SYRE - A COMPUTER SYSTEM FOR ANALYSIS OF BUILDING ECONOMICS

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Synopsis
There is a great need for economic analyses in the construction process, especially at the early stages of the designing process. At the department of Byggproduktionsteknik (Construction Management) at the School of Civil Engineering, Lund University a computerized system of building economics is under construction. It has been named SYRE. The overlapping purpose of SYRE is to cover all kinds of cost estimating concerning a building project. Today (October 1988) the part of the system dealing with investment costs for ordinary builders work is completed.

The SYRE system is based on cost datas concerning all kinds of components (e.g. bricks or studs). The components are specified with man hour and material cost per unit. The components are combined into various sections and the sections are combined to various buildings. All the costs are continuously updated, thanks to the up-to-date prices on the material and thanks to the Resource Register where wages, indirect labour costs, general requirements, overhead and benefit are continuously updated. All the quantities in the building project reports are related to the gross area of the building. Thus, it is possible to rapidly estimate the effects of changing the size of the building or the changing of one section to another or one component to another.
The system is now used to develop a new estimating model for government loans for housing on behalf of the swedish Ministry of Housing.

The need of economic analysis in the construction process

There is a great need of economic analysis in the construction process. Various interested parties - communities, architects, contractors, authorities, owners etc - have such a need on various occasions and for various reasons.

All their demands have common ingredients but are yet of quite different kind in regard to the level of detail or generality. The contractor has very detailed information about the project in question and a continous contact with actual costs and is consequently capable of making very good final estimates of the construction costs. The owner of a building has normally good knowledge of maintenance costs but is often short of data concerning construction costs. Therefore, he has difficulties in estimating the profit of investing in extra arrangements for decreasing the energy consumption or similar reconstruction works.

When analysing the economy of a building project many different types of costs must be considered.

A Investment costs
* Financial costs during the project
* Project administration and planning
* Ground and exploitation
* Site work (paving, walks, landscaping etc)
* Building
  - Grading
  - Foundation work
  - Superstructure (walls, roof, slabs and other normal builder's work)
  - Heating, ventilating, plumbing
  - Electrical work
  - Conveying system

B Annual costs
* Capital costs
* Maintenance costs

In my dissertation (J Söderberg, Byggherrens kostnadsstyrning, "*The client's cost planning*", Lund 1978) I studied the problems experienced by clients in their attempt to control costs during the initial stages of a project.

In the dissertation I described a model of how cost planning works within the process of design.

Cost planning must be integrated into the process of design. Cost planning can also be realized if aids such as methods of estimation, check lists and data distribution are used.

It is important to state that cost planning must not be equivalent to a one-sided seeking to lower cost.

An effective cost planning system should comprise the following:

* that the final cost of the project be known with reasonable accuracy when the decision to invest is made,
* that during the process of product determination, deviations from projected costs be known, and
* that when choosing between various alternatives, the full economic effect of each alternative be known.

The ability of a client to plan the cost of a project is influenced by a great many factors:

1. The design is influenced by various interested parties some of which can be controlled only partly by a client and some not at all.
2. Data on costs and methods of estimation used by contractors are not readily available.
3. It may not be possible for a client to estimate the influence of sufficiently many factors to effect cost planning.
4. No common language exists in which an unambiguous account of a building project can be stated. Decisions may thus be made on the basis of misunderstood information.

SYRE - a computerized system of building economics

At the department of Byggproduktionsteknik (Construction Management) at Lund University, School of Civil Engineering, a computerized system of building economics is under construction. It has been named SYRE and it is meant to be used by clients and their consultants or by authorities in order to analyse building costs.

The system is supposed to deal with both investment costs and annual costs. Within those two groups of costs the system will consider all kinds of costs like fees to consultants and charges from the authorities.

Another purpose of SYRE is to make it possible to integrate the system into CAD or similar systems for computerized design.

The construction of SYRE is based on results from my researching financed by the Swedish Board of Building Research during the years 1976-1978. Responsible for research and computer development is Mats H Persson.

Today (October 1988) the part of the system dealing with investment costs for ordinary builder's work is now completed and we are working with completing SYRE with installation costs.

One of the main thoughts about SYRE is that it must be possible to handle cost information on various levels and with various mixture at the same time. Therefore the system has got estimate reports allowing adjustments on all levels of the economic model. Independent of the level on which the adjustments are made the entire estimate for the project will be influenced, upwards and downwards in the hierarchy of the system.

