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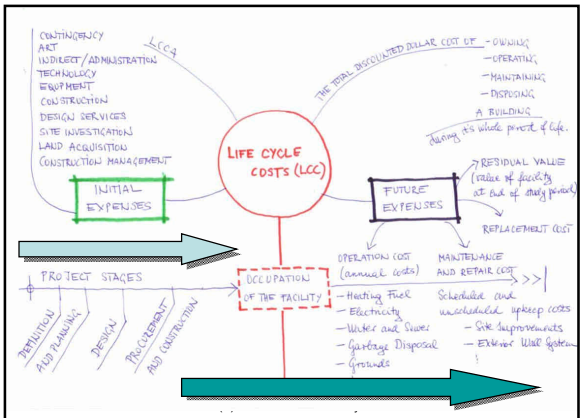
10 – 03 - 2011

Budget, Cost Estimation



Why it is important to knew about costs for an architect?

- usually costs play key rule in an investment
- Must knew:
  where,
  why and
  how do arise costs.
- to give advises to the investor or owner

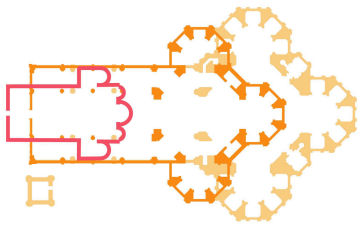
Sometimes there are extraordinary cases.

Three examples:

Dome, Florence, Italy (1294 – 1434)

Santa Maria del Fiore

Santa Maria del Fiore, Florence, Italy (1294 – 1434)

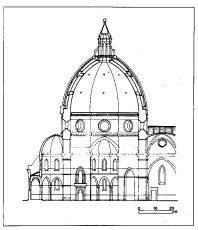


Santa Raparata was demolished
Arnolfo di Cambio's Desing (1296)
enlarged by Francesco Talenti (1367)
actual plan

Time and Cost Management - really?

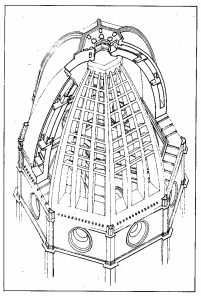
Santa Maria del Fiore, Florence (1296 – 1436)

Time and Cost Management - really?



Filippo Brunelleschi, Florence, Dome

Section and
the structure of the cupola



Dome, Florence, Italy (1294 – 1434)

Ross King: Brunelleschi's Dome. The Story of the Great Cathedral in Florence, Pimlico, 2005

Some examples in the world

Edinburgh Scottish Parliament

Scheduled to open in 2001, it did so in 2004, more than three years late with an estimated final cost of £414 million, many times higher than initial estimates of between £10m and £40m.

Some examples in the world

Olympic Stadium (Montreal), Canada

Despite initial projections in 1970 that the stadium would cost only **C$ 134 million** to construct, strikes and construction delays served to escalate these costs. By the time the stadium opened (in an unfinished form), the total costs had risen to C$264 million.

In 1986, a large chunk of the tower fell onto the playing field during another Expos game. A contract for a new permanent steel roof was awarded in 2004, with an estimated $300 million price tag.
In mid-November 2006 the stadium's costs were finally paid in full. The total expenditure (including repairs, renovations, construction, interest, and inflation) amounted to **C$1,610 million**, making it the second most expensive stadium ever built.
Though some Montrealers have called for the stadium to be demolished, it would be an extremely long and expensive project. Due to its unique structural design and the metro line directly underneath, it is not possible to implode the stadium. Instead, it would have to be dismantled piece by piece, which would take years and cost an estimated C$700 million.

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Some examples in the world

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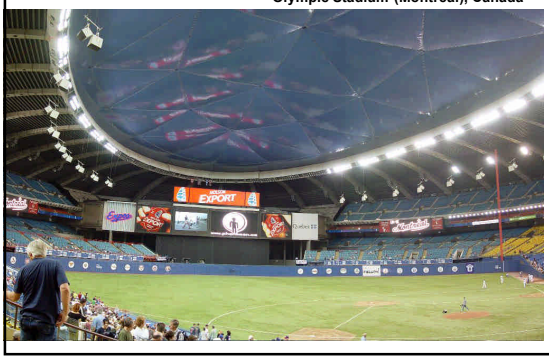


Some examples in the world

Olympic Stadium (Montreal), Canada

Causes of Cost Overrun

Three types of explanation for cost overrun exist:

Technical: imperfect forecasting techniques, inadequate data, etc,

Psychological: optimism bias (over-estimating the likelihood of positive events and under-estimating the likelihood of negative events), and

Political-economic: the result of strategic misrepresentation of scope or budgets.

