasing the dimensions, to make the form more complicated, or the system more complex etc., increases the number of restrictions and so it inevitably tends towards increasing the *closedness* of the system.

. . . and the lost casing systems

— second: as a *lost* casing system (more accurately: as a surface-structure), as a product of a planted factory, or a factory transplantable even to the building site. This kind of mould is already suitable for aiming simultaneously at more different purposes since the lost casing system beyond shaping the structure can also form the architectural surface, satisfy functions of building-physics, participate in the loadbearing, or even perform essential tasks of technology and in this case the architectural efficacy of the system does not depend any more only on the combinatorial qualities of the surface-structure since it is easy to see that it can be significantly increased not only by the convertibility of the machine but also by the transplantability of the very factory as well and so — depending on its degree — the product (which interests the society in the first place) can be rendered flexible and its producing system even totally *open*.

The auxiliary structures of the complementary technologies

The third question to be analysed according to this, is the following: in what do the *auxiliary structures* of the individual complementary technologies differ from each other, in other words: what are the possible supporting, bracing, stiffening, adjusting etc. auxiliary elements, by means of which the complementary technologies keep their casing systems in proper position during pouring in and occasionally hardening of the concrete?

It calls for no proof that the auxiliary structure used for keeping a casing system in in-situ position is in itself a system, the construction of which is dependent on the chosen mould and so it is obvious that the complementary building method may construct the system of the auxiliary structures in two ways, as follows:

— on the one hand: in case of the *regainable* casing systems *as an attached co-ordinated subsystem* as an inseparable structural part depending upon the casing system, from which it clearly follows that it can not have any role in the variability of the final product;

— on the other hand: in case of the *lost* casing systems *as a self-reliant co-ordinated system* totally independent from them, which is not only simply regainable but — by means of the build-in combinatorial qualities — it can become at the same time one of the fundamental bearer of the variability as well.

The load-bearing structural systems of the complementary technologies

Finally, the fourth question: in what do the load-bearing structural systems of the individual complementary technologies differ from each other, more accurately: what be can the structural systems of the individaul products of the complementary technologies which combine a factory production of the casing system with an in-situ pouring. The answer is very instructive again since it draws up *the other specific feature* of the complementary building.

Since the product of the complementary building — as we have seen — are basically characterized by the fact that manufacture never starts out from the final product, nor from its load-bearing structure frame but always start out from the surface of the load-bearing structure,

therefore from this is evidently follows that the arising structural system is not simply a function of the casing system (which, as it is known, can equally be regainable or lost surface-structure) but it is also a function of the *mode of shaping* of the chosen load-bearing structure;

since, however, this mode of shaping (not touching here upon the covering of large spaces) in case of *vertical* load-bearing structures can be point-like, slab-like, folded, or box-like; in case of *horizontal* load-bearing structure can use plane slabs, beams, beam-grids, or some kind of their combination;

and since it is exactly this mode of shaping composed of so many factors which decides whether we can or may think in cells (rooms), in stripes (zones), in undivided (through-going), divisible (or, rather, redivisible) spaces,

therefore it evidently follows that — in the last analysis — the *product*, the final result of the complementary building and the *structural system* through which it is realized can equally be *closed or open.*

After all: *the complementary building methods are founded on a surface-principled construction, they always combine some kind of factory production of casing systems with a kind of in-situ technology of pouring, their products are always individual buildings produced by some kind of mass-production methods and their load-bearing structural systems — depending upon the mode of shaping — can equally be closed and open.*

3. About the non-tectonic systems in general

Short definition of non-tectonic building

The non-tectonic systems — classed with the complementary building technologies — *are open, lightweight, silicatebased building systems founded on the Gutenberg principled fragmentation.*

In the non-tectonic systems, building is a complementary operation, that is, a process in which we combine the factory-production of surface elements with some kind of technology of pouring in of concrete either in the factory or on the building site, whereby we produce structural units (in the factory) or call into being the structures themselves (on the building site).

In the non-tectonic building method the final product (that is the building) is realized in such a specific building process where additivity (that is the axiom of building) is founded on the simultaneous non-loadbearing (non-tectonic) capacity and temporary or incidental instability of semantically meaningless (Gutenberg-principled) surface elements. In this building method the immediate product of manufacture is not the load-bearing structure but its surface and therefore alignment of surface elements of vertical and horizontal structures does not lead to immediately load-supporting—load-transferring (that is: tectonic) junctions between these surface elements.

This definition, the above determination of the specificity of the non-tectonic systems is still too *general* and by far not complete since it does not answer the question of how we can enforce this specificity, that is in other words: in what do the individual non-tectonic *building methods* differ from each other, and so it does not determine the terrain which can be covered by the non-tectonic systems within the universe of the industrialized building. This is to be explored, so we have to proceed — with the necessary detours — in this direction.

