Modelling of buildings and projects with utility assessment

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ABSTRACT: The paper describes the methodology of computer modelling of the building process of facilities and projects with utility assessment and the main principles of the integrated cost estimation, project management and quality assurance microcomputer based system developed recently. This expert system is based on quick modeling of the building process by use of typical construction technology network diagrams, which can be prepared in advance. The typical network diagrams can be modified according to the spatial conditions of a certain building and to the amount of construction works and materials. For utility assessment a vector of 10 main aspects (criteria) was created with a common measure unit and certain level of importance each. A database of construction processes was created including the aspects for utility assessment. Thanks to these features the model of the building process can be made about 50 times quicker than current project management systems and it can be used for bidding, project planning and management and utility assessment.

1 INTRODUCTION

When projects are to be undertaken it is necessary to visualize all the operations of the project, arrange these operations in their proper sequence, achieve confidence that every participant of the building process (the owner, the architect and the contractor) understands each of his tasks, acquires the know-how and means necessary to perform them and feels convinced that the method chosen for performing all tasks is the most progressive and economical. Thus all projects have to be efficiently planned at the investor's (owner's), architect's and contractor's sides. In the planning and design stage of the project several specific problems must be solved and many points of view have to be taken into this decision process. A lot of these questions can be efficiently solved by creating of a computer model of the building process of the project. The model must be based on the construction technology and cost analysis and must reflect all technical, technological and economical features. One of the significant questions is the utility of the project, too.

The utility can be defined as the quality or condition of being useful; usefulness. It is a very general concept for the user to be able to evaluate the utility of a building or of a project on the base of this definition. Especially the architect and the investor should have a simple computer method to be able to assess the utility of the project he wants to undertake or design. The utility of the project is a very complex idea. It is a hard work to assess the utility - it is not possible to evaluate the utility only as one magnitude, as for different participants of the building process – the owner (final user), the architect and the contractor of the project the utility of the building or of the project means something very different. Different features of the utility can be defined from the point of view of the whole community. Therefore more aspects have to be taken into the method of the utility assessment and a vector of criteria of utility assessment must therefore be created, see e. g. Jain (2006). Naturally, all aspects do not have the same importance, so they must be allotted their weights (importances). It would be very advantageous if all utility assessments aspects could have the same exact measure unit and if they could behave as certain resources, so that they could be calculated mathematically. Then they could be put into a project computer modeling system as resources linked to building constructions and in this way the utility of a whole building or of a project which consists of several building constructions could be evaluated. For modeling of the building or of a project the methodology of construction technology design, see Jarský et al. (2003) can be very efficiently used. Therefore the CONTEC project preparation and management system which includes the database of building constructions with 50 resources each and a big set of typical network diagrams that enable very quick creation of the model of a building or of a project consisting of more facilities can be then used for the calculation. With the help of the system the user has the possibility to simulate the proposed composition of constructions and construction processes in the project and the time and resource allocation flow of the building process on a microcomputer even if the topical relevant data about the project in the planning stage are poor. The more precisely the task is determined; the better results can be obtained from the model. The utility assessment method of building and projects designed by the author is based on this concept and is briefly described below.

2 DESIGN AND IMPORTANCE OF THE UTILITY ASSESSMENT ASPECTS

During the design of the criteria for utility assessment of buildings and project three main areas for the evaluation were stated – the contractor, the investor (owner) and the community. About 15 aspects for all areas were identified and finally 10 main criteria were picked out for the definition of the utility assessment vector. The criteria of the utility assessment vector are as follows:

1 for the contractor:
- realization technology
- environmental impact during the building process
- energy intensity during the construction
- risk during the construction

2 for the investor (owner):
- lifetime and fire resistance
- quality
- operation energy intensity

3 for the community:
- build-up of free area
- noise, traffic, operation emissions
- recycling of used materials

For all aspects a common measure unit was proposed – 1 finyar (fiňár in Czech), abbreviation 1 FIN. It is something like a special sort of currency and in this way all aspects can work as resources in the utility vector assessment calculation. The lesser the amount of finyars will be allotted for a certain criterion the better is the resulting assessment. The importance of all aspects was evaluated by a group of four experts. The aspects were mutually compared one to each other and at every comparison the value 1 was divided into two parts according to the higher of lower importance of the two compared aspects. If the importance of both compared aspects was equal both of them got the value 0.5. If one aspect was more significant than the other, it got the value from 0.51 to 1.0, the other got the value of the complement to 1. The actual values of weights (importance) of all criteria were then calculated as the average of values defined by mentioned four experts.

