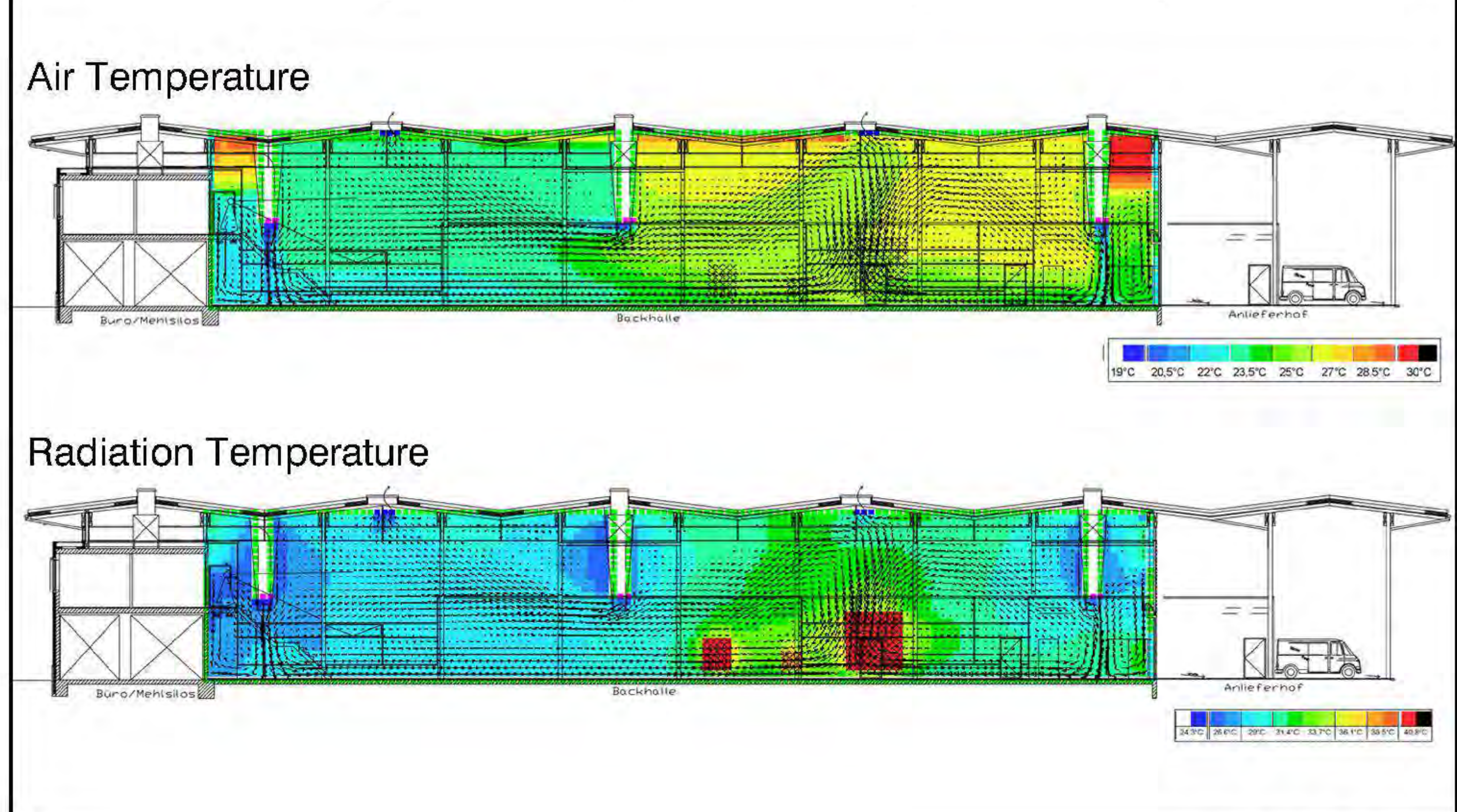


# Example - Energy Optimisation at an Industrial Bakery

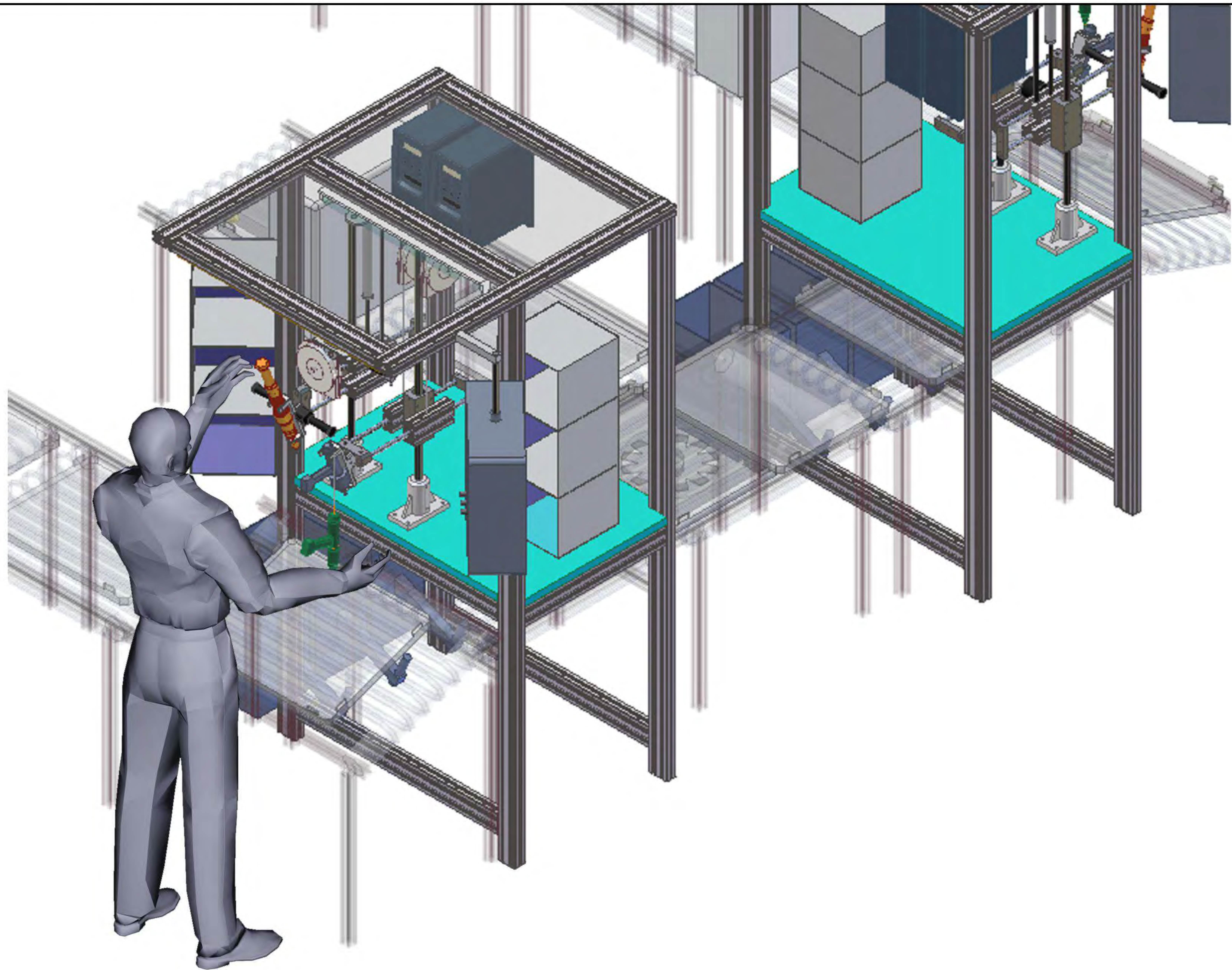
Energy Balance			
Thermal Loads in Hall	Qel [ kW ]	Waste Heat [ % ]	Thermal Load [ kW ]
<b>Mixing Dough</b>			
Mixing Weighing	2	0,22	0,44
Kneading	30	0,09	2,70
<b>Processing Doug</b>			
Roll Divider Rounder	11,5	0,13	1,50
Press	1	0,28	0,28
Dough Divider	2	0,22	0,44
Dough Divider	5,5	0,15	0,83
<b>Fried Pastries</b>			
<b>Confectionery</b>			
<b>Miscellaneous</b>			
<b>Fermentation Room</b>			
<b>Total [ kW ]</b>			<b>19,93</b>
Area [ m <sup>2</sup> ]	816		
Synchrony	0,8		
<b>Total specific Energy [ W/m<sup>2</sup> ]</b>			<b>19,54</b>

Lower annual Energy Requirement				
	Heating Performance		Ventilation Annual Need	
	Perform. in kW	Annual Need in kWh/a*m <sup>2</sup>	Perform. in kW	Annual Need in kWh/a*m
<b>Starting Situation</b>	90	32	192	576
<b>Optimised Situation</b>	34	31	117	449
<b>Improvement in Percent</b>	62 %	4 %	39 %	22 %