In figure 1 examples of levels and mixtures are given.

As you can see in figure 1 the report concerning the actual building project is combined by sections from the data base. The sections are combined by components from the data base. In figure 2 a part of the data base concerning sections and components is shown. We will there study how the section "Outer Wall Type 101" is put together.

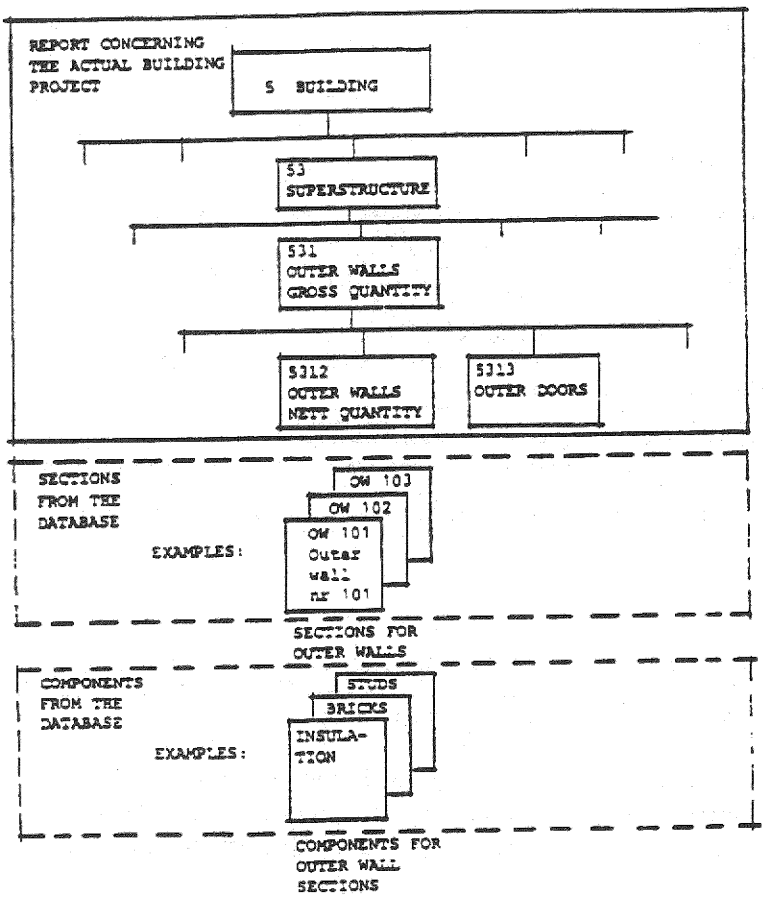

Figure 1. Examples of levels and mixtures in the SYRE system.

OUTER WALL TYPE 101		QUANTITY	MAN HOURS	WASTE FACTOR	MATERIAL SKR
FA3.6111	SCAFFOLD	1.00 M2	0.19	1.00	16
FF0.0125	FIXING CRAMPS	4.00 EA	0.10	1.05	13
FF4.0212	FACADE BRICK 120 MM	1.00 M2	0.90	1.10	110
FH5.0565	STUDS 45*45 MM	2.50 M	0.16	1.10	11
FH5.0565	STUDS 45*120 MM	2.10 M	0.17	1.10	23
FH5.1371	STUDS 45*120 MM IMPR.	0.40 M	0.02	1.10	7
FH5.3851	ANCHOR BOLTS M8	0.67 EA	0.13	1.05	7
FK2.4411	INSULATION 45 MM	1.00 M2	0.08	1.05	12
FK2.4416	INSULATION 120 MM	1.00 M2	0.08	1.05	25
FO1.1111	GYPSUM BOARD 13 MM	1.00 M2	0.18	1.05	19
FO1.1211	GYPSUM BOARD 9 MM OUTD	1.00 M2	0.13	1.05	19
			2.14		262
			LABOUR COST		355
GENERAL REQUIREMENTS					
SUPERVISION: 49 SHACKS: 39					
EQUIPMENT: 47 OTHER GENERAL REQ: 35					170
OVERHEAD AND BENEFIT (8 %)					63
SECTION COST PER M2		(DATE 88.10)			SEK 850

COMPONENT REGISTER (part of)