3 ON MODELLING THE PROJECT AND THE BUILDING PROCESS

3.1 *Basic documents of the model*

The model of the building or reconstruction process is based on the main documents of the construction technology design (Jarský et al. 2003). The main documents in the construction technology design include files of technological analysis sheets or programmes, and network diagrams. The close link between these documents which is used in the expert computer system enables to elaborate bar charts, line-of-balance graphs (time-space graphs), allocation graphs of different technological and economical resources, quality assurance checklists and environmental plans. Hitherto the said documents, on one hand technological analysis sheets (programmes) and on the other hand network diagrams were mostly processed subsequently, separately. Their close construction technology relationship was often disregarded and network diagrams elaborated without construction technology analysis and synthesis contained a number of errors which made them useless for construction project control with all consequences thereof, regarding economical, time and quality losses. Quality assurance checklists and environmental plans were not usually elaborated at all or by a separate division with no connection to the actual flow of the building process, the same with environmenal plans. The simultaneous elaborating of technological standards, network diagrams, cost analysis, quality assurance checklists and environmental plans eliminates the processing of network diagrams without the technological analysis and synthesis and makes possible to use the close link between technological analysis sheets and documents for quality management in the project. The methodology of the automated creation of the basic documents of the construction technology design is described in particular in (Jarský 2000).

The technological analysis sheet or programme determines the technological structure of the production process (sequence of construction processes, volume of production, labour and cost consumption, number and profession of workers or machines etc.). According to the calculated network diagram the technological analysis sheet includes a bar chart which indicates the time structure of the production process. Further a technological scheme showing the spatial structure of the process is usually added. The connection between the time structure and the spatial structure of the building process can be seen in the line-of-balance graph. The quality assurance checklist which is automatically created according to the technological analysis sheet consists of instructions for performing the quality checks of the resulting product at every significant construction process, similarly the environmental plan which includes checks of all environmental aspects of all construction processes

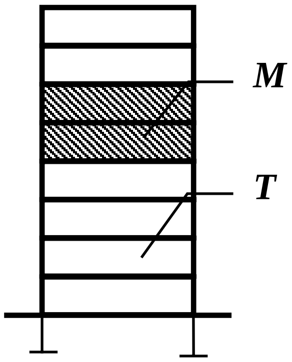
According to the values of the duration of the processes and the minimum working space necessary it is possible to determine the critical approximation of construction processes and to link these processes immediately in the optimum way in the construction technology network diagram method with regards to the condition of the quality of the resulting products of construction processes. Thus all documents mentioned above after the network diagram calculation depict floats of the construction processes. Floats are subsequently used for the optimisation of the building process from the point of view of limited resources in different time periods.

3.2 *Links of the construction technology network diagram*

The construction technology network analysis method used by the expert system was designed for simultaneous evaluating of technological analysis sheets and network diagrams and for the optimisation of linking the construction processes from the point of view of maximum use of minimum working space on site necessary for the efficient, economical and safe performing of construction processes including technological pauses.

This network analysis method uses the activity-on-node network diagram. All four types of links of activities introduced in the precedence graph method (finish - start, start - start, critical approach and finish - finish) are included in the construction technology network analysis method too. The main disadvantage of the precedence graph method is the necessity to know the actual values of lag times between every two activities that are linked together and their duration while creating the network diagram. This would make the concurrent evaluation of the technological analysis sheets and of the network impossible.

Therefore the construction technology network analysis method introduces the 5th type of link, the construction technology link that results from the condition of release of the minimum working space on a structure by the previous work gang so that the following work gang could start as soon as possible. The lag time is not given by a certain time value but it is calculated by the computer according to the duration of linked activities and to the spatial structure of the building, which is represented by a working space index f. This index is determined by the ratio of the minimum working space needed for the gang divided by the total working space in the building, e. g. in a 8 storey administrative building the usual minimum working space are 2 floors, so the working space index f is 2/8, that is 25 %, see Figure 1. Introducing this link in the construction technology network graph method means not only a simplification of inputting the data of the network diagram but it permits a wide formation and utilisation of typical network diagrams as computer files for the erection, maintenance and reconstruction of different sorts of buildings with the possibility of their modification according to the spatial structure of the actual building. There are usually only three main types of working space for different activities on site (f_1 for subterrain structure or works on the roof, f_2 for erection and plumbing, f_3 for finishing works). In the typical network diagram the values of the working space indices are given parametrically. While stating data about the actual building the typical network diagram can be modified by stating of the 3 main working space indices only.