Calculation of Cost Overrun

Percentage: actual cost minus budgeted cost, in percent of budgeted cost

Ratio: actual cost divided by budgeted cost

For example:

the budget for building a new bridge: $100 million

the actual cost: $150 million

the cost overrun: 50 % or the ratio 1.5

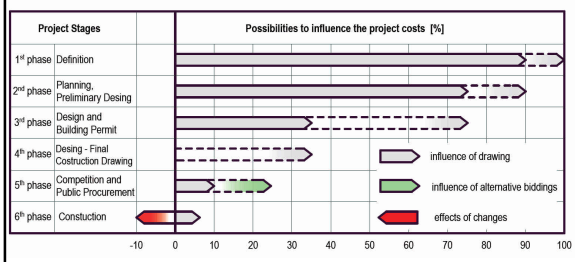
Technical Causes of Cost Overrun

- Cost estimates method and the detail of the plan is inadequate,
- defective cost data,
- imprecise cost estimates (calculation) method,
- price increases during the beginning of planning and the delivery of the investment period,

Technical Causes of Cost Overrun

- additional costs because of the change of the investment program and the plans,
- unforeseen construction conditions (e.g., poorer soil conditions, adverse weather),
- hindering the construction (e.g., late delivered plans, external action of associations),
- lack of cost management in planning and construction process.

Possibilities to influence the project costs (%)



How can we calculate costs?
The principle of cost calculation

Quantitative factor x cost factor = cost

geometry of the building:
- functional basic area
- the size of the surfaces of the floors
- surfaces of the facade

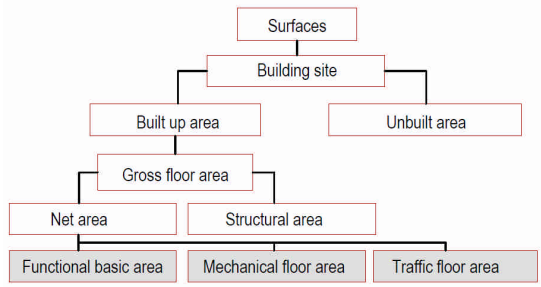
qualitative factor :
- using of the building (detached house or hospital)
- claim level of the building
- conditions of the market

Quantitative factor

- Relevant parameter at the time of the planning, construction and use.
- Quantitative factor is needed for:
  - characterization of the building,
  - definition, controlling and management of the construction costs,
  - comparison of variant design solutions,
  - definition, controlling and management of the operating costs,
  - calculation of the rent,
  - calculation of the worth of the real estate, etc

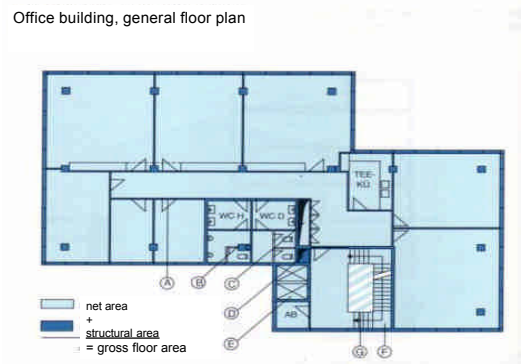
That is: ~ is very important at the calculation.

(DIN 277-1) Volume and surface areas of buildings. Part 1: concepts and methods of calculation