COMP CODE	COMPONENT TEXT	UNITE	MAN HOUR	MTRL COST	WASTE FACTOR
FF4.0212	FACADE BRICK 120	M2	0.900	100.00	1.10
FH5.0569	STUDS 45*45 MM	M	0.065	4.00	1.10
FH5.0571	STUDS 45*120 MM	M	0.080	10.00	1.10

RESOURCE REGISTER

LABOUR WAGES	85 SEK/HOUR
INDIRECT LABOUR COSTS	95 % (TRAVELLING COSTS INCLUDED)
SUPERVISION	23 SEK/HOUR
SHACKS	18 SEK/HOUR
EQUIPMENT	8 % OF MATERIAL + LABOUR COST
OTHER GENERAL EQUIPM.	6 % -"-
OVERHEAD AND BENEFIT	8 % OF TOTAL COST

Figure 2. Part of the data base concerning sections , components and resources.

Outer Wall type 101 has got a "recipe" that tells the computer to collect specific quantities of component from the Component Register, e.g. Studs 28x45 mm. Every component is described in the register with six kinds of data (example: Studs 28x45 mm):

CODE — The first letter (F) tells us that this is an outer wall component. The second letter (H) and the figures tells us that this is a wood-component with a special quality and size (45x45 mm).

COMPONENT TEXT — A short description of the component.

UNIT	The quantity unit that is used for this component (in this case: m = meter).
MAN HOUR	The time per unit (hour per m) that it normally takes for a worker to handle this kind of component (0.065).
MATERIAL COST	The actual cost for the component per unit in Swedish kronor (SEK), here 4.00 SEK per meter.
WASTE FACTOR	The material cost is rised with a waste factor that varies with the type of component. In this case we believe that the waste will be 10 %.

As shown in figure 2 the Outer Wall Type 101 consists of eleven components. The quantities are given per square meter of the section. The sum of man hours are 2.14 per square meter of the section. To get the labour costs the computer collects the actual labour wages and the indirect labour costs from the Resource Register (bottom of figure 2). That is:

Labour Costs. 85 SEK + 95 % of 85 SEK = 166 x 2.14 hours = 355 SEK

All material costs including waste are summed = 262 SEK

Labour costs and material costs together are equal to 617 SEK

For general requirements we use two ways for the estimation:

Supervision and site shacks are related to the man hours as shown in the Resoruce Register:
Supervision: 23 SEK/hour x 2.14 hours = 49 SEK
Shacks: 18 SEK/hour x 2.14 hours = 39 SEK

Equipment and other general requirements are related to the sum of labour costs and material costs:
Equipment: 8 % of 617 = 47 SEK
Other gen. eq.: 6 % of 617 = 35 SEK

The total sum of general requirements is 170 SEK per square meter.

The total sum so far for the section is 787 SEK and with 8 % for overhead and benefit we can note 850 SEK per square meter in all for this Outer Wall Type 101.

The costs of the components are updated as soon as the material costs or the labour costs ar rising. Thus the system can always present up-to-date costs at all levels in the system (from the component level to the building level, compare with figure 1).

In figure 3 we present a report concerning an actual building project, an office building. As noted at the bottom of the figure this is a simplified version of a project report.

This building project report can be used in a number of ways. We will here demonstrate one of them. Imagine that we are at the very start of the design process concerning an office building. We only know a few things about the project: The staff of the office will be 90 persons and the office will be a building with two floors and no cellar.

By comparing with other office buildings we can estimate that the total gross area (BTA) will be about 1 800 m2 (20 m2/person).

