MATERIALS AND TECHNOLOGIES UTILIZED IN THE CREATION OF ARCHITECTURAL MODELS

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The preliminary consideration of criteria directly influencing the choice of technology and material is always essential for the expression of the architect's or investor's images. The principal decisions include the following:

1. Purpose of the Model

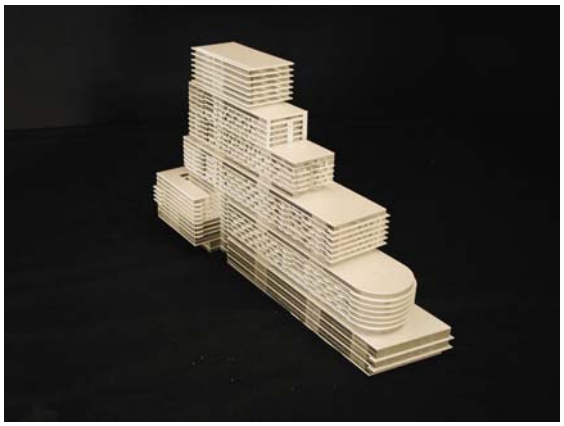
During the creation of an *idea* testing model which is mainly intended for the testing of the suggested masses in context with contingent surrounding development it is advantageous to use extruded polystyrene as the out coming material, i.e. for the designed buildings and the terrain modelling as well.

The *working model* serves predominantly for the architect's designing work itself and also for the primary presentation of the project to the investor for whom it is sometimes difficult to orientate within the framework of the architectural drawings only. In this case the models are made of various cardboards, balsas, timbers and other easily available materials.

The *final, or exhibition* model serves for the presentation of an already completed model to the investor or to the public. This model type requires a more detailed elaboration of facades and colour solution of the design in order to depict the designed project as most lifelike as possible. The materials used for this group of models are first of all plastics and acrylates, which guarantee the colour and shape stability of the model.

2. The Scale of the Model

The chosen scale of the model also determines the degree of detail on the elaborated model and thus the choice of the utilized material as well. The buildings in the scale of 1:500 and smaller, i.e. in town-planning models, are usually modelled without the plastic shaping of the facades. Larger scales bring about the necessity of a more detailed elaboration of the facades.



3. Finances and Time

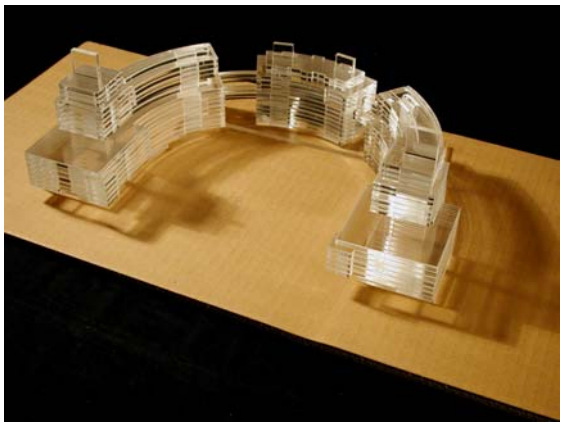
The last but not least factors influencing the choice of materials and technologies for the model creation are also the price of the model and the deadline of its completion. The simple paper, polystyrene or balsa models cost several hundreds of Czech crowns and can be created within several days while creation of the exhibition detailed-elaborated plastic models requires many thousands of crowns and weeks and months of the production period.

4. The Availability of Technology

The technology of machine working of the materials enables to work different sorts of materials in comparison with the hand working. The above-mentioned machining technologies include the usage of computer-controlled cutters, laser beam, water jet etc.

The following survey shows a diverse assortment of materials for the material production. This assortment can be hardly enumerated. Its diversity is caused by the fact that every model is a unique original, the creation of which is a process of searching ways and means for the shaping of this original. Even the choice of the model production method is a process of permanent development. Every sort of model has its pattern in some of the preceding models but thanks to its distinctness it must be solved from the beginning again.

At first let us become acquainted with some of the materials used for the model production. Simpler models and working models are made of paper-based materials, various cardboards and line boards. Very popular are light sandwich plates with polystyrene core, especially for easy cutting with common breaking-blade knives. The most well known materials are perhaps the Kappa-Line plates with a polyurethane core, which is not friable during the cutting. These materials are produced by numerous producers under various brand names (Foam-X, Bienfang etc.), which differ not only in their price, but also in the density of the polyurethane core and in their special surface treatment. Further materials are model-making balsa, cork, veneer, DTD and MDF plates, various types of plywood and wood in the form of prism timbers of various degrees of hardness and quality. A very suitable material for constitution of the level-line terrain is extruded polystyrene being easily thermally separable by means of a resistive wire into which low voltage electric current is supplied.