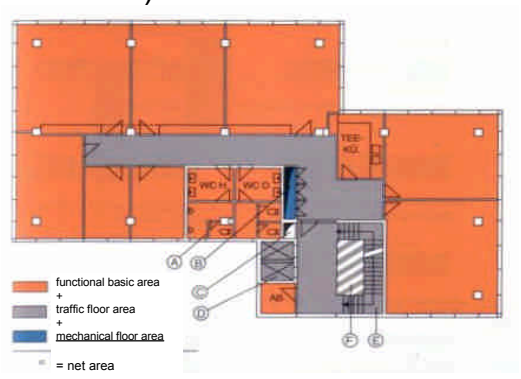


(DIN 277-1) Division of the gross floor area

Office building, general floor plan

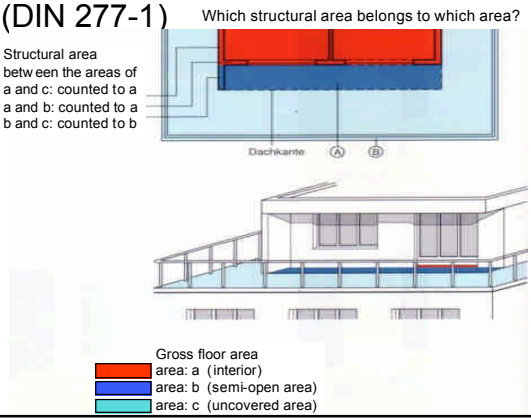


(DIN 277-1) Division of the net area

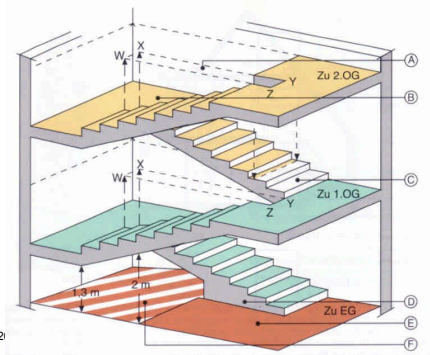


(DIN 277-1) Which structural area belongs to which area?

Structural area
between the areas of
a and c: counted to a
a and b: counted to a
b and c: counted to b



(DIN 277-1) It is a precise standard.



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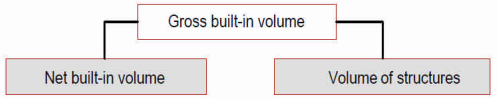
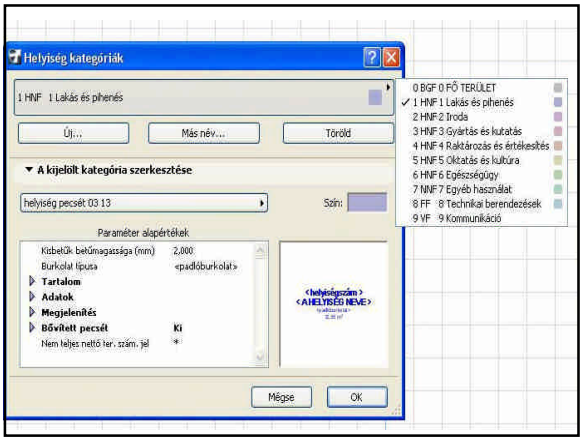


DIN 277-2: Partition of net floor area

Number	Net area	Room category (functions)
1	Functional basic area	housing and recreation
2		office work
3		manufacturing and research
4		storage and sales
5		training, education and culture
6		medicine and nursing
7		other usage
8	Mechanical floor area	technical equipment
9	Traffic floor area	traffic



The principle of cost calculation

Quantitative factor x cost factor

= cost

geometry of the building:

- functional basic area
- the size of the surfaces of the floors
- surfaces of the facade

qualitative factor :

- using of the building (detached house or hospital)
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- conditions of the market

Cost factor

Expenses fall under two major sections:

Initial expenses:

Initial expenses are usually equal to the investment of a project.

Future expenses:

Future expenses are usually equal to the incurring costs after the occupation of a facility.

Cost factor

There are two standards in Germany which summarise the costs in the building industry:

- the Standard 276-1 (DIN, 2006) contains the total investment cost of a project (Initial expenses) and
- the other German Standard 18960 (DIN, 2008) defined the future expenses at the life of a building.

Cost factor: future expenses

The German Standard 18960 (DIN, 2008) defined the following future expenses at the life of a building:

100 Capital costs: interest loss and amortization
200 Object management costs: personal costs in connection with the operation of the building and other material expenditures
300 Operating costs
400 Maintenance costs

Cost factor: total investment cost

The Standard 276-1 (DIN, 2006) contains the total investment cost of a building project.

The aim of the DIN 276-1 standard is to give the opportunity to stand up a complete structure of building costs and makes it possible to project all costs of a planned investment.

Each cost element is encoded and divided to three levels.

The first level refers to all the costs of the project (budget):

Budget: the total investment cost (DIN 276-1)

100 Building plot
200 Infrastructural facilities
300 Building – constructions
400 Building – installations
500 Outdoor constructions and installations
600 Furniture and artworks
700 Additional expenses

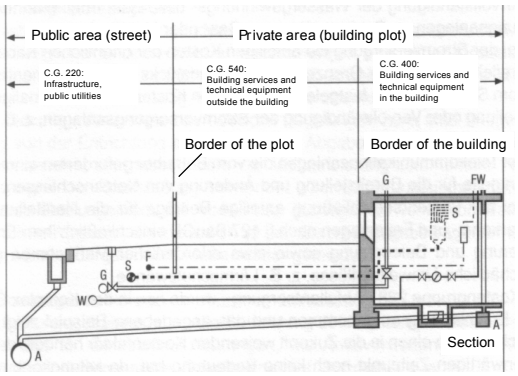
DIN 276-1

100 Building plot
- **110** Plot price (value)
- **120** Incidental costs of ownership
  - 121 alignment
  - 122 cost of legal procedures
  - 123 notary costs
  - 124 estate agent pay
  - 125 duty
  - 126 valuation, and related expertise
  - 127 authorization fees
  - 128 plot alteration, withdrawal from cultivation
  - 129 other incidental expenses
- **130** Liberation costs of the plot
  - 131 indemnification
  - 132 resolving form restrictions
  - 139 other