4. The architectural efficacy and its degree in the industrialized building in general

Aiming at variability. . .

In the industrialized building aiming at variability is in one way or another immediately connected with the technologies applied. It is quite evident, namely, that each technology, in a kind of way, is given some architectural possibility, architectural efficacy, or rather, is bound to certain constraints, necessities. One thing is certain, however, namely, that the totality of these technologies is suitable to satisfy every social or technical requirements of architecture.

. . . and the possibilities of satisfying requirements of variability. . .

It is also evident that the individual technologies — exactly as a consequence of their characteristic features — can satisfy only parts of the whole, can cover only certain areas, and in fact — owing to their internal laws — mostly at the cost of more or less compromises.

The essence of the problem from point of view of building lies exactly therein that we have to call into being buildings which though structurally unified are different in plan, function, level of demand and aesthetic appearance.

The different industrialized building methods, however, are suitable for satisfying this demand in very different ways and on different degree.

. . . in case of technologies planting manufacture in the factory, . . .

The technologies planting manufacture *in the factory* assemble the buildings from standardized manufactured parts on the building site. Since in case of such buildings the elements manufactured in the factory — irrespective whether they are box-like, slab-like or rod-like — themselves can not be shaped, therefore the shaping of the building is depending on the possibilities offered by the manufactured elements to create various assemblies. The efficacy of the system is thus determined by the number of possibilities of the assembly, which in other words means that *in case of technologies planting manufacture in the factory the architectural efficacy is the function of the combinatorial qualities of the structural system.*

. . . in case of technologies concentrating manufacture on the site, . . .

The technologies concentrating manufacture *on the site* (not touching here upon the family of monolithic reinforced concrete buildings erected on the site in in-situ position) construct the buildings from elements created on the site underneath the final position and then moved into final position. Since in case of such buildings it is not the building (nor its structure) which is determined but only the manufacturing apparatus, therefore the shaping of the building, the degree of alignment with the claims is determined by the number, efficacy and coupling of the otherwise standardized machines, which in other words means that *in case of technologies concentrating manufacture on the site the architectural efficacy is the function of the combinatorial dualities of the building- and lifting apparatuses.*

. . . and in case of the complementary technologies

The *complementary* building methods — as we have seen — always realize the buildings as a combination of some kind of factory production of a casing system with a kind of in-situ technology of pouring.

In case of such buildings

— since the immediate object of manufacture is always the mould itself (the elements of which themselves can not be shaped), and

— since this mould can be unregainable (and called in this case lost casing system), or regainable (and called in this case surface-structural system), and

— since these moulds are always kept in proper position by some kind of auxiliary structural system during pouring in and hardening of the concrete,

therefore the shaping of the building depends on the possibilities offered by the elements of the mould to create various assemblies, the efficacy of the system is thus determined by the number of these possibilities, which in the last analysis means that *in case of the complementary technologies the architectural efficacy will be simultaneously an immediate function of the combinatorial qualities of the casing system or surface structural system and the auxiliary structural system.*

5. The architectural efficacy and its degree in the non-tectonic systems specifically

Let us start out from the short summary of the hitherto said. The silicate-based lightweight systems are founded on a *surface-principled* construction, this is their nature, so they belong to the row of the *complementary* building methods. The *nature of complementarity*, however, manifests itself in these systems in a completely *specific* form, in so far as their surface elements have neither load-bearing capacity nor final stability (so, as regards their *construction* they are *non-tectonic)*, they are semantically meaningless (so, as regards they *nature* they are *Gutenberg*-principled), and finally these surface elements are manufactured in such a way that the factory does not see and does not have to see the final product (so *manufacture* — as regards its *nature* — is *blind manufacture*).

We got as far as this, so it is very sensible to have a closer look here at the *nature of the assembly*, more accurately, we have to examine how *complementarity* so fundamentally important from the point of view of architectural efficacy is enforced in the totality of the silicate-based non-tectonic building.

Advantages arising from complementarity . . .

The silicate-based non-tectonic building methods always realize the buildings in a complementary operation, that is in a process in which they combine the production of some kind of surface-structural system (based on pouring in of gypsum in the factory) with a kind of technology of freezing (based on pouring in of concrete either in the factory or on the building site).