M - minimum working space
T - total working space available
f - working space index

$$f = \frac{M}{T} \bullet 100 \quad [\%]$$

Figure 1. Working space index

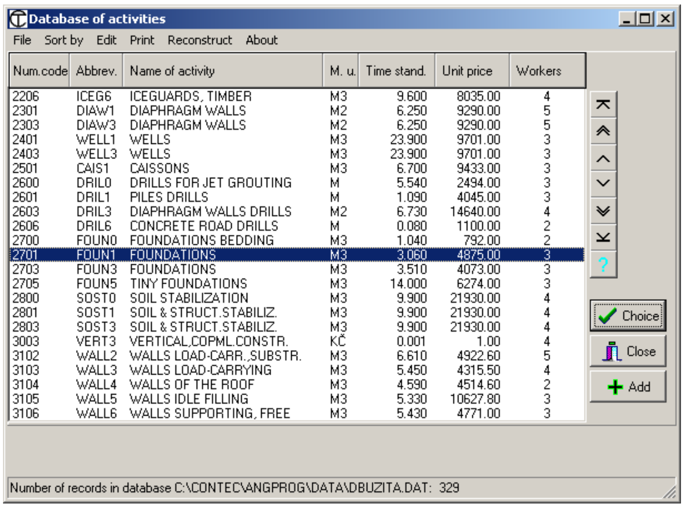
Further, the construction technology network analysis method introduces the 6th type of link, the flow link that results from the condition of continuous course of a construction process on different products, e. g. sections, buildings etc. The 7th and 8th types of link, the partial links, describe the condition that a following activity can start (or must finish) after the completion of a certain part of the previous activity or vice versa. These links are determined by the partial link indices that represent the ratio of the duration of finished part of the previous activity divided by the total duration of the previous activity (type 7) or the ratio of the duration of unfinished part of the following process divided by the total duration of the following process (type 8). If this index is negative it represents the same ratio but for the following (type 7) or preceding (type 8) activity.

Using the flow link modified typical network diagrams or evaluated network diagrams of buildings can be automatically linked into a greater network that may represent the building process of the whole project consisting of more buildings, e. g. a housing estate, an industrial plant, or its maintenance or reconstruction. In this case the flow links are generated by the system at activities that are performed by specialized work gangs that proceed continuously from one building to another. The network diagram can be calculated on deterministic or stochastic bases, (Jarský 2000).

3.3 *Conditions and means for modelling the project*

The main condition for modeling the erection, or reconstruction process is stating the task and intentions of the investor. Sometimes the investor has only very approximate imaginations what he wants to be built. In the very first stage he usually knows e. g. that there is an intention to build two concrete industrial halls, one about 40 000 m^3 of build-in space and the second with about 15 000 m^3 of space. He has some propositions and drafts about the layout and about the construction system. Later the investor usually has a certain level of design of the project including the bill of quantities which is very significant.

Then, a database for the quick modeling of the building process is available. This database consists of the main data about all construction processes at the technological structure of work gangs. It includes main facts about time standard, productivity of labour, price of the product, number of workers, technological pause and other 50 economical and technological resources (material costs, wages, costs for machines, overheads, average profit, machines, materials, professions) and the

