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NEW TRIPLET VISIONS ON SUSTAINABLE BUILDING

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Abstract

The theme for the second World Sustainable Building Conference is “Action for sustainability”. A new vision has been developed that makes actions easier by specifying sustainable measurements by compartments. Each compartment contains three levels of sustainability and there are four compartments defined: energy, water, materials and space.

The compartment energy has been introduced by Lysen (1996) under the name “Trias Energica” after Charles de Montesquieu his “Trias Politica” from 1752. This first three-step vision had not a sequence in the degree of sustainability. Duijvestein (1997) introduced a more structured method, which placed the three steps in sequence of sustainability. The most favorable measurement was put on top and the least favorable became the last step. This process has led to the “Trias Energetica”.

Based on this same concept, new concepts are derived for the compartments water, materials and space. In accordance to the Trias Energetica, the terms “Trias Hydrica” (for water), “Trias Hylica” (for materials) and “Trias Toponoma” (for space-usage) are introduced. These triplet visions make it possible for governments to make policy by aiming on steps instead of specific measurements. By doing so the freedom of creativity for the architect, constructor and customer will be greater and the measurements can better fit the construction’s functions.

1. Introduction

The first sustainable step-based model in the Netherlands has been presented by A.G.W.J. Lansink (www.parlement.com 2005) in the late seventies. His model, the so called “Ladder of Lansink”, contains five steps to cope with the Dutch waste disposal (www.dubo-centrum.nl 2005):

1. Prevention: try to make the least waste as possible by producing and consuming products environmental friendly;
2. Product reuse: try to reuse a product in its original state as often as possible;
3. Material recycling: when the product cannot be used in its original form, then try to recycle its materials;
4. Combustion as source of energy: when the product really forms waste, then it can be incinerated in an oven with generation of energy;
5. Combustion: less favorable is to burn the refuse without the generation of energy;
6. Landfill: the least preferable option is to dispose products and materials.

The first three-ways-model has been introduced by Lysen (1996) under the name “Trias Energica”. He named it after Charles de Montesquieu his “Trias Politica” from 1752. In that paper a sustainable energy supply was suggested by:

1. A continuing improvement of energy efficiency;
2. A bigger use of sustainable energy sources;
3. A cleaner use of the remaining fossil fuels.

Duijvestein (1997) introduced a more structured method, aimed at the building industry, which placed the three ways in preference of sustainability. The most favorable measurement was put on top and the least favorable became the last step. This aligning process has led to the, in the Netherlands common used “Trias Energetica”, which has three distinctive steps:

1. Use less energy by taking energy saving technologies;
2. Use sustainable energy sources as much as possible;
3. When there is still an energy demand left, then use fossil fuels as efficient as possible.

The energy aspect is not the only aspect, which makes a building more or less favorable for the environment. Based on the same concept of avoiding, making sustain and making efficient, new models are derived for the compartments water, materials and space. By using the three step model for these aspects it is possible to make specific, but soundly based, choices. An accent can for example be made by pointing out the low water usage of or the optimal material use in a building. After the explanation of the possibilities of the already known "Trias Energetica" for the building industry, the three new models will be presented.

2. Trias Energetica

When a structure in the Netherlands is build, the most important design aspect, after the esthetics and construction, will be the energy use. Before a building license is granted, measurements must be taken, so that the structure copes with the so called Energy Performance Coefficient (NNI 2001). This coefficient symbolizes the proportion between functional energy use and the needing energy demand. Energetic measurements are needed to take this coefficient down to the restricted 1.0 (Bouwbesluit 2001). This mathematical procedure has been standardized and the future goal is to lower the coefficient as much as possible.
The energy saving policy is in the Netherlands concentrated on the heating of houses and offices. In countries closer to the equator the climate demands a policy, which concentrates on the cooling. Nevertheless the necessary energy for heating or cooling has to be minimized and the source has to be as sustainable as possible.

The "Trias Energetica" refers to three categories of measurements, which can bring a sustainable solution for the energy demand for houses and offices:

1. Take measurements which make the building's energy-use less, like insulation and efficient ventilators for example;
2. The second step is to use as much sustainable sources for the energy demand as possible. The use of solar power in an active or passive way or the use of wind energy are examples in this category;
3. If there aren't enough sustainable sources, then it is necessary to use fossile sources. Use in this case the supplies as effective as possible. The use of highly efficient boilers is a way to turn gas into heat.