In case of such buildings

— since the object of manufacture — the mould — is always some kind of surface element (which, actually, is nothing else then the negative of the loadbearing structure); and

— since this mould (which in an expediently preplanned form even itself can be shaped through cutting) from the point of view of mass-production is founded in every case on the *convertibility of machine* — irrespective whether pouring happens in the vertical plane (with casting battery or carrousel) or in the horizontal plane (with belt or conveyer); — and

— since the factory based on these convertible apparatuses can equally be conceived as *planted or transplantable factory;* and

— since the aesthetically neutral surface elements (depending of course upon the actual local conditions and within the reasonable limits of sizes, volumes, demands of rigidity, degree of readiness, conditions of transportation, in short: within the reasonable limits of an expedient and possible *degree of complementarity*) can be united into bigger, monolithic, rigid structural unit (plane-elements, smallspace elements, box-units etc.) already *in the factory* itself; and

— since both the surface elements and the structural units (preassembled from these surface elements) are always kept in proper position by some auxiliary tools during the pouring in and hardening of concrete (that is in case of preassembly operations *in the factory* by some kind of *manufacturing apparatus*, whereas in case of final assembly operations *on the site* by some kind of *auxiliary structural system*); finally

— since the shaping of the building that is the efficacy of the system is determined (as in each complementary building method) by the possibility offered by the elements of the mould to create various assemblies.

. . and their effect in case of the non-tectonic systems

therefore in case of the silicate-based non-tectonic technologies the *architectural efficacy* is not only a function of the combinatorial qualities of the *surface-structural* system and the *auxiliary structural* system, but beyond this and at the same time it is also a function of the *convertibility of the machines*, the *transplantability of the factory* and the *degree of complementarity*, that is the expediently chooosable ratio of operations in the factory and on the building site (whereby it becomes possible for us to take into an all-embracing from the *geographical* place of the adaptation), which in the last analysis — and in accordance with the hitherto said — means that *the architectural efficacy — within the industrialized building — may reach its maximum theoretically in the non-tectonic systems.*

This statement;— which might as well be regarded as a very dense summary of the results of our research and which will be further supported by the theses to follow — is basically founded on the very specific complementarity, more accurately: on the specific *double-complementarity* of the non-tectonic systems.

6. The principle of complementarity in general and in the non-tectonic systems: the principle of double-complementarity

The complementary building methods with their regainable casing systems enforce the principle of complementarity in such a way that they unconditionally and rigidly separate the factory-production of the mould from the casting operations on the building site.

The non-tectonic systems with their unregainable surface elements do not necessarily apply this categorical separation since their unrivalled architectural efficacy in the last analysis is based exactly on the circumstance that the factory and site operations may penetrate into each other and that thereby they can enforce complementarity not only between the factory and the building site but also within them.

This is the so-called *principle of double-complementarity* and this principle is founded on that very specific feature of the non-tectonic systems, that in these systems the axiomatic universal and interrelated principles of building — the *additivity* and the *disintegration* — and the fundamental and complementing systems of the industrialized building — the *co-ordination* and the *tolerance* — can always be enforced in *two ways*, as we shall see.

The non-tectonic building, as a technology, is based on the principle of double-complementarity.

7. The principle of double additivity: simultaneous applicability of the assembly operations in the factory and on the site in the non-tectonic building

Additivity, as it is known, is the universal principle of assembly. Building as a process is based on the principle of additivity.

In the non-tectonic building additivity can be enforced even in two ways since in this complementary — that is partly factory- partly on-site — technology the individual phases of the building activity can not only follow each other but can also penetrate each other, and

— since this penetration can already be started within the very factory, that is with the elements themselves (as for instance in the case of a tissue-structural floor element concreted in the factory),

therefore the non-tectonic building can call into being quite a range of variations of additive assembly operations both in the factory (in the different forms of preassembly operations within the factory) and on the site (in the most different forms of final assembly or preassembly operations on the building site) because within due limits of rationality it can almost freely choose the ratio of assembly operations in the factory and on the site, since

Two basic types of assembly in the factory additivity in plane and in space

the assembly *in the factory* (quite accurately: the preassembly operation in the factory) can be realized *in two ways*, and depending upon whether we unite the elements into structural elements or parts in one given plane, or more given planes, we may speak about *additivity in plane* or *additivity in space;* whereas

Two basic types of assembly on the site: in-situ and underneath in-situ additivity

the assembly *on the site* can again be made *in two ways*, and depending upon whether we fix the non-loadbearing (or partly loadbearing) and temporarily instable elements in their final in-situ position, or underneath the in-situ position, we may speak about *in-situ (final) additivity* or *additivity underneath the in-situ position* (not to mention that additivity can also be related to the assembly of the structural elements or units already preassembled in the factory).