PROJECT NAME: FREDRIK 15, LUND, OFFICE BUILDING 2 FLOORS, NO CELLAR DATE: 88.10

TOTAL GROSS AREA (BTA): 2 112 M2

CODE	TEXT	REAL QUANT	UNITE	UNITE COST SEK	COST MSEK	RELATIVE QUANTITY
5	BUILDING				6138	
51	GRADING				120	
52	FOUNDATION WORK				480	
53	SUPERSTRUCTURE				5538	
531	OUTER WALLS (GROSS QUANT)	764	M2	1966	1502	0.362
5312	OUTER WALLS (NETT QUANT)	741	M2	850	630	0.351
	OUTER WALL TYPE 101	298	M2	850	253	0.141
	OUTER WALL TYPE 102	159	M2	750	119	0.075
	OUTER WALL TYPE 103	284	M2	910	258	0.134
5313	OUTER DOORS	2	EA	4500	9	0.001
	OUTER DOOR TYPE 107	1	EA	5000	5	
	OUTER DOOR TYPE 108	1	EA	4000	4	
5314	WINDOWS	251	EA	3342	839	0.119
	WINDOW TYPE 121	49	EA	3100	152	0.023
	WINDOW TYPE 122	202	EA	3400	687	0.095
5316	ENTRANCE SECTIONS	2	EA	12000	12	0.001
	ENTRANCE SECTION TYPE 102	2	EA	12000	12	0.001
532	SLABS	2112	M2	490	1035	1.000
533	ROOF	1061	M2	800	849	0.500
535	COMPLEMENTS (STAIRS ETC)				60	
536	INTERNAL WALLS (GROSS)	1392	M2	350	487	0.629
537	INTERNAL SURFACES (Flooring, painting etc)	6614	M2	220	1455	3.132
538	EQUIPMENT				150	

Notes. This is a simplified version of a project report. In the normal case all sections would be presented on the level with four figures in the code, e.g. 5374 PAINTING. Only the sections belonging to 531 are specified in this report. Abbreviations: M2: Square meter. EA: Each. SEK: Swedish kronor. MSEK Thousand Swedish kronor.
Total gross areea (BTA): The area of all floors limited by the outside of the outer wall.
Relative quantity: The ratio between actual quantity and the total gross area (BTA)

Figure 3. Report concerning an office building.

Then we can choose the Fredrik project in figure 3 as a reference for our new office (Gerda). The Fredrik project was built in 1982 but the values in figure 3 are up-to-date (1988-10) thanks to the arrangement with continous updating of the components.

To get our first budget for Gerda we put in 1 800 m2 BTA instead of 2 112 m2 BTA in the Fredrik project. Then the computer gives us a project report as in figure 4, thanks to the relation between all part quantities and the total gross area (BTA).

The report in figure 4 is presented on a level with three figures in the code (e.g. 531) within 53 SUPERSTRUCTURE and with two figures for the rest. The budget for account No. 5, BUILDING, is 5 231 000 SEK. The entire budget is based on qualities and quantities from the reference project (Fredrik) but related to the new area (BTA). We can call this estimate a synthetic estimate, because it is based on synthetic quantities and qualities. As soon as the architect starts his designing work the quantities and the qualities are going to change continuously from synthetic to real values (that is why the system is called SYRE: SYnthetic to REal values).

The important thing with the SYRE system is that all the synthetic quantities are based upon real building projects but all the prices are up-to-date.

It is possible to present the Gerda project (figure 4) in a much more detailed budget. For example, we can tell the number of windows type 121 there is in the project budget. But at this early stage of the product determination process is it not necessary to get down to such a low level of description.

PROJECT NAME: GERDA 18, LUND, OFFICE BUILDING 2 FLOORS, NO CELLAR DATE: 88.10

TOTAL GROSS AREA (BTA): 1 800 M2

CODE	TEXT	REAL QUANT	UNITE	UNITE COST SEK	COST MSEK	RELATIVE QUANTITY
5	BUILDING				5231	
51	GRADING				102	
52	FOUNDATION WORK				409	
53	SUPERSTRUCTURE				4720	
531	OUTER WALLS (GROSS QUANT)	651	M2	1966	1280	0.362
532	SLABS	1800	M2	490	882	1.000
533	ROOF	900	M2	800	724	0.500
535	COMPLEMENTS (STAIRS ETC)				51	
536	INTERNAL WALLS (GROSS)	1132	M2	350	415	0.629
537	INTERNAL SURFACES (Flooring, painting etc)	5638	M2	220	1240	3.132
538	EQUIPMENT				128	

Figure 4. Report concerning the new office project, Gerda. First budget

On the other hand, it is possible for the architect to tell the client what qualities there are in the estimated price. He can either show the client the referens building in site or make a list, describing the qualities that there are in the budget. This means that if the client at once says: "I don't like that kind of windows. I want windows of that type!", then the architect can rapidly change the budget by putting cost data of the new windows into the computer, even at this early stage of the process.

Another way of using the SYRE system is for examining the influence of various constructions in a building project. It is very easy to change a section to another and immediately get the effect on the total budget for the project. In the same way it is very easy to create new sections by combining various components.

Because of this quality of the system we are now using SYRE to develop a new estimating model for government house loans on behalf of the swedish Ministry of Housing. In that project we can easily analyse the economic effect of various building solutions.