To make a building sustainable there are a couple of directions for inviting solutions:

- Passive solar energy: (Step 1 & 2) This method is focused on minimizing the need for heating by using a high degree of insulation, reducing ventilation loses and effectively putting incoming sunshine into good use. This means a south orientation on the northern hemisphere and a north orientation on the southern hemisphere. In countries closer to the equator with higher average temperatures the insulation makes it possible to cut down on the cooling energy. In these countries the orientation of the estate has to avert incoming sunshine;
- Active solar energy: (Step 2) Not only passive, but also active solar energy can make a house or office more sustainable. Active solar energy can be achieved by making use of a solar collector (for tap water) or photo voltaic panel (for electricity);
- Home information technology: (Step 1 & 3) The use of information technology in home can reduce the energy need by controlling ventilation, lighting en heating. The combination of home information technology with low temperature heating will guarantee a higher comfort for the users of the building by providing the demanded temperature on the right time;
- Geothermal energy: (Step 2) The earth provides fossil fuels for centuries now, but the more direct supply of energy for the heating of space is only one century young. The principle of geothermal energy can not only provide the necessary heat, but by using a heat pump it is also possible in some parts of the world to cool offices and houses. In the Netherlands heat pumps are used to heat up in the winter and to cool down in the summer. In Iceland geothermal energy for heating is not only favorable because of sustainable reasons, but also from an economic point of view (http://www.energy.rochester.edu/is/reyk/ 2005).

There are however more directions possible and the four given directions can also be combined. For the realization of a good summer- or wintercomfort and a healthy climate within a house or office, there are also complementary measurements like hybrid ventilation and a specific material choice. A total concept for building designs consists of a unique combination of measurements, which together result in an energy policy.

3. Trias Hydrica

The water usage of a building is the second aspect, that also will be viewed on a three step base. The goal of a sustainable project is to score a low Water Performance Coefficient. This coefficient expresses the primary water usage for consumption, washing and sanitation. The Water Performance Coefficient is not yet formalized by the Dutch Building Code.
The water-version introduced here, will be called “Trias Hydrica” and contains the following categories:

1. The first category consists of measurements that avoid clean water usage. You can prevent the unnecessary use of water by using water saving toilets and showers;
2. In the second category the sustainable sources are found, like rainwater use for toilets and washing machines;
3. In third place it is recommended that the expensive clean drinking water will be used in steps. Water will first be used for bathing, and then the same water can be used for the garden.

Just like with the Trias Energetica, there are also design solutions for a water sustainable building. Examples are:

- Housing without sewerage. (Step 1) In many western countries houses are connected with the sewerage. The traditional toilets use vast amounts of water, which demands large sewer pipes. Toilets without flush and the use of reed for household water treatment make it possible to construct housing without sewerage;
- Rainwater collection. (Step 2) It is possible to use the entire roof for catching rainwater. This rainwater can be stored in a tank underground. The water then can be used for sanitation, gardening and washing clothes. So this concept of rainwater use goes a lot further than using a simple water butt;
- Grey water network. (Step 3) To cope with the problem of using high quality drink water for purposes that can suffice with a lower quality, there has been developed a so called grey water network. This network can supply offices and houses a kind of water, that can be used for washing and toilets etc. but hasn’t the same quality as drink water. The treatment of this grey water or household water is less intensive and less harmful for the environment. A Dutch experiment in a district of the city Utrecht has failed, because bacteria and wrong use of the system provided a risk for the public health (http://www2.utrecht.nl/ 2005).

4. Trias Hylica

The same translation for energy and water can be made for the materials in a construction. Not only the quantity of materials is a factor for the environment, but maybe even more important is the quality of the used materials in a construction. For the production of aluminum is much more energy required than for wood. But in the case of aluminum window-frames for example, it lasts longer and needs less maintenance.
There is not a specific coefficient for the choice of materials yet, but there are Life Cycle Analysis programs to determine the environmental waste of materials. Producers of building materials also determine certain environment profiles, but these procedures aren’t yet standardized. At this moment to the name of “Trias Hylica” three steps can be distinguished:

1. A first category of measurements will prevent unnecessary use of materials, like recycling, usage of remainders from materials, smart efficient designs, and combinations of functions;
2. The second step is to use local sustainable material sources for the buildings material demand. Examples of this category are loam, shells, shelllime, flax, wood, and cork;
3. The last possible step is to use non-sustainable sources in the most effective way. The usage of high strength concrete and steel for example.

The same procedure can be used here as with the Trias Energetica and Hydrica. Three solutions can be used for designing a sustainable building:

- Optimizing the design. (Step 1) In other industries, like product design and the airplane industry, it is already common good, but in the building industry it is still possible to optimize the design. Optimizing in such a way, that the needing materials are minimized. The prevention of using materials can go on and on, because of the development of new and stronger materials with better specifications;
- Using renewable materials. (Step 2) A solution, that fits the second category, is the use of renewable materials. These materials are inexhaustible and have a natural origin, which gives in certain conditions favorable effects on the inside climate;
- Easily dismantled housing. (Step 3) With the use of finite materials it is important, that they can be used as many times as possible. The recycling process can be eased by building easily dismantled houses. Parts of the construction can be reused as a whole or can be torn down until only raw materials remain.
- Prefabrication of construction parts. (Step 1 & 3) Opposite to onsite production of construction parts, a offsite production can have certain advantages. The prefabrication of concrete floor elements for example ensures higher strength and therefore a smaller weight. It is also possible to deliver these parts just-in-time, so that they will not be damaged by lying on the construction site.