All this together in the last analysis means that in the non-tectonic systems the additivity of the surface elements can not only be enforced on the building site but already within the factory itself, and so *the non-tectonic building as a process is based on the principle of double additivity* (that is additivity applicable both in the factory and on the site) and as such, it is unique within the industrialized building methods

8. The principle of double disintegration, simultaneous applicability of the Gutenberg-principled and mechanization principled decomposition in the non-tectonic building

Disintegration, as it is known, is the universal principle of manufacture. Building as a product is based on the principle of the disintegration.

In the non-tectonic building — quite accurately: in the phase of manufacture of the non-tectonic technologies — disintegration can be enforced in two ways, since in this very specific complementary technology — as we have seen — the building activity, that is the process of assembly can already be started *in the factory* itself, thus, the factory production does not necessarily have come to an end with the manufacture of the surface elements, since these — even within the factory — can also be united into structural parts, units of the most different function and sizes, through proper preassembly operation.

From the technological point of view this feature is of vital importance because it means that in the non-tectonic building the *manufacture* (that is the process based on the decomposition of the building into constituent parts) can apply the method of disintegration even *in two ways* and depending upon whether we decompose the final product into *non-tectonic surface elements* or into *tectonic structural parts*, we may speak about *one-fold*, or *two-fold disintegration.*

The one-fold disintegration. . .

The *one-fold* disintegration is actually a *Gutenberg-principled decomposition*, that is the decomposition of the surface of some undetermined final product according to the principle of component (that is according to the principle of the open systems) into surface elements which have neither load-bearing capacity nor immediate stability (which means that they are non-tectonic), and which are semantically meaningless (that is that they might as well be called *"letter" — principled*).

. . . the two-fold disintegration . . .

The *two-fold* disintegration is actually a *Gutenberg-principled and mechanization principled decomposition*, that is the decomposition of the load-bearing structure of an already determined final product according to the principle of coach-work (that is according to the principle of the closed or demi-closed systems) into structural elements which are loadbearing in themselves (that is that they are tectonic), which are semantically meaningful (that is that they might as well be called *"word"*-, or *"sentence"-principled*), and which can be produced in the factory through preassembly and concreting of non-tectonic surface elements.

. . . and the principle of double disintegration

All this together in the last analysis means that in the non-tectonic systems the disintegration related to the *whole* can not only be enforced in the semantically meaningless surface elements, but in the semantically meaningful structural parts as well, and so *in the non-tectonic systems the building as a product can be based on the principle of double disintegration (that is on the simultaneous applicability of the Gutenberg-principled: and mechanization principled decomposition)*, and as such, it is unique in the industrialized building.

9. Unconditional opennes and possible closedness of the non-tectonic systems: the principle if component and the principle of coach-work as complementary principles of construction

The non-tectonic systems, as it is known, are classed with the non-tectonic building methods, the nature of complementarity, however, as we have seen, is quite specifically double in these systems, since the universal and interrelated principles of building: the additivity and the disintegration can always by enforced in two ways in them.

From the point of view of building industry this feature is of vital importance because it means that the non-tectonic systems can enforce the diagonally opposite principles of construction of the industrialized building — the *principle of component* and the *principle of coachwork* — as *complementary principles of construction* in such a way that at the same time they ensure the openness — that is the attribution of the system — exactly in the very foundations.

This statement — which again emphasizes the specific character of the non-tectonic systems — is immediately justified if we have a closer look at the principle of double disintegration.

Primacy of the Gutenberg-principle

In the non-tectonic systems the mechanization (coach-work) principled decomposition (e.g.: preassembly of box-units in the factory) can only and exclusively come into being on the basis of the Gutenberg-principled (component-principled) decomposition, that is on the basis of the preassembly of non-tectonic surface elements.

The *Gutenberg-principled* decomposition is thus unconditionally the *primary*, whereas the mechanization principled decomposition the *secondary*.

The unconditional openness

The openness of the non-tectonic systems is thus unconditional (since it is in the nature of the system and always given), whereas the *closedness is only possible*, and applied for purpose.

10. The specific double co-ordination, compulsory sequence, zero level and technological relevance in the non-tectonic systems

The non-tectonic building as a technology, as we have seen, is based on the principle of double complementarity, since in this technology the universal and interrelated principles of building — the additivity and the disintegration —, and the fundamental and complementary systems of industrialized building — the co-ordination and the tolerances — can always be enforced in two ways.

We have already analysed the principles of double additivity and double disintegration. Now, according to the sense we must have a closer look at a system of co-ordination and tolerances, starting again with the notion itself.

About co-ordination in general

Co-ordination in general spells systematization, that is arranging correspondences, relations, references according to some principle, and as such, it is a characteristic concomitant of each phase of the industrialization of building.