FM - figure 2.19

# Simulation of Assembly Workstation, Example



# Table of Indices - Benchmarking regarding Real Estate, Example

[ according to Neumann ]

## Building Economy

- site occupancy index
- gross cubage
- primary usable floor area
- net floor area

## Space Provision Costs

- interests
- rents
- lease payments
- taxes
- duties
- insurances

## Operating Costs

- administration costs
- cleaning costs
- technical operations / building maintenance
- safty
- disposal

according to  
DIN Stand. 18960

## Consumption

- water
- waste water
- cooling water
- heat energy
- air conditioning
- operational electricity
- rental of devices ( e.g. meters )
- costs for reading the meters and distributing the share of costs

## Infrastructural Costs

- area management
- communication
- EDP
- catering
- fleet
- in-house print shop
- copy service
- typing service
- medical service

# Types of Areas according to DIN Standard 277

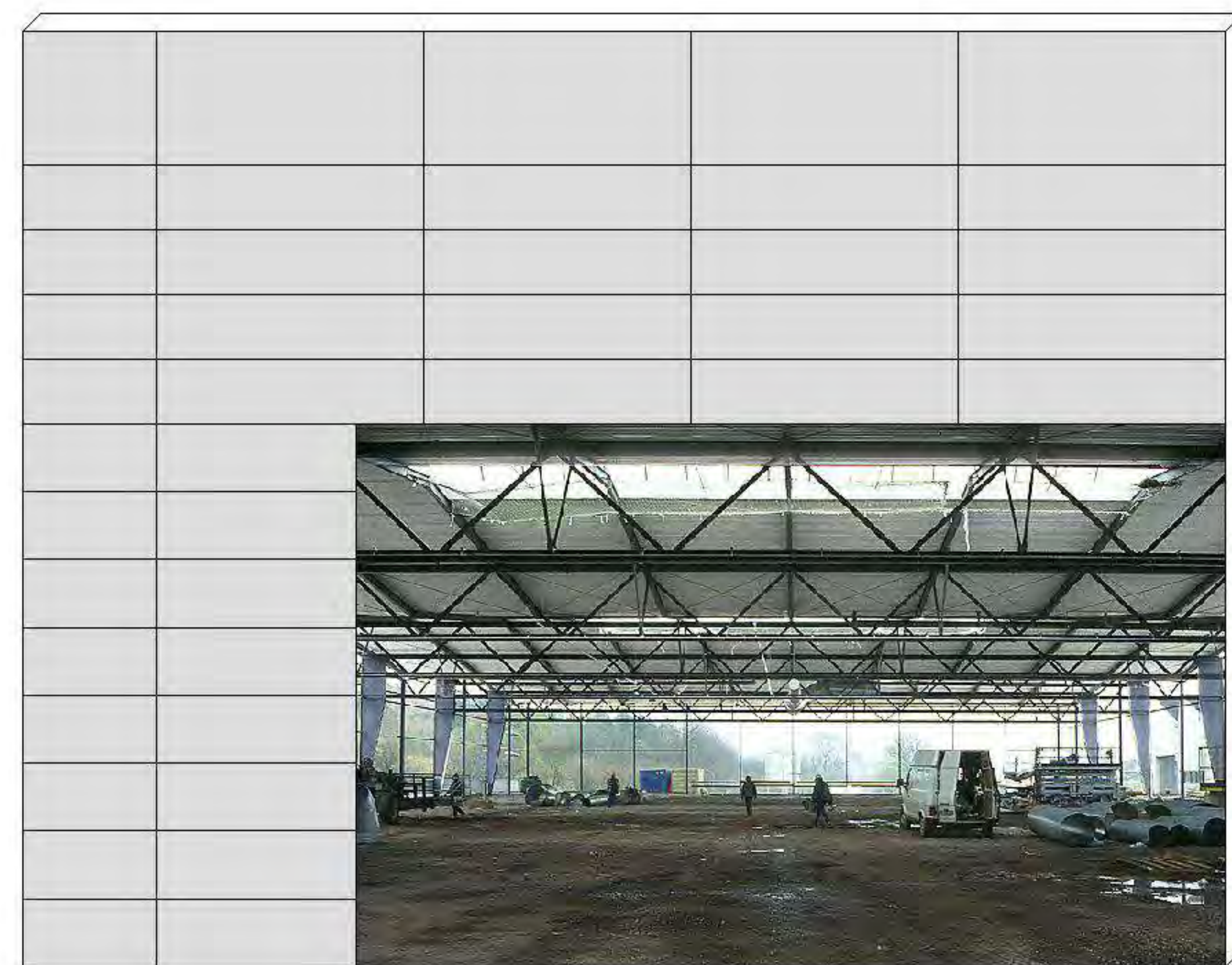
<b>Gross Floor Area</b>	Gross Floor Area is the total of all areas of all floors within a building. Excluded are such areas of unusable roofs and constructive voids. Gross floor area is subdivided into construction area and net floor area.
<b>Gross Cubage</b>	Gross Cubage is the built volume, its bottom limit being underside the bottom slab and its other limits being the outline of exterior walls/roofs.
<b>Operational Area</b>	Operational Area is regarded as that part of net floor area which houses central operational equipment within a building. Provided that it is a building's purpose to house one or more parts of operational equipment which serve for supply and disposal of other buildings.
<b>Construction Area</b>	Construction Area is the total of all areas that are covered by rising constructional elements on all floors within a building, e.g. walls, columns. Construction Area includes such areas covered by chimneys, non-accessible cores, doorways, recesses as well as slots.
<b>Net Floor Area</b>	Net Floor Area is the total of usable areas between rising constructional elements of all floors within a building. Net Floor Area also comprises those areas of open installations and fixtures.
<b>Net Cubage</b>	Net Cubage is the total of all volumes of all rooms whose area is included in net floor area.
<b>Usable Area</b>	Usable Area is that part of net floor area that provides for a building's purposeful utilisation. Usable area is subdivided into primary usable area and secondary usable area.
<b>Traffic Area</b>	Traffic Area is that part of net floor area that provides for access to rooms, traffic within the building and leaving the building in case of emergency. Areas needed for moving within rooms that count as usable or operational area, e.g. paths between furniture, do not count as Traffic Area.