A broad expansion can be currently observed in the field of plastic-based materials. Nowadays the plastics commonly replace natural materials and some of their properties are even better than those of their organic counterparts. In our model-making practice we utilize PC-controlled cutters and there is a PC-controlled laser-cutting device for our disposal as well. The plastics are optimum materials for these modern technologies and therefore during the recent years we have carried out intensive research into this area of their utilization. For laser ablation we use acrylate plates, more familiar under the brand name of Plexiglas. This material replaces the classical silicate glass and its usage has brought about several extra advantages. The weight of Plexiglas is half in comparison with that of glass. Plexiglas shows excellent elasticity and bending strength even on impact and when broken it does not tend to fragment. Besides the classical transparent colour and several shades of opal (milk white) there is a large scale of transparent and translucent shades. Plexiglas is famous for its excellent light-scattering properties, which determine it for the usage in trans-illuminated applications. One of the most important criteria for the right Plexiglas choice is the plate production method. The cast plates are characterized by high molecular weight, strength and easy manipulation. The extruded plates with their low molecular weight are therefore more flexible and more suitable for vacuum working. For the division of Plexiglas by laser beam it is more convenient to use the cast plate because the separated edge is more accurate without any tracks of laser beam and its further polishing is unnecessary.

The plastics intended for cutter working are divided into two basic groups of materials: the first group is extruded plates of tough polystyrene (HPS plates). The second group is PVC-based materials. The most well known representative of the HPS plates is perhaps Polystyrol produced in the thickness of 0,5 - 5 mm. This material is characterized by very low specific weight. Polystyrol is about 25% lighter than the hardened PVC. Thanks to its very good consistency during thermal shaping (130 – 150^{o}C) it is recommended in all cases when sharp shapes of final products are required. Polystyrol can be very well connected by sticking, i.e. not only reciprocally with other Polystyrol parts but also with other materials. Suitable are glues – solvents on the base of toluene, dichloromethane and butyl acetate. PVC-based materials are used for creation of the models themselves less frequently, especially because it is more difficult to stick these materials together in comparison with the HPS ones. The most well known representative of this group is perhaps Vikunyl, produced in clear, white and colour versions. It is produced in the thickness of 0,14 mm. Into a special group belongs the mass which is sometimes called “artificial wood”. This is a hardened, dimensionally very stable light forming

polyurethane-based material with good strength and toughness, which is easily mechanically elaborated. A representative of this material are Sika-Block – model plates – which are produced in the thickness from 50 mm up with various physical properties. Its characteristic property is homogeneous, fine-grained structure of material with slight moisture-absorption. The strength of its edges during abrasion is very good.
A separate chapter on materials is colours used for models. Architectural models are most frequently produced in white version; the terrain is either white too or elaborated in various grey shades. Very frequent is the requirement for life-like colouring of the models. The colours producers´ assortment is so rich that it is not a problem to meet this requirement; it is, however, necessary to change the working procedure in contrast with the unicolor model production. Tue choice of the final model colours should be carried out very carefully so that the resulting model did not look kitschy. Some colours can be also successfully used in the shaping of the surface structure, e.g. colours of the textured-spray-paint type.

The working procedures used in model production are influenced by machinery equipment of the model-making workshop. For paper model production we can be satisfied with a breaking-blade knife called ”cutter”, a ruler, a pencil, a pair of scissors, glue, a worktop and a large amount of patience. Even with this minimum equipment it is possible to create very nice models. As the worked material we can use various sorts of cardboards, line boards, kappa plates or balsa. The emphasizing of the model can be achieved if a transparent foil is used for the window filling. On this foil by means of a copy machine we can transfer the window articulation and frames, which is very impressive on models in the scales from 1:500 to 1:200. By means of this simple equipment it is even possible to divide plastic plates of the thickness under approximately 1 mm.

The technology of working the other materials requires standard workshop equipment (a circular saw, drills, a lathe). Various types of grinding machines for surface treatment play a significant role. With regard to the size of the worked parts we can advantageously utilize the electrical appliances, which are in the producer’s catalogue marked by the type series of “mini”.