The possible methods of co-ordination: standardization, dimensional co-ordination, modular co-ordination, double co-ordination

The industrialization of building can avail itself with different possible methods of co-ordination. If systematization is only connected with some manufacturing operation than, generally, we speak about *standardization*. If standardization is related to the dimensions of the manufactured elements, then we are talking about *dimensional co-ordination*. If standardization does not stop at co-ordinating the dimensions of the elements but relates these dimensions to one another through inserting the 10 cm international basic module grid, then it is *modular co-ordination*, which gets a decisive role first of all in the determination of the fundamental structural parameters (modular spans, heights, etc.). The *double co-ordination* does not stop at the modular structural parameters but beyond this draws into the systematization the different submodular structural thicknesses as well, and thereby it can establish a mutual and unambiguous reference not only between the *elements* and the *modular grids*, but also between the elements and the *submodular grids* built into the apparatuses manufacturing these elements.

The non-tectonic systems, as we already know, are built upon the reference system of double co-ordination

The two ways of enforcing double co-ordination

In the non-tectonic building, however, co-ordination — more accurately the *double co-ordination* applied — can be enforced *in two ways*. On the one hand within the *structural system* itself (in the manufacture and assembly of the surface elements), on the other hand in the *auxiliary structural system* itself (that is in the manufacture and assembly of the auxiliary structural elements).

The phase of assembly as a double operation

This very specific formation of the role of double co-ordination can again be traced back to the very specific double complementarity of the non-tectonic system. Within the non-tectonic building, namely, the phase of *assembly* means a double operation even in two senses:

— it is double on the one hand because the operation of assembly can happen partly *in the factory* and partly *on the site*, since, as we have seen, these two operations according to the principle of double complementarity may even penetrate into each other;

— it is double on the other hand because the assembly operation in itself is already composed of *two* different additive operations and it not only means the *assembly of the surface elements* simply, but prior to this it means a kind of *preassembly of the elements of the auxiliary structural system* as well.

The order of assembly: the constraint of sequence

Finally, it calls for no proof that these two kinds of assembly operations (i.e.: the assembly of the auxiliary structures and that of the surface elements) are closely related to each other as well, and depending upon the form — that is the method of shaping — of the load-bearing (vertical or horizontal) structure and upon the process of its creation — that is the method of building — the *constraint of sequence* — which determines the relative position and the order of assembly of the auxiliary structures and the actual structures — will always vary respectively.

It is obvious that the *system of co-ordination* elaborated for a determined building, as well as the *constraint of sequence* mentioned above can exclusively be made concrete with full knowledge of the *reference plane* fixing the position of the fundamental parameter grids. In the always filled by the "zero" level of co-ordination.

The "zero" level of co-ordination

In the non-tectonic building by the *"zero" level of co-ordination* we mean that horizontal plane underneath which the world of building of the traditional foundations (which are always bound to the site and the soil and which are consequently never co-ordinatable and unconditionally "inaccurate") comes to an end, and above which the "accurate" system of the double co-ordinated non-tectonic building is started.

The non-tectonic building starts the precise (vertical or horizontal) adjustment of the co-ordinated (auxiliary-structural or structural) system from the "zero" level of co-ordination and accomplishes the precise adjustment itself always in two steps (proceeding from the unprecise towards the precise). This systematic two-step adjustment of the precise dimension — which can be followed in each phase of the non-tectonic building — is actually nothing else than enforcing the *system of tolerances* unseparable from the applied system of co-ordination. This will be expounded in detail in the next point.

Technological relevance and its degree in the industrialized building, in general

In the industrialized building *technological relevance* isdefined as an immanent (inherent) quality of manufactured structural systems by means of which these building — structural — technological systems can most favourably satisfy a system of concretely determined requirements in a concretely determined particular case.

The system of requirements of industrialized building, however, is extremely composite and complex not only because quite a series of technological, economical and social constituents have to be taken into consideration but first of all, because this system of requirements keeps constantly changing in space and in time. *A technology satisfying a system of determined requirements possibly most favourably in a given space and in a given time inevitably loses its validity — its relevance — if applied at another time or in another place.*

From this it clearly follows that when evaluating the adaptability of manufactural systems to some particular case varying in space and in time, their efficacy from a technological point of view can only be scaled on the possibilities offered by the system to create various adaptations, in other words, by *the capacity of the system for self adaptation.*

This adaptability, this capacity for self-adaptation — which renders it possible for manufactured structural systems to adjuct themselves to requirements varying in space and in time — is what we call the *degree of technological relevance*, and this in turn is again an immediate function of combinatorial qualities of structural system.