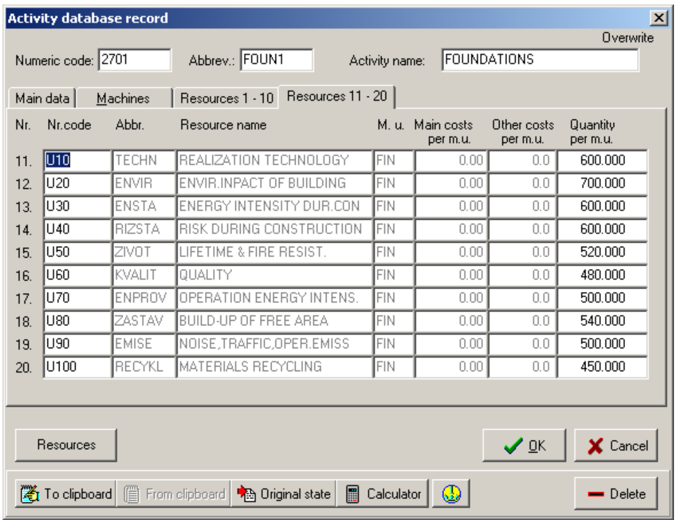


Num.code	Abbrev.	Name of activity	M. u.	Time stand.	Unit price	Workers
2206	ICEG6	ICEGUARDS, TIMBER	M3	9.600	8035.00	4
2301	DIAW1	DIAPHRAGM WALLS	M2	6.250	9290.00	5
2303	DIAW3	DIAPHRAGM WALLS	M2	6.250	9290.00	5
2401	WELL1	WELLS	M3	23.900	9701.00	3
2403	WELL3	WELLS	M3	23.900	9701.00	3
2501	CAIS1	CAISSONS	M3	6.700	9433.00	3
2600	DRIL0	DRILLS FOR JET GROUTING	M	5.540	2494.00	3
2601	DRIL1	PILES DRILLS	M	1.090	4045.00	3
2603	DRIL3	DIAPHRAGM WALLS DRILLS	M2	6.730	14640.00	4
2606	DRIL6	CONCRETE ROAD DRILLS	M	0.080	1100.00	2
2700	FOUN0	FOUNDATIONS BEDDING	M3	1.040	792.00	2
2701	FOUN1	FOUNDATIONS	M3	3.060	4875.00	3
2703	FOUN3	FOUNDATIONS	M3	3.510	4073.00	3
2705	FOUN5	TINY FOUNDATIONS	M3	14.000	6274.00	3
2800	SOST0	SOIL STABILIZATION	M3	9.900	21930.00	4
2801	SOST1	SOIL & STRUCT.STABILIZ.	M3	9.900	21930.00	4
2803	SOST3	SOIL & STRUCT.STABILIZ.	M3	9.900	21930.00	4
3003	VERT3	VERTICAL,COPML.CONSTR.	KČ	0.001	1.00	4
3102	WALL2	WALLS LOAD-CARR.,SUBSTR.	M3	6.610	4922.60	5
3103	WALL3	WALLS LOAD-CARRYING	M3	5.450	4315.50	4
3104	WALL4	WALLS OF THE ROOF	M3	4.590	4514.60	2
3105	WALL5	WALLS IDLE FILLING	M3	5.330	10627.80	3
3106	WALL6	WALLS SUPPORTING, FREE	M3	5.430	4771.00	3

utility aspects vector per measure unit of the construction. The values of the utility aspects are given in the interval <0 FIN/m. u.; 1000 FIN/m. u.>. The neutral value for each aspect is 500 FIN/m. u., the “good” values are lesser than 500 FIN/m. u., the “bad” values are greater than 500 FIN/m. u. The greater the value of FIN/m. u. of the aspect is the worse is the influence of the aspect on the utility. Nowadays, there are more than 500 building constructions and construction processes included in the database, see Figure 2 and 3.

Figure 2. Part of the listing of the database of constructions

For the possibility of quick making of the quality assurance checklists and environmental plans the database of the checks of the quality of resulting



Nr.	Nr.code	Abbr.	Resource name	M. u.	Main costs per m.u.	Other costs per m.u.	Quantity per m.u.
11.	U10	TECHN	REALIZATION TECHNOLOGY	FIN	0.00	0.0	600.000
12.	U20	ENVIR	ENVIR.INPACT OF BUILDING	FIN	0.00	0.0	700.000
13.	U30	ENSTA	ENERGY INTENSITY DUR.CON	FIN	0.00	0.0	600.000
14.	U40	RIZSTA	RISK DURING CONSTRUCTION	FIN	0.00	0.0	600.000
15.	U50	ZIVOT	LIFETIME & FIRE RESIST.	FIN	0.00	0.0	520.000
16.	U60	KVALIT	QUALITY	FIN	0.00	0.0	480.000
17.	U70	ENPROV	OPERATION ENERGY INTENS.	FIN	0.00	0.0	500.000
18.	U80	ZASTAV	BUILD-UP OF FREE AREA	FIN	0.00	0.0	540.000
19.	U90	EMISE	NOISE,TRAFFIC,OPER.EMISS	FIN	0.00	0.0	500.000
20.	U100	RECYKL	MATERIALS RECYCLING	FIN	0.00	0.0	450.000

products (what must be controlled, in which way, according to which standards etc. and the database of environmental aspects were created. Both are linked with the database of construction processes.

Figure 3. Chosen activity with utility assessment aspects

A set of typical network diagrams of certain types of facilities and their way of erecting based upon the construction technology network diagram method, see Jarský (2000), (2006), was created. The typical network diagram of a building or maintenance process as a computer file contains the data about the sequence of the construction processes, and their linkage. It is preferable to use as much as possible especially the construction technology link stated parametrically or other sorts of links with the lag time equal zero. Under these conditions the typical network diagrams can be easily modified according to the spatial structure of the actual building. The volume of production and costs and price of all activities are included too. They are related to an adequate custom-made measure unit, usually m3 of build-in space or m2 of reconstructed area in case of a reconstruction. As stated above, the typical construction technology network diagram can be modified according to the spatial structure of the building process by using the 3 main minimum working space indices.

Last but not least the computer expert project preparation and management system, see Jarský (2000), was adapted so that it is capable to calculate and evaluate the utility vector including the weighted values in a certain tabular form.