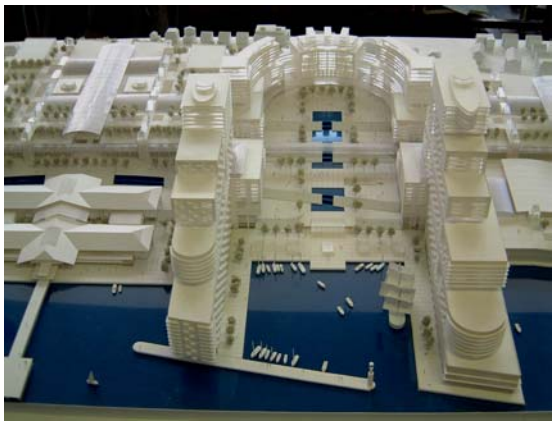
The coming of computer technology has influenced the area of model production as well. In the simplest form it has facilitated the drawing of recurrent elements, such as windows, and after printing it

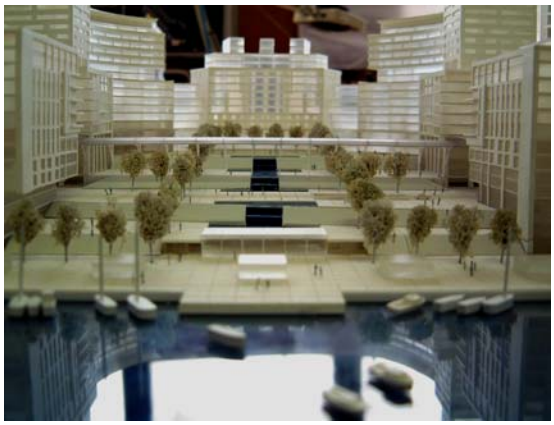
serves for the papering of the walls on paper models. The development of engraving cutters and sign making devices is also applied to model production. Now, what is the model-making procedure with the computer support like?

The first step is transmission of the working papers for model making into the computer. It actually means transfer of the facade drawing into the CAD programme, considering the necessity of planning the way of the model construction and creating the particular layers of which the facade will be constituted. The choice of the construction material is fully optional because the transfer of the drawings is only planar in 2D. The result of this step is a CAD file with the drawing of particular elements of the model.

The second step is adjustment of this drawing within the programme controlling the engraving cutter. What is the engraving cutter? This is an additional periphery of the computer, which is provided with a positioning device which enables, in axes x, y and z, to move the motor-driven clamping head for various types of cutters. Almost every engraving cutter has its own controlling programme, in which the user chooses the depth and speed of working and defines further parameters (cutter type, speed etc.). The next computer-controlled device, which is successfully used for model production, is a laser two-dimensional cutting device. It is actually a planar plotter, which instead of the writing head has a little mirror, which reflects the laser beam into the material placed under it. The laser plotter used by us operates with the output of 25W and cuts Plexiglas of the thickness under 5 mm. With the small output of the laser it is possible to engrave the material.

The third step - engraving, eventually the cutting itself, comes afterwards. Then the facade in the scale of 1:100 consists of several layers, e.g. the first HPS plate 0,5 mm, in which the openings of the glass fillings are cut, in the second plate of 1 mm the window opening is cut and above it there is the last layer which expresses the facade itself. It is further possible to distinguish between engraving into a material by means of which we create a structure on the material but which is not divided, e.g. the pattern of bricks, roof covering etc., and on the other hand cutting into the full thickness of the material when the material is divided. Then, in case of recurrent identical elements, the production is very simple, accurate and effective. This enables separate colouring of each particular layer and thus achievement of the desired colour elaboration. The ideal field of engraving cutters usage is the production of spatial constructions, such as trussed beams or railings.





The model parts produced in this way are connected, or they can be contingently stuck upon the model ”core”, i.e. load-bearing structure, which can be made of e.g. Plexiglas. The acquisition of an engraving cutter is a considerably expensive matter and its usage without preceding experience is not as simple as it has been described above, therefore it is also possible to purchase various typical model semi-products (railings, profiled beams etc.) The support of the computer-controlled working devices in model production enables to elaborate a higher degree of detail than in the classical manual work. It is necessary to remind that by means of these devices only parts for the model are produced, not the model as a whole, that is why we use the word ”support”. Architectural model making is and certainly will remain a piece manual work, which cannot be fully automated.

After the model production follows the next, also very important activity, i.e. documentation of the model. By means of special optical sounding apparatus it is possible to obtain photo documentation of the model interior, contingently to take snapshots from a pedestrian’s point of view and thus materialize the project assessment before its realization. The classical photo documentation of the model is taken by digital cameras or, in case of dynamic shots, by digital video camera the usage of which enables further computer operations for the purpose of the maximum achieved effect for the subsequent presentation.

The above-described materials and technologies were after several tests applied to the creation of the historical core model of the town Hradec Králové. This model is carried out in the scale of 1:500 and was produced at the Faculty of Architecture, Czech Technical University in Prague. For walkways and communications we used the PVC plates of Vikunyl with the thickness of 0,3 mm in two shades of grey colour. For the levelling of the terrain in the square extruded polystyrene has been used. The basic masses for the building creation are blocks of MDF plate. The facades of the houses and churches are cut into a HPS plate, which is 0,5 mm thick. For the roofs we used the material of SikaBlock M 600, predominantly in the original colour of the material. The other colours are of the acrylate Dulux type and are water-soluble.