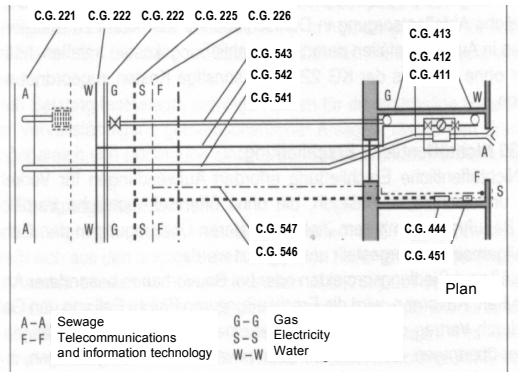
DIN 276-1

200 Preparation and infrastructure
- **210** Preparation
- **220** Infrastructure - public utilities
- **230** Infrastructure - Internal
- **240** Renting public area
- **250** Temporary arrangements

DIN 276-1



DIN 276-1

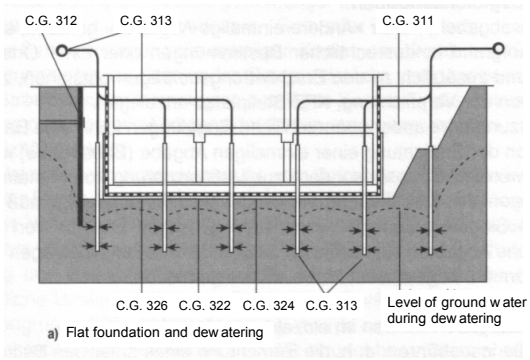


DIN 276-1

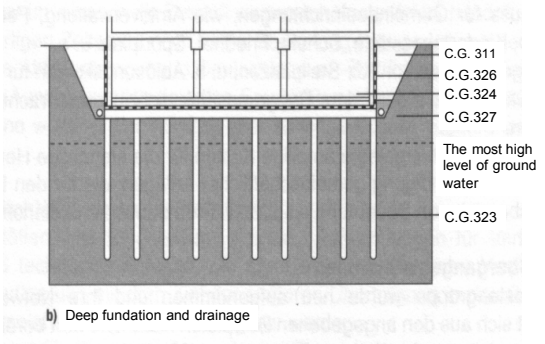
300 Building - building constructions

- **310** Pit for basement level
- **320** Foundation
- **330** External walls
  - 331 external load-bearing walls
  - 332 external walls, infill walls
  - 333 outer pillars
  - 334 external doors and windows
  - 335 facade
  - 336 interior finish for pillars, exterior walls
  - 337 external walls assembled
  - 338 shading
  - 339 other
- **340** Interior walls
- **350** Floors
- **360** Roof
- **370** Built-in appliances
- **390** Other arrangements related to building constructions

DIN 276-1



DIN 276-1



DIN 276-1

400 Building - building services and technical equipment

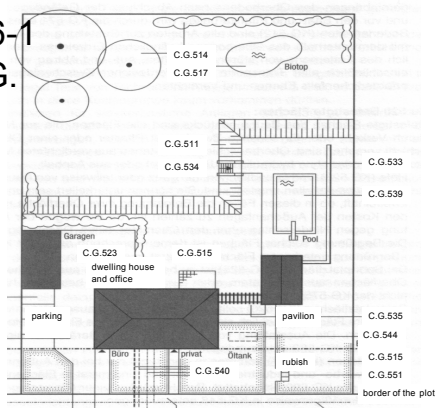
- **410** Water, sewage, gas
- **420** Heating
- **430** Ventillation and air conditioning
- **440** Electricity
- **450** Telecommunications, information technology
- **460** Transportation equipment
- **470** Technology Equipment
- **480** Integrated building management and security management
- **490** Other arrangements related to building services and technical equipment

DIN 276-1

500 Facilities outside the building
- **510** Landscaping
- **520** Stabilized and paved surfaces
- **530** Building constructions outside the building
- **540** Building services and technical equipment outside the building
- **550** built-in appliances outside the building
- **560** Water surfaces
- **570** Green surfaces
- **590** Other arrangements related to facilities outside the building

600 Furniture and art objects
- **610** Furniture, textiles, medical and scientific instruments, equipment, signs
- **620** Art works: sculpture, altar, mosaic, painting …

DIN 276-1
500 C.G.