3.4 *Creating the model and calculating the utility vector*

When the user simulates the building process he calls up in the very first stage the typical network diagram of the certain building, modifies it by stating the actual main working space indices and the computer generates the first draw model of the erection process, including the time and cost analysis data which are transferred from the database of construction processes. Thus, the user can get the first model much quicker than by the use of classical project management systems that require creating the network diagram by adding relevant activities one after another and stating their duration, resources and links. The created model has to be defined with more precision according to the facts known about the building. It is known that 80 % of the price and costs is influenced by 25 – 30 % of activities only. Volumes of production of these significant processes have to be stated according to the construction design, prices of the production, labour consumption and resources needed are calculated automatically according to the database of activities. If the exact bill of quantities is available its values can be automatically transferred into the model. After the calculation of the network diagram the user gets the early and late terms of starts and finishes of all activities. By the change of number of workers in the gangs or by changing the tension index of time standards the duration of activities and thus the whole network diagram can be modified. Activities of all sorts (not only those from the database) can be included into the network. After making these models for all buildings that are included in the project it is possible to make a network diagram of the whole project by connecting the partial networks and linking them together with flow links in case of continuous work of specialized work gangs in linked buildings.

Thus, it is not necessary to create the network diagram individually from the very beginning for every project. The expert system enables to build up the model of the building process of the project very quickly from prefabricated sections, typical network diagrams of different facilities, and to define it with more precision easily according to the facts gained from the investor's task. It can be easily updated in case of a change of different conditions. The network can be automatically recalculated from the point of view of keeping the deadline of the project required. The system then selects activities that have to be shortened by adding a certain number of workers or by increasing the intensity of work, while keeping technological rules and all links of the network. The system enables to print the calculated network diagram in different forms (technological standards, bar chart, line-of-balance graph, resource allocation graphs of price, costs and cash flow, labour consumption, need of work force etc.), in Czech, Slovak, English, Italian or Russian. Even in the very first stage of the plan it is possible to create the quality assurance checklist and the environmental plan. The particular network diagram can be then aggregated into the higher information level of technological stages, steps of completion, to the level of facilities and others.

All documents that are gained on the base of the construction technology network diagram can be easily updated according to the actual completion of construction processes on site at a certain term. If there is a delay, the system suggests what measures are to be done to be able to keep the final deadline of the project. At the same time it keeps the technological rules of the building process. This can be visualized in the comparative bar chart, where the updated version of the building process drawn in thicker lines is compared in one document with the planned flow of the process, see Figure 4. Term of updating is illustrated by the red vertical line. Critical activities are drawn in red, non-critical activities in green and delayed activities in blue.

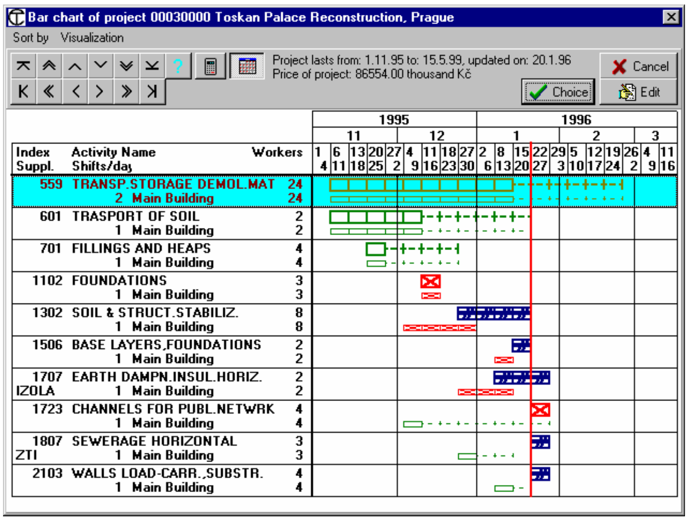


Figure 4. Part of a comparative bar chart

According to the recalculated network diagram the line-of-balance graph can be automatically drawn on the plotter, see Figure 5, where a very simple example of a building process aggregated into technological stages is illustrated.