# Comparing Utilisation Indices regarding Administration Buildings

Values (1999) Relatings to Gross Floor Area, Indices/Unit	Best Values		Worst Values		Average Value
• Building Maintenance and Repair (DM p.a.)	9,49	10,24	23,85	24,53	16,06
• Heat Energy Consumption (kWh p.a.)	77,25	79,42	99,63	114,04	89,04
• Consumption of Electricity (kWh p.a.)	18,15	23,60	31,03	62,29	30,99
• Water Consumption (cbm p.a.)	0,14	0,15	0,19	0,39	0,20

according to:  
 Leitfaden Gebäude- und Liegenschaftsmanagement in Kommunen  
 Osttd. Sparkassen- und Giroverband 2002

# Catalogue of Requirements, Performance Characteristics of Building Structure



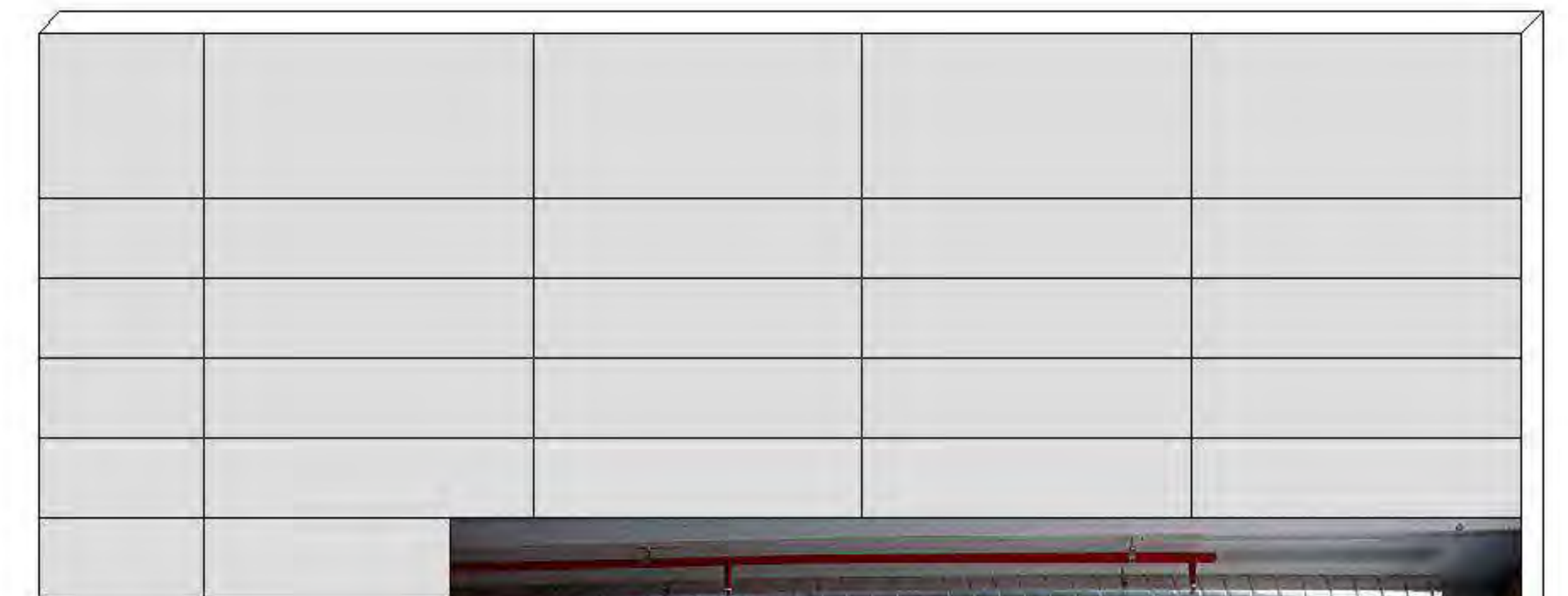
- Load Bearing Structure



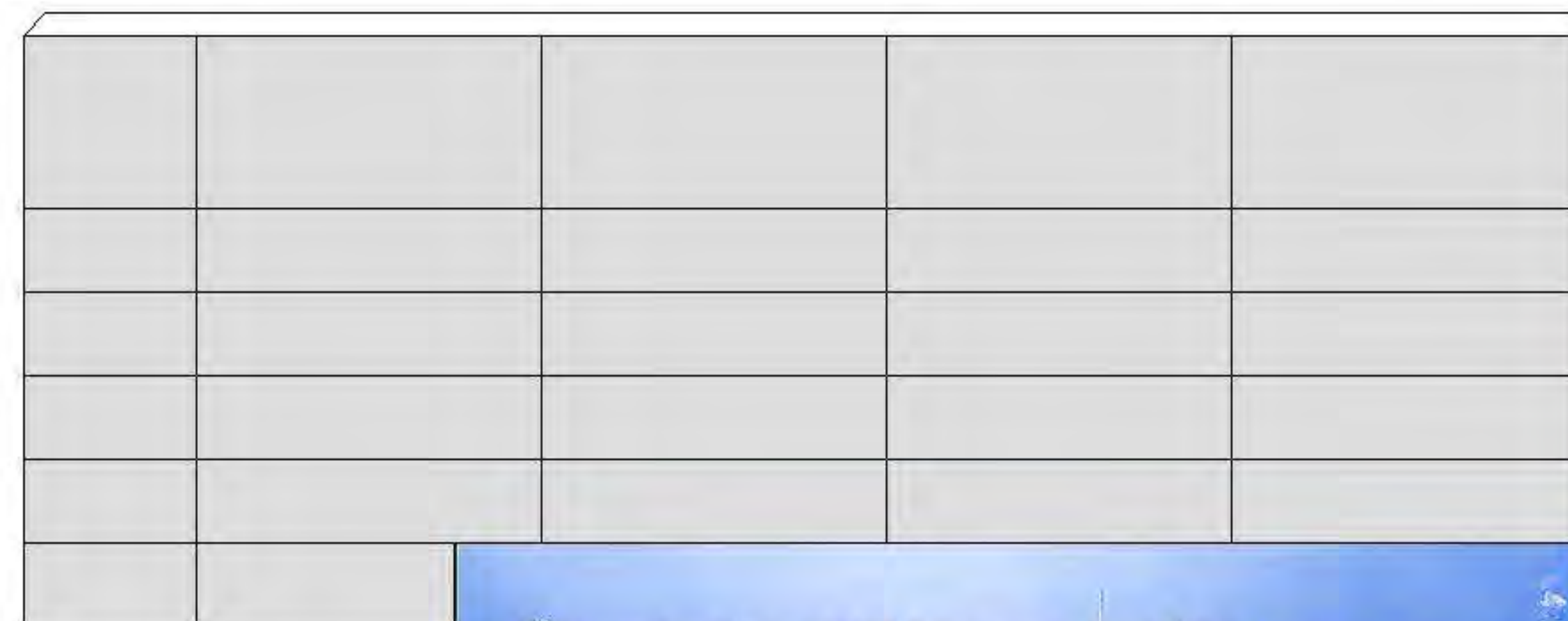
- Outer Shell



- Media