Technological relevance and its degree in the non-tectonic systems

The lightweight, silicate-based non-tectonic systems — as proven by our whole work — *are expressely open system.* This in other words, means, that in these systems the solution of any building task — above the zero level of co-ordination, of course — is theoretically completely open both from design and from manufacture-assembly points of view:

- from *design* point of view, because their *architectural and technological efficacy is equally maximum*, since in the non-tectonic systems variability is not only a function of the combinatorial qualities of the structural system and the system of auxiliary structures, but beyond this and at the same time it is also a function of the convertibility of machines, transplantability of the factory and the degree of complementarity, that is, the expediently choosable ratio of operations in the factory and on the building site;
- from *manufacture-assembly* points of view because their *degree of technological relevance is theoretically maximum* since in the non-tectonic systems it is not the building task — characterized by different levels of quantity or quality — which is subordinated to manufacture but on the contrary, it is the manufacture-assembly that is adjusted to the prevailing social-sociological, technical-economic, geographic-climatic, architectural-building etc. requirements and possibilities.

The degree of technological relevance in the industrialized building reaches its maximum in the non-tectonic systems. The combinatorial qualities of these system namely, offer almost unlimited possibilities for adaptation to requirements varying in space and in time and actually it is this circumstance which also renders it possible for the system to create a series of products ranging from *individually manufactured individual products*, through *individual products produced by mass-production methods* up to *mass-products produced by mass-production methods.*

The fact that in the non-tectonic systems technological relevance reaches a maximum degree is of crucial importance from building industrialization point of view because it makes something possible that we could never realize in the mechanization-principled technologies, that is an equally *optimum solution of building tasks characterized by the most different* levels *of quantity or quality.*

Levels of technological relevance

The non-tectonic systems, thus, may enforce technological relevance on very different *levels:*

- in case of *low-level (ad hoc) relevance (individual—incidental technological validity)* the designing architect may reasonably apply an in-situ building method of low or medium degree of complementarity; may conceive the building as an expressly individual product and solves the task (eg.: detached family house etc.) in such a way to be able to simplify manufacturing apparatuses to such a degree that they may be "amortized" even after one building; aims at using possibly unregainable auxiliary structures and applies possibly medium-sized elements, so that in the process of building they may be manipulated by hand;

— in case of *medium-level relevance (occasional-areal technological validity)* the designer-architect works with planted workshop and applied mass-production methods for manufacturing individual products; for this reason he applies the choosable building method with a medium or high degree of complementarity and aims at breaking up the building into components small enough to remain transportable and complex enough to benefit from factory production conditions;
— in case of *high-level relevance (geographic-zonal technological validity)* the designer architect — theoretically — may equally work with planted or transplantable factory and his fundamental effort is to be equally able to produce individual or mass-products by means of mass-production methods; for this purpose he uses the selectable building methods with medium or high degree of complementarity; chooses the reasonably largest sizes for the components and — in case of working with transplantable factory — aims at maximum or even total elimination of transportations.

Technological irreversibility in general and in the non-tectonic systems

If in the industrialized building in general, we succeed in satisfying a system of unambiguously determined requirements as favourably as possible in a given space and in a given time by means of a given building-structural-technological system, then — exactly as a consequence of the technological relevance — we unavoidably (confessedly or unconfessedly) call into being an *irreversible technology*, that is a technology definitely and exclusively bound to that particular place and that can not be transferred from there to another place without alteration. *The irreversibility of the technology, consequently, is nothing else then the criterion of the correctness of application.*

The fact that in the developing countries the system of requirements of mass-construction* shows extreme discrepancies, in other words, the social-sociological, technical-economic, zonal-geographic, building-architectural etc. requirements vary in a rather wide range, *brings to the fore the adaptation of building systems of high degree of technological relevance. This explains why the*

* In our previous studies the general problems of building in developing countries could only be analysed very densely. This is why it seems particularly expedient here to mention a technical-economic consideration definitely pertinent to this theme is support of our conviction, that *the real domain of the adaptation of non-tectonic systems is mass-housing in developing countries.* The consideration goes as follows:

Whilst in developed countries the specific cost of building constructions, or rather the specific cost of the primary loadbearing structures — that is to say: that the specific part of the building cost where the silicate-based, lightweight, non-tectonic systems may save a particularly considerable sum of money — does not amount to more than approximately 10—20% of the total building cost, in developing countries, exactly the opposite is relevant: *in developing countries, namely, the building cost of the primary loadbearing structures in low-costhousing may reach even 80—90% of the total building cost!*

non-tectonic systems may set up a claim for an outstanding role in the mass-construction of developing countries particularly in hot arid tropical or subtropical areas and consequently they may chart a new course for development in the hungarian building industrial export as well.