5. Trias Toponoma

The latest edition is a three step vision for space-usage. The space, a building site requires, has to be justified for future generations, because constructions last for many years. Places, which are used for houses and offices, will only in rare cases be given back to nature. It is necessary to reflect very precisely if a certain spot may be built on to.
The natural potential of an enclosed area, like a region or province, has to be at least stable to ensure a sustainable space use. So when an urban area extends, the natural potential in one part decreases. This asks for intervention in another part of the enclosed area, which increases the natural potential. The natural potential of an area can be classified by the seven Hemorobie stairs from Beetstra (1998).
The space use of a building is a very different aspect than the energy, material or water use. In a recent study (Entrop a.o. 2004) however a translation has been made. This so called “Trias Toponoma” contains the following three steps:

1. Use as little ‘fresh’ natural space as possible by using the third dimension of buildings. In the center of a city it is necessary to build higher or (in the ground) deeper structures and to appoint more functions to a building;
2. When it isn’t possible to get the necessary building volume in the city, then the city can be enlarged in an area of little natural importance. Enlarge the city with a so called green vision, that makes nature a part of the extension for recreational functions;
3. The least sustainable option is to make an extension in a more natural environment around the city. Construct in an extensive way (across a large surface), which does not affect the main natural structure of the area.

In this Trias there are also a few principles to realize sustainable solutions:

- Principle of building in the city before expanding. (Step 1) The concept of non-extension to the city asks for inventive solutions to cope with the ever growing building demand. It demands not only technical solutions, but for one part also patience of the urban civilians. A dense city will keep space open for nature, but will shrink personal freedom of its habitants;
- Space-saving. (Step 1) In the Netherlands space saving in industrial areas has led to a few interesting examples which fit the goal of a sustainable approach of space use. The first is the combined use of facilities by multiple offices; for example one central canteen in an industrial zone. The second is the use of flexible workplaces, which can be used by more than one employer;
- Compensation principle. (Step 2 & 3) This principle will make building projects in the urban area more attractive by making building projects in the open field more expensive. The lost of nature most be compensated in other areas to keep an overall quality and quantity level of natural environment;
- Light town-planning. (Step 3) The third principle is based on the impact of large building volumes on the natural environment. By placing just little groups of buildings or just a few buildings in a wide open natural landscape, it can be possible under strict conditions to keep the main natural function of the area alive. Maybe the natural function can even be improved, which can be the case when country seats are created;
- Multiple space use. (Step 3) Space can be used for multiple functions in three different ways (RMNO 2000). Certain functions can be piled; on a mall for example apartments are built. A certain function

can be used for different purposes; a school can function as a course center in the evening. It also possible to mangle functions in an area; in a residential area also specific offices or industries can be allowed.

6. Conclusions

The building process is quite natural a case of designing, that asks for careful considered choices. The four three-step-models make it possible to design sustainable buildings in an orderly way. Although sometimes paradoxical decisions must be made, are there two design concepts that try to make a building as sustainable as possible by using its durability and by ensuring attractiveness:

- Lifecycle lasting living. This method focuses on measurements to make it possible for habitants to live their entire life in one and the same house. The house can be refitted according to common disabilities of elderly people;
- Customer orientated building. This second method focuses on the wishes of the customer. The building process and the selling process of constructions are originally strongly separated. By bringing the customer in contact with the constructor, a house or office can better fit the customer's demands. However certain wishes from the customer must be questioned, because the knowledge of the customer is not always adequate to deal with certain building aspects.

With these two overall concepts in mind, three specific uses for the three step models can at this moment be distinguished:

- Communication. In the field of communication it is, because of the systematic approach, easier to communicate with involved parties, like the architect, builder, installer, and of course the customer. People do not need to know every little detail of a newly invented measurement, but it can be sufficient to express the level of sustainability in the three-step-model.
- Judging tool. The taken measurements can be well elucidated on the base of their first, second or third position in the specific Trias. By aiming on one or two aspects it is possible to make a building more water, energy, material and/or spot sustainable. The Triases can be used to judge designs and to choose the most favorable sustainable measurements, which also fit the customer's demands.
- Making inventories. There is also a possible use for existing buildings. It is possible to clarify the sustainability of a house or office, so that the market value of the building can vary with the sustainability degree on each aspect. Their can be thought of a kind of environment classification of buildings like the proposed energy certificate in the European Directive for Energy Performance of Buildings (EPD, 2002/91/EG).

In Canada so called "Green Globes" (www.greenglobes.com 2005) are being used to rate the sustainability of buildings for three similar aspects as the triades energy, water and resources. These "Green Globes" system further speaks of emissions, indoor environment and environmental management. All these aspects can be compared with the "three-step-method" to make a more comprehensive system. Around the world there will probably be more methods or systems, which share the same purpose. Combining the best qualities of these is one of the major challenges for the future of the built environment.

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