DIN 276-1

700 Additional costs
- **710** Owner responsibilities
  - 711 technical guidance, control
  - 712 program of functions and list of rooms; plant technology …
  - 713 management, project management
  - 719 other
- **720** Facility planning, preparation
  - 721 studies and analysis (soil mechanics, site, traffic analysis ..)
  - 722 cost, efficiency calculations
  - 723 site studies
  - 724 environmental impact studies
  - 725 competitions
  - 729 other

DIN 276-1

- **730** Architecture and engineering activities
  - 731 building design
  - 732 outdoor facilities
  - 733 interior design
  - 734 engineering and transport facilities
  - 735 structure planning
  - 736 building services engineering, building electricity
  - 739 other
- **740** Expert opinions
  - 741 energy
  - 742 acoustics
  - 743 soil mechanics
  - 744 alignment
  - 745 lighting design
  - 746 fire service
  - 747 accident and health service
  - 748 environment
  - 746 other

DIN 276-1

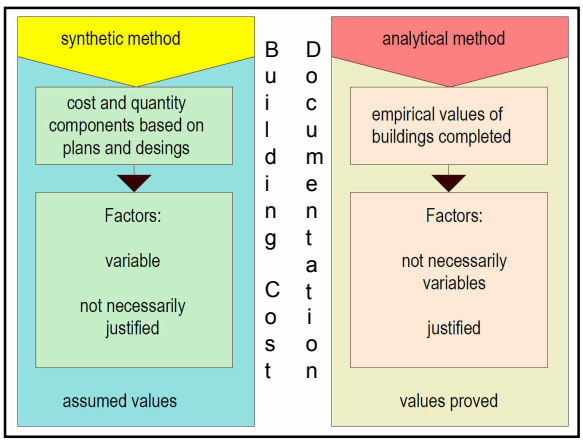
- **750** Art
  - 751 tendering of works of art
  - 752 pay for works of art
  - 759 other
- **760** Financing
  - 761 capital acquisition costs
  - 762 loan
  - 763 loss of interest
  - 769 other
- **770** General costs associated
  - 771 control, permits, receipt
  - 772 construction site operation
  - 773 sample costs (e.g. concrete strength test)
  - 774 test operation
  - 775 insurance
  - 779 other: reproduction, documentation, communication, foundation stone, etc..
- **790** Other additional costs

Building Cost Documentation

The data are set up on the one hand based on empirical values of buildings completed – *analitycal method* -,

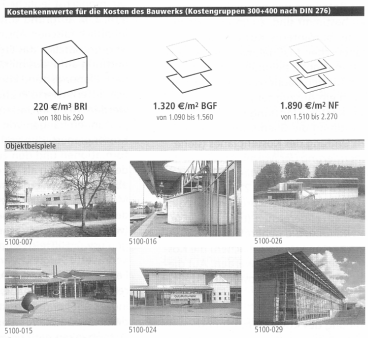
On the other hand based on forecasting made from plans, designs and standards (norms) – *synthetic method*.

The calculation of costs should take into account all factors which may impact on costs.



Building Cost Documentation

- Analytical method



BKI
(Baukosteninformations -centrum Deutscher Architektenkammern)

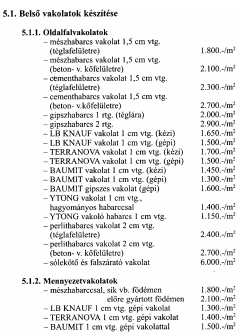
Unit costs for elements of buildings

Kostenkennw erte für Gebäude

50

Building Cost Documentation

- Synthetic method



5.1. Belső vakolatok készítése

5.1.1. Oldalfalvakolatok

– mészhabarcs vakolat 1,5 cm vtg. (téglafelületre)	1.800.-/m²
– mészhabarcs vakolat 1,5 cm vtg. (beton- v. kőfelületre)	2.100.-/m²
– cementhabarcs vakolat 1,5 cm vtg. (téglafelületre)	2.300.-/m²
– cementhabarcs vakolat 1,5 cm vtg. (beton- v.kőfelületre)	2.700.-/m²
– gipszhabarcs 1 rtg. (téglára)	2.000.-/m²
– gipszhabarcs 2 rtg.	2.900.-/m²
– LB KNAUF vakolat 1 cm vtg. (kézi)	1.650.-/m²
– LB KNAUF vakolat 1 cm vtg. (gépi)	1.500.-/m²
– TERRANOVA vakolat 1 cm vtg. (kézi)	1.700.-/m²
– TERRANOVA vakolat 1 cm vtg. (gépi)	1.500.-/m²
– BAUMIT vakolat 1 cm vtg. (kézi)	1.450.-/m²
– BAUMIT vakolat 1 cm vtg. (gépi)	1.300.-/m²
– BAUMIT gipszes vakolat (gépi)	1.600.-/m²
– YTONG vakolat 1 cm vtg., hagyományos habarccsal	1.400.-/m²
– YTONG vakoló habarcs 1 cm vtg.	1.150.-/m²
– perlithabarcs vakolat 2 cm vtg. (téglafelületre)	2.400.-/m²
– perlithabarcs vakolat 2 cm vtg. (beton- v. kőfelületre)	2.700.-/m²
– sólekötő és falszáraztó vakolat	6.000.-/m²