11. The specific double tolerance of the non-tectonic systems: the principle of etalon-tolerance and its adaptation

The element as etalon

In the non-tectonic building — in order to be able to eliminate the errors of tolerances unavoidably arising in the system, quite accurately: in the phase of manufacture of the non-tectonic technologies, and in order to be able to establish a total harmony between the dimensions of the actual structure and those of the auxiliary structure — we introduced the possibility of using the element as an "etalon", which in other words means that in the non-tectonic building we accepted the principle of establising the system of tolerances on the close alignment of the manufactured elements and called this principle the *principle of etalon-tolerance.*

The etalon tolerance: the system of tolerances in the non-tectonic building

The recognition of this principle and its adaptability as system of tolerances is based on the fact that in the non-tectonic building — as we have seen — the process of assembly can not be restricted simply to the assembly of the *structural system* since this process is technologically inseparable from some kind of preassembly of the *auxiliary structural system.* In the non-tectonic building, thus, the satisfying of requirements of precision can not be exclusively entrusted to the traditional system of tolerances applied in the manufacture and assembly of the *elements*, since at the same time it also becomes an immediate function of the system of tolerances applied in the manufacture and assembly of the *auxiliary structures.*

Enforcing the principle of etalon tolerance. . .

In order to be able to enforce the principle of etalon tolerance the non-tectonic building presupposes that one of the two interrelated systems — that is either the *structural* system or the *auxiliary structural* system — applied in the process of assembly is "ideal", which means that it accepts the *actual* total dimension of the closely aligned elements — "whatever" size it is — as *precise* total dimension.

. . . in the system of auxiliary structures: the questions of minus-tolerance. . .

If we enforce the principle of *etalon tolerance* in the *system of auxiliary structures* then in the manufacture of the elements of the structural system itself (and so *eo ipso* in their assembly as well) we have to work naturally with *minus-tolerance*, which means that in the manufacture the sizes accepted have to be at all events *smaller* than the theoretical sizes.

. . . and in the structural system: the questions of double tolerance

If, however, we enforce the *etalon tolerance* in the *structural system*, that is *in the manufacture of the surface elements*, then in the system of auxiliary structures we have to work necessarily with *position and negative tolerance* which means that we have to apply a *double tolerance* allowing deviation from the theoretical sizes both upwards and downwards.

The absolute and the relative precision in the non-tectonic building

It is obvious that the elements of the auxiliary structural system of double tolerance can not be (and do not have to be) adjusted immediately and precisely but only intermediately, with the two-way additivity of the manufactured (e.g.: floor-) elements treated as etalon, and after their close alignment. The auxiliary structural system constructed according to the principle of double tolerance, namely, is such an unprecisely assemblable system ("unprecise" both in positive and in negative sense), which renders it possible that the two-way alignment of the elements (which are treated as etalon and which are "unprecise" both in the positive and in the negative sense) should always lead to the precise fixing of the existing actual situation.

This *precision* as compared to the *actually* arising situation will be unconditionally *absolute* (since "it is of such a size as it is"), as compared to the *planned* situation, however, it will remain *relative*.

12. The nature of the silicate-based non-tectonic systems; the basic methods of non-tectonic building

The contents, possibilities and limits of openness in the non-tectonic building

On exploring the characteristic features of the non-tectonic systems we revealed the components of this specificity and cleared up their correlations. There remained only one question to be answered, the question of how we can enforce this specificity, that is to say: what are the basic methods of nontecton ic building, quite accurately: what are the contents, possibilities, limits and m ethods of openness in the silicate-based open systems.

This will be dealt with now, starting the expounding of the theme expediently with summing up the essence of some already known components.

Nature of the non-tectonic systems

The non-tectonic systems are classed with *complementary* building technologies. This is thus the *nature* of the system, the "*genus proximum*", and according to this:

the non-tectonic building methods — just as all the other complementary building methods — are founded on a *surface-principled* construction, they always combine the *factory*-production of some kind of *casing system* (in our case: mould) with some kind of technology of *pouring in of concrete* either *in the factory* or *on the site*, whereby they produce structural units (in the factory) or call into being the structures themselves (on the building site), their products, the buildings, are always *individual* buildings produced by some kind of mass-production methods (which does not mean that they are not repeatable but that they are not called into being by the constraint of repetition); and their loadbearing structural systems — depending upon the mode of shaping — can equally be *closed* or *open*.