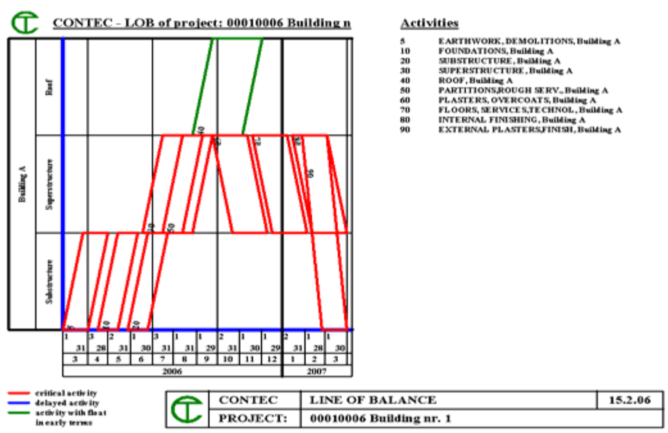
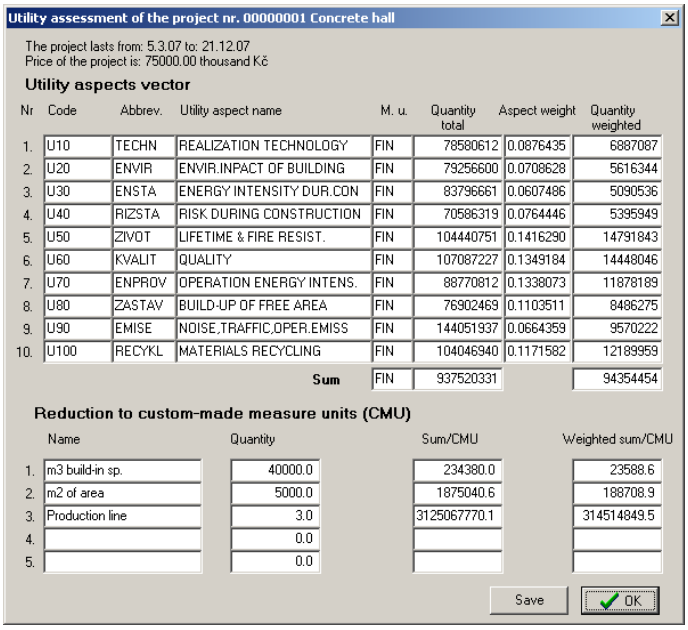


Figure 5. Simple line-of-balance (time-space graph)

The outputs from the system are used for evaluation of operational plans on site and for operational registration with the link to the invoicing agenda. On the other hand, the operational registration files from the invoicing system can be used for automatic updating of the network diagram in the CONTEC system and then recalculating the terms of activities and of the operational plan. A new resource allocation balance is the result of the updated model of the building process. Quality assurance checklists and environmental plans can be updated simultaneously in similar way from the point of view of terms of quality checks of products and environmental aspects of the construction processes.

After creating the model of the project the user can transfer the data about the utility aspects for all activities from the database mentioned above. The system then calculates the whole utility vector in a table form, see Figure 6.



Utility assessment of the project nr. 00000001 Concrete hall

The project lasts from: 5.3.07 to: 21.12.07
Price of the project is: 75000.00 thousand Kč

Utility aspects vector

Nr	Code	Abbrev.	Utility aspect name	M. u.	Quantity total	Aspect weight	Quantity weighted
1.	U10	TECHN	REALIZATION TECHNOLOGY	FIN	78580612	0.0876435	6887087
2.	U20	ENVIR	ENVIR.INPACT OF BUILDING	FIN	79256600	0.0708628	5616344
3.	U30	ENSTA	ENERGY INTENSITY DUR.CON	FIN	83796661	0.0607486	5090536
4.	U40	RIZSTA	RISK DURING CONSTRUCTION	FIN	70586319	0.0764446	5395949
5.	U50	ZIVOT	LIFETIME & FIRE RESIST.	FIN	104440751	0.1416290	14791843
6.	U60	KVALIT	QUALITY	FIN	107087227	0.1349184	14448046
7.	U70	ENPROV	OPERATION ENERGY INTENS.	FIN	88770812	0.1338073	11878189
8.	U80	ZASTAV	BUILD-UP OF FREE AREA	FIN	76902469	0.1103511	8486275
9.	U90	EMISE	NOISE,TRAFFIC,OPER.EMISS	FIN	144051937	0.0664359	9570222
10.	U100	RECYKL	MATERIALS RECYCLING	FIN	104046940	0.1171582	12189959
			Sum	FIN	937520331		94354454

Reduction to custom-made measure units (CMU)

	Name	Quantity	Sum/CMU	Weighted sum/CMU
1.	m3 build-in sp.	40000.0	234380.0	23588.6
2.	m2 of area	5000.0	1875040.6	188708.9
3.	Production line	3.0	3125067770.1	314514849.5
4.		0.0		
5.		0.0		

Save OK

Figure 6. Simple line-of-balance (time-space graph)

All documents that are gained on the base of the construction technology network diagram can be easily edited and updated according to the actual compositions of constructions. The utility assessment method is completely free for the user. He can define his own utility assessment vector composed of his own aspects, he can identify his own values of weights (importance) of these aspects, he can even design his own database of constructions with allotting of the amount of FIN to every utility aspect in every building construction that is included in the database.

Nowadays, there are 4 types of these databases available – the database for housing and structural engineering, the database for industrial buildings, the database for engineering structures (bridges, roads and infrastructure) and the database for hydraulic structures.

4 EXAMPLES OF USE ON BUILDING SITE

The main documents of the construction technology and cost analysis created in the mentioned way can contain the model of the building process of the project that includes all necessary data for the building process control and management, resource allocation balancing and utility assessment. The described way of preparation and management was used in some cases of reconstruction of historical buildings and in a large number of significant new projects.