5.1.2. Mennyezetvakolatok

– mészhabarccsal, sík vb. fvldémen előre gyártott födémen	1.800.-/m² 2.100.-/m²
– LB KNAUF 1 cm vtg. gépi vakolat	1.300.-/m²
– TERRANOVA 1 cm vtg. gépi vakolat	1.400.-/m²
– BAUMIT 1 cm vtg. gépi vakolattal	1.500.-/m²

rch

Factors affecting the cost

- Independent factors not related to cost elements:
  - cyclical effect on the market (the date of execution)
  - regional market conditions (local price levels, degree of competition)
  - method of the competition,
  - type of construction contract,
  - the scale of the investment,
  - user requirements,
  - site conditions,
  - building geometry,
  - aesthetic and structural specialties.

Factors affecting the cost

- Cost element related factors,
  example: cost element: basement excavation
  - soil class ,
  - shape and depth of the excavation pit,
  - transport distance,
  - the building location (city, outer space),
  - type of ground support (slope, shotcrete, slurry wall, timber shoring ...),
  - type of dewatering (does not exist at all or exists..).

Price index

- The price index is given for the cost update.
  If you want to use data from more Building Cost Documentations you have to convert the data to a common price level.
- The prices are also used for forecasting.
  Example:
  conversion from 2002 to 2011 price level, if the base year is the 2005th (2005 = 100%)
  price level in 2002: 92.0
  price level in 2011: 118.0
  unit price in 2002: € 2,500,000
  unit price in 2011:
  2500000 x 118 / 92 = € 3,206,522

Sorting of the calculation methods

Function-orientated methods
- based on function-unit (for example workplaces, parking spaces or the number of hospital beds)
- based on useful basic area
- based on room-categories (the counting depends on only the program of rooms, the building's type is equal)

Building-orientated methods
- "two –factors methods"
- based on surface model
- by distribution to building construction units

Realization-orientated methods
- by distribution to work types
- based on specifications
- based on ABC-analysis

1. Function-orientated methods

Example:	based on function-unit	
Building type:	Office building average technical equipment	
Cost:	Total cost 100 cost group, without a plot	
Price Validity:	November 2002; Gross price	
300 work places x	50 000 €/work pl	15 000 000 €

1. Function-orientated methods

Example:	based on useful basic area	
Building type:	Office building average technical equipment	
Cost:	Building cost 300 + 400 Cost Group	
Price Validity:	November 2002; Gross price	
5 000 m2 useful basic area x	2 200 €/m2 =	11 000 000 €

1. Function-orientated methods

Example:	based on room-categories (DIN 277)	
Building type:	Office building average technical equipment	
Cost:	Building cost 300 + 400 Cost Group	
Price Validity:	November 2002; Gross price	
room category 1 (e.g. storage) 800 m2 x	1 550 €/m2 =	1 240 000 €
room category 2 (e.g. office space) 3 700 m2 x	2 250 €/m2 =	8 325 000 €
room category 3 (e.g. chamber) 400 m2 x	3 400 €/m2 =	1 360 000 €
room category 4 (e.g. kitchen) 100 m2 x	5 250 €/m2 =	525 000 €
room category 5 0 m2 x	7 700 €/m2 =	0 €
room category 6 0 m2 x	12 000 €/m2 =	0 €
Building cost:		11 450 000 €

2. Building-orientated methods

Example:	"two –factors method": unit area cost estimate	
Building type:	Office building average technical equipment	
Cost:	Building cost 300 + 400 Cost Group	
Price Validity:	November 2002; Gross price	
8 300 m2 gross floor area x	1 350 €/m2.gfa =	11 205 000 €

Example:	"two –factors method": unit volume cost estimate	
Building type:	Office building average technical equipment	
Cost:	Building cost 300 + 400 Cost Group	
Price Validity:	November 2002; Gross price	
28 000 m3 gross built up volume x	400 €/m3.gbv =	11 200 000 €