Quality of the non-tectonic systems:

the non-tectonic systems differ from all the other complementary technologies in two fundamental things (and these give the *quality*, the "*differencia specifica*" of the system), the one is connected with the *quality of manufacture* (that is the nature of disintegration), the other with the *quality of assembly* (that is the nature of additivity). According to this:

the Gutenberg-principled disintegration and the blind manufacture,

— first, the non-tectonic systems differ in so far as their operation of *manufacture* is always founded on the *Gutenberg-principled disintegration* and that thereby — through a process called by us *blind manufacture* — they call into being *silicate-based, lightweight, open* systems;

the additivity of surface elements and the double complementarity

— second, the non-tectonic systems differ in so far as their operation of *assembly* is founded first of all on the principle of *additivity* of *surface* elements (that is on the additivity of such surface elements which in themselves have neither loadbearing capacity nor final stability) and that thereby — through a process called by us *non-tectonic* building — they call into being such building methods in which the *complementarity* is *double* (since they can create complementarity not only between the factory and the building site but even within them), and which, exactly thereby, can enforce the principles of additivity and disintegration and the system of co-ordination and tolerances — both in the factory and on the building site — always in two ways.

The blind manufacture of surface elements and the double complementarity of the building method: actually these are the two specificities which determine the terrain of the non-tectonic systems within the universe of the industrialized building, since all the components of the characteristic features of the system — analysed in detail in the theses — are immediately derived from them, so this is the basis in the last analysis of the specific architectural efficacy of the non-tectonic systems as well, quite accurately: the basis of the fact that the *silicate-based lightweight system can create every precondition of planning for change and producing for change both from architectural and from structural-technological points of view* (and this applies to the final products under very different geographic—areal conditions as well).

About the openness of the non-tectonic systems from architectural, structural and technological points of view

The non-tectonic system are thus "par-excellence" open systems.

From *architectural* point of view they are open — because they can connect the functional freedom with the freedom of architecture and therefore — adjusting themselves of course to be constraints of geometry given by the chosen structure — they can be treated freely and richly even in from;

— because the architectural variations constructable on the system can be related to undetermined buildings, it is only the chosen structural form, namely, that is to be taken constant, whereas the very architectural arrangement — always realizable with variable spans, variable heights and even with variable structural thicknesses — remains variable at all events.

From *structural* point of view they are open

— because they can satisfy the most different requirements with quite a range of structural forms, since the most different kinds of cellular and microcellular structures varying in forms and sizes, and the combinations of reinforced concrete shell- and tissue-structures are always at disposal;

— because the vertical loadbearing structure can be unbroken or folded, slab-like or box-like, whereas the horizontal structure — with its "span-indifference" within rather broad limits — can equally use beams, beam-grids or anisotropic, plane, closed-cellular slabs, etc; and last but not least

— because the surface elements shaping the structure (the "moulds" — the "negatives") are variable even in themselves, since their overall dimensions and thicknesses can move on a rather broad scale.

From *technological* point of view they are open

— first, because the non-tectonic building can enforce the diagonally opposite principles of construction of industrialized building, the *principle of component* characteristic of open systems and the *principle of coach-work* characteristic of closed systems (that is the *Gutenberg*-principled disintegration and the *mechanization* principled disintegration) as *complementary principles of construction* in such a way that at the same time it ensures the primacy of the Gutenberg-principle (that is the blind manufacture of the surface elements) and thereby it renders the *openness* of the system *unconditional*, whereas the *closedness* of the system only *possible;*

— second, because the non-tectonic building with its double complementarity can call into being quite a range of *non-tectonic building methods* for solving building tasks of very different nature and volume. *The characteristic distinguishing feature of these technologies is always given by the method of additivity and disintegration*, since — depending upon the circumstances — the factory itself can equally be planted or transplantable, and finally this is which determines the degree of *technological relevance* by means of which the system can adjust itself most favourably to the ever changing social, economic, geographic etc. conditions.

The basic methods non-tectonic building

The scientific results of the research — which, as we have seen, rely upon the more than a decade's research work of the authors as a comprehensived; whole and which are summarized in the theses above — are actually embodied — in the strictest sense of the word — in the *basic methods of non-tectonic building: the in-situ, the lifting, the box-unit, the box-frame unit, the closed-cellular, the lift-cell and the tilt-lift building methods.*

Until now all seven types have been elaborated. In this volume of our Periodica — in the forthcoming article — a special study will be devoted to the analysis of these *building methods and their principles of construction* and that is why in this "paragraph" we only give an enumeration.

By way of conclusion, however, let us remark here, that the basic building methods can expediently be combined with each other as well and thereby the non-tectonic systems establish almost boundless possibilities for the architect and the constructor for calling into being technological variations and combinations for solving the tasks, and finally, this is the crux of the problem. For what else could be the reason of establishing open systems of building if not the ensuring of the optimum solution of the tasks of architecture and construction under the most different conditions and requirements which ever keep changing in space and in time? — and this was our aim too, from very beginning.

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