A very interesting example of the cost and time analysis performed by the CONTEC system is the reconstruction of the building of Industrial and Construction Bank at the Nevsky Prospect in St. Petersburg in Russia. This project started in 2001 and was finished summer 2003.

Figure 7. Promstroibank St Petersburg, Russia - north façade

The north façade of this building is illustrated on Figure 7. This building that was originally built at the end of 18th century completely burnt out in 1993. In this case, especially the beginning of the reconstruction is decisive. There were very difficult ground conditions on this site because it lies under the water level of the river Neva. The load bearing walls had to be underpinned by oblique piles, new diaphragm walls had to be built and a lot of injections and ground consolidation had to be performed. The south-east wing of the building was completely demolished and then erected in a new shape. All ceilings were demolished and rebuilt. A new glazed roof steel structure was built and all necessary technological equipment including safes and computer systems for the bank had to be replaced. In the construction technology and cost analysis the climate and weather conditions had to be respected as some of them had a very negative influence on the building process. Lots of changes were made during the reconstruction process and the model had to be updated regularly once in 2 months.

One of the very interesting cases which was controlled by the expert system is the reconstruction of 18 renaissance houses with gothic cellars in the Ungelt area in Prague Old Town. The middle of the area is the Týn Court which is surrounded by 11 houses. The other 7 houses are situated just near by. In the planning stage a feasibility study was worked

out which solved the optimum use of all the space from the architectural, historical, technological and economical points of view. All vaulted ceilings were saved and wooden ceilings were reconstructed. There are many beautiful architectural details on these buildings (stone portals, staircases, sgraffito façades etc.). A part of one finished building of this area is illustrated on Figure 8. New build-in units (windows, doors) were produces according to the old photographs and paintings of this area. The project management documents based on the construction technology network analysis were elaborated to visualise the building process divided into construction processes.

Figure 8. Part of the reconstructed Týn Court in Prague

Another interesting example of use of the system for modeling and cost and utility assessment of the reconstruction process is the Toscano Palace near the Prague Castle, see Figure 9. This renaissance palace belongs to the Czech Ministry of Foreign Affairs. The main purpose of reconstruction was to modernize especially the internal equipment of the building while conserving significant architectural and historical details, such as portals, towers, façade and the courtyard. In this case a lot of old frescos were discovered in the flow of the reconstruction which had to be renewed and the building process was stopped for 8 weeks. In that case the model of the reconstruction process had to be regularly updated (once a month approximately.). The main significance of the network model was in the capability of respecting of delays caused by these discoveries or due to other changes and to calculate measures to be done to keep the final deadline of the project. The resulting delay was only 3 weeks compared with the original schedule.

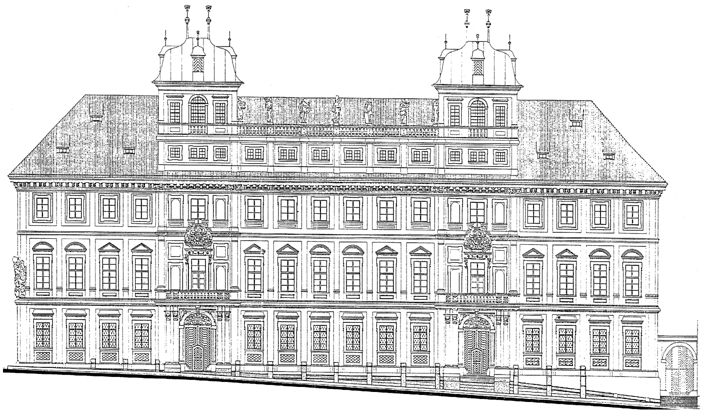
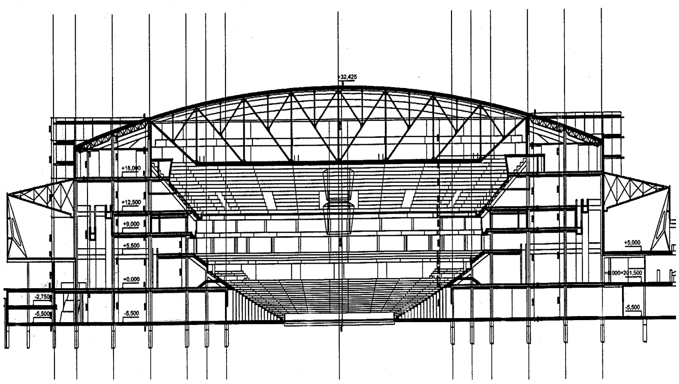


Figure 9. Toscano Palace in Prague - western façade

As an example of new significant projects I would like to name the Sazka arena in Prague, see Figure 10 – the biggest ice-hockey arena in the Czech Republic. The system was used in the