2. Building-orientated methods

Example:	"two –factors method": based in cost breakdown structure		
Building type:	Office building average technical equipment		
Cost:	Building cost 300 + 400 Cost Group		
Price Validity:	November 2002; Gross price		
building: 300 + 400 cost groups		100 %	11 450 000 €
200	Infrastructural facilities	5 %	572 500 €
300	Building – construction	80 %	9 160 000 €
400	Building – installation	20 %	2 290 000 €
500	Outdoor construction and installation	10 %	1 145 000 €
600	Furniture and artworks	2 %	229 000 €
700	Additional expenses	18 %	2 061 000 €
Total cost:		135 %	15 457 500 €

without the cost group 100 (Plot price or value)

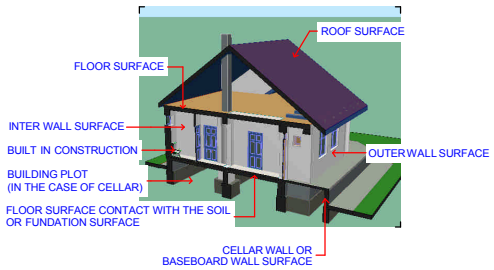
Example:		based on surface model	
Building type:		Office building	
		average technical equipment	
Cost:		Building - building constructions	
		Cost group 300	
Price Validity:		November 2002; Gross price	
310	Pit for basement level		
7 000	m2 x	40 €/m2 =	280 000 €
320	Foundation		
2 900	m2 x	290 €/m2 =	841 000 €
330	External walls		
5 600	m2 x	470 €/m2 =	2 632 000 €
340	Interior walls		
8 200	m2, gross floor area x	200 €/m2 =	1 640 000 €
350	Floors		
5 000	m2 x	290 €/m2 =	1 450 000 €
360	Roof		
3 400	m2 x	340 €/m2 =	1 156 000 €
370	Built-in appliances		
7 100	m2, useful floor area x	60 €/m2 =	426 000 €
390	Other measures related to building constructions		
8 200	m2, gross floor area x	60 €/m2 =	492 000 €
Total cost of Building - building constructions 300:			8 917 000 €

2. Building-orientated methods

61

Based on surface model

SURFACE UNITS



The shape of the buildings can be described with the main building units.

11/03/2011 (C)MSc. Arch. László Szőnyi 62

2. Building-orientated methods

Example:		by distribution to building function items	
Building type:		Office building	
		average technical equipment	
Cost:		Floors	
		Cost group 350	
Price Validity:		November 2002; Gross price	
351	slab structure		
5 200	m2 x	140 €/m2 =	728 000 €
352	floor covering		
4 300	m2 x	70 €/m2 =	301 000 €
353	ceiling cover		
4 000	m2 x	50 €/m2 =	200 000 €
359	other		
5 200	m2 x	20 €/m2 =	104 000 €
Total cost of Floors 350:			1 333 000 €

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2. Building-orientated methods

Example:		by distribution to building construction units	
Building type:		Office building	
		average technical equipment	
Cost:		Floor covering	
		Cost group 352	
Price Validity:		November 2002; Gross price	
352.01	concrete floor covering with anti-dust coating surface		
800	m2 x	30 €/m2 =	24 000 €
352.02	plastic floor covering		
2 600	m2 x	70 €/m2 =	182 000 €
352.03	ceramic tile (on the raw floor contsruction)		
600	m2 x	130 €/m2 =	78 000 €
352.04	stone		
300	m2 x	320 €/m2 =	96 000 €
Total cost of Floor covering 352			380 000 €

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Example:	conversion from building construction elements to the cost based on work type		
Building type:		Office building	
		average technical equipment	
Cost:		Floor covering	
		Cost group 352	
Price Validity:		November 2002; Gross price	
352.01	**concrete floor covering with anti-dust coating surface**		
800	m2 x	30 €/m2 =	24 000 €
352.01.025	Concreting work	80 %	19 200 €
352.01.034	Painters work	20 %	4 800 €
352.02	**plastic floor covering**		
2 600	m2 x	70 €/m2 =	182 000 €
352.02.025	Concreting work	40 %	72 800 €
352.02.036	Covering work	60 %	109 200 €
distribution the cost group 352 (floor covering) to work type			
352.01.025	Concreting work		92 000 €
352.01.034	Painters work		4 800
352.02.036	Covering work		109 200 €
Total cost of Floor covering 352.01 and 352.02:			206 000 €

3. Realization-orientated methods

Example:		by distribution to work types	
Building type:		Office building	
		average technical equipment	
Cost:		Cost group 300:	
		Building - building constructions	
Price Validity:		November 2002; Gross price	
300	**Building - building constructions**	**100 %**	**8 900 000 €**
300.000	Jobsite mobilization	5 %	445 000 €
300.001	Scaffolding works	1 %	4 450 €
300.002	Excavation	3 %	267 000 €
300.012	Masonry works	9 %	801 000 €
300.013	Concrete and reinforced concrete works	30 %	2 670 000 €
300.025	On-site concrete works	1 %	89 000 €
and so on			