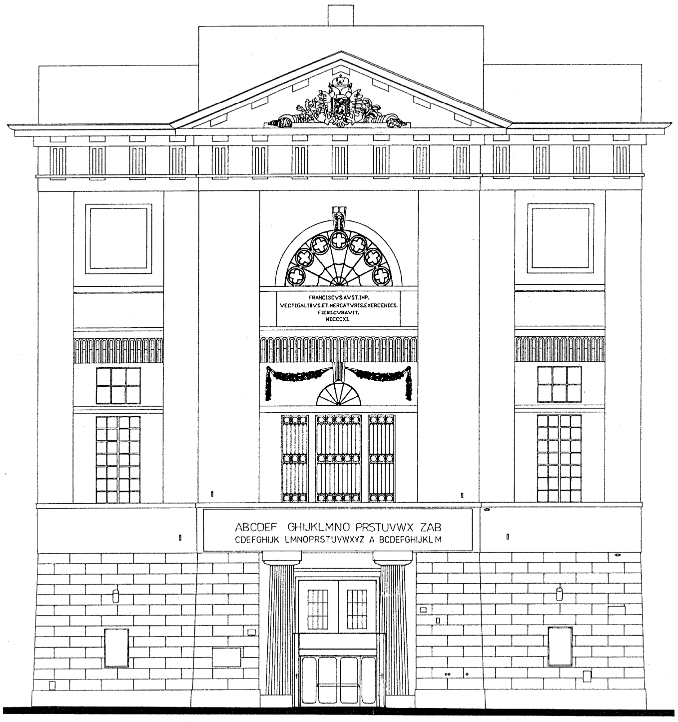


planning stage of the project for elaborating of the plan of the organization of the building process.

Figure 10. Cross-section of the Sazka arena in Prague

For the former exhibition hall in Hybernia Palace, figure 11, originally built in the classic style at the beginning of 19th century which was rebuilt to a musical theatre, a particular model of the reconstruction process control and utility assessment was created. As some parts of the load bearing structure had to be changed and replaced by a steel construction, there were lots of problems with the sequence of demolition processes and the erection of different parts of the new load bearing construction. The network diagram managed to model all linkages according to static requirements. The model was regularly updated according to the state of completion of the reconstruction and the musical theater was opened in 2006.

Figure 11. Hybernia Palace in Prague, western façade



5 CONCLUSIONS

This paper briefly describes a new design of the methodology of the utility assessment of buildings and projects. It is based on a vector of 10 main aspects (criteria) for utility assessment which was designed with a same measure unit. The aspects were given a certain level of importance each. A database of construction processes was created including the aspects for the utility assessment. On the base of the methodology of the construction technology design a method for modelling of realization of building and projects based on the construction technology network diagram with utility assessment was created and a computer system for this purpose was developed. This system is capable of a quick modelling of a building or a project that is composed from constructions by means of typical construction technology network diagrams. It enables to calculate and tabularly illustrate the resulting utility vector and its sum with regard to the importance of every utility aspect. The methodology is completely free for the user who can define his own values of every utility aspect, even the aspects themselves.

The main documents of the construction technology design created by the help of the expert system can contain the model of the building process of the project that includes all necessary data for the building or reconstruction process control and management. The system enables to create the building process model with appropriate cost assessment and time-cost analysis about 50 times quicker than current project management systems. It can respect all specific attributes, links and constraints of the reconstruction process of historical buildings. Therefore it is possible to use the documents as a part of a feasibility study, bid, construction technology design and operative plan for the project management of the erection or reconstruction process itself. This model can be updated according to the bill of quantities or cost estimation. Afterwards the quality assurance checklist and the environmental plan can be automatically created. All documents that are gained from the system can be easily updated according to the actual completion on site at a certain term. If there is a delay, the system suggests what measures are to be done in the future to be able to keep the final deadline of the project. All documents can be automatically translated to Czech, English and Russian.

The system is able to model the costs for the necessary maintenance and reconstruction process during the whole lifetime of the building. According to the databases that are regularly updated twice a year the user can model and choose the best variant of construction units according to his goal and requirements, even in the very first stage of planning.

The designed methodology of the utility assessment and modelling of the building process of facilities and projects can be used especially in the phase of planning the projects by owners, designers and architects for utility assessment and much more – for feasibility studies, planning, obtaining bank loans to finance the projects and last but not least in project management itself.

The described system can be used on IBM PC compatible computers under Windows 9x, ME, NT, 2000, XP and Vista operational systems.

The data for the utility assessment are regularly updated. The author plans for the near future to develop especially the database for utility assessment with better precision and to create more version of the database to distinguish some special facilities. We plan to create a database with the data for building and civil engineering facilities, for the infrastructure, roads, railways etc.

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