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3. Realization-orientated methods

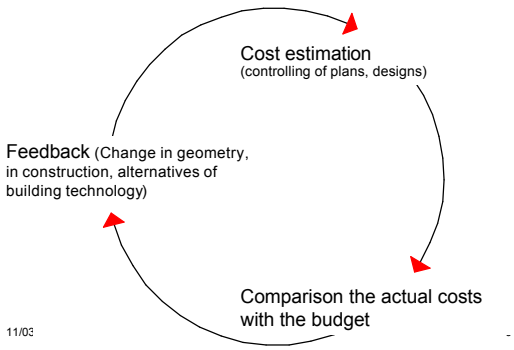
Example:		method based on specifications	
Building type:		Office building average technical equipment	
Cost:		On-site concrete works (WBS 025)	
Price Validity:		November 2002; Gross price	
Tételek:			
025.01	Floor, concrete		
700	m2 x	13 €/m2 =	9 100 €
025.02	Floating screed (floor)		
1 500	m2 x	16 €/m2 =	24 000 €
025.03	Floor, concrete to floor heating		
800	m2 x	35 €/m2 =	28 000 €
025.04	Reinforcing steel mesh		
2 300	m2 x	2 €/m2 =	5 290 €
Total cost of On-site concrete works (WBS 025):			66 390 €

Example:		method based on ABC-analysis	
Building type:		Office building average technical equipment	
Cost:		On-site concrete works (WBS 025)	
Price Validity:		November 2002; Gross price	
1.	**Development of the main work**		
025.01	Floating screed (floor), with reinforcing steel mesh		
0,20	h/m2 x	40 €/h =	8,00 €
	Material costs		8,00 €
	Reinforcing steel mesh		2,30 €
	Unit price of the main work		18,30 €
1 500	m2 x	18 €/m2 =	27 450 €
2.	**Aggregation of costs and calculation of the remaining part**		
025.01	Floating screed (floor), with reinforcing steel m		27 450 €
025.02	Floor, concrete		9 100,00 €
	Total cost of the main work:		36 550,00 €
	Cover of the remaining items (20% excess):		7 310,00 €
	Total cost of floor, concrete:		**43 860,00 €**

3. Realization-orientated methods
68

PROJECT STAGES	EXISTING DOCUMENTS, DATA	COST ESTIMATING AND CALCULATING METHODS
1. DEFINITION	LIST OF ROOMS, FUNCTIONS, REQUIREMENTS	BUDGET based on function-unit based on useful basic area based on room-categories "two –factors methods"
2. PLANNING, PRELIMINARY DESIGN	BUILD-UP IDEAS, SCECHES, FINAL PRELIMINARY DESIGN	COST ESTIMATION based on surface model
3. DESIGN AND BUILDING PERMIT	CONSTRUCTIONS, MATERIALS, DETAILS, PRESCRIPTIONS	COST ESTIMATION by distribution to building construction units
4. DESIGN - FINAL COSTRUCTION DRAWING	DETAILS, FINAL SOLUTIONS	COST ESTIMATION method based on specifications
5. COMPETITION, PUBLIC PROCUREMENT	SPECIFICATIONS, CONTRACTOR BIDDINGS	COST ESTIMATION by distribution to work types
6. CONSTRUCTION AND SUPERVISION	BILLS, DATA REALISED	COST CONTROLL based on bills
7. DOCUMENTATION		UPDATING COST DOCUMENTATION

System of cost management



11/03

1st phase: Cost estimation

- It is important to keep the participants of the investment in intensive connection
- Have to determine the target planned
- Have to make the designs
- Have to organise competition for the constaction

Cost estimation always must be synchronised with the design.

2nd phase: Comparison the actual costs with the budget

- The costs as they actually occur are continuously compared with the budget.

- Cost reports are prepared at regular time intervals. (making it possible for the owner to determine the cost status of the project)

•Information in proper time is required if effective action against cost overruns is to be taken.

3rd phase: Feedback

• Significant differences lead to change of the designs.

• Management consideration is quickly focused on those job areas that need attention.

•Prefering the alternative biddings at the competition is suggested.

Criteria

• Using such a cost estimating method, that we can use in each project stages.
• Data could be transported to one project phase to the other.
• Systematic Work Breakdown Structure of the costs.
• Use of project cost code.
• Documentation of cost data of buildings accomplished.
• Use of Building Cost Documentation with data of analyzed method.
• Treatment of costs: both direction among the project phases.

Thank you very much for your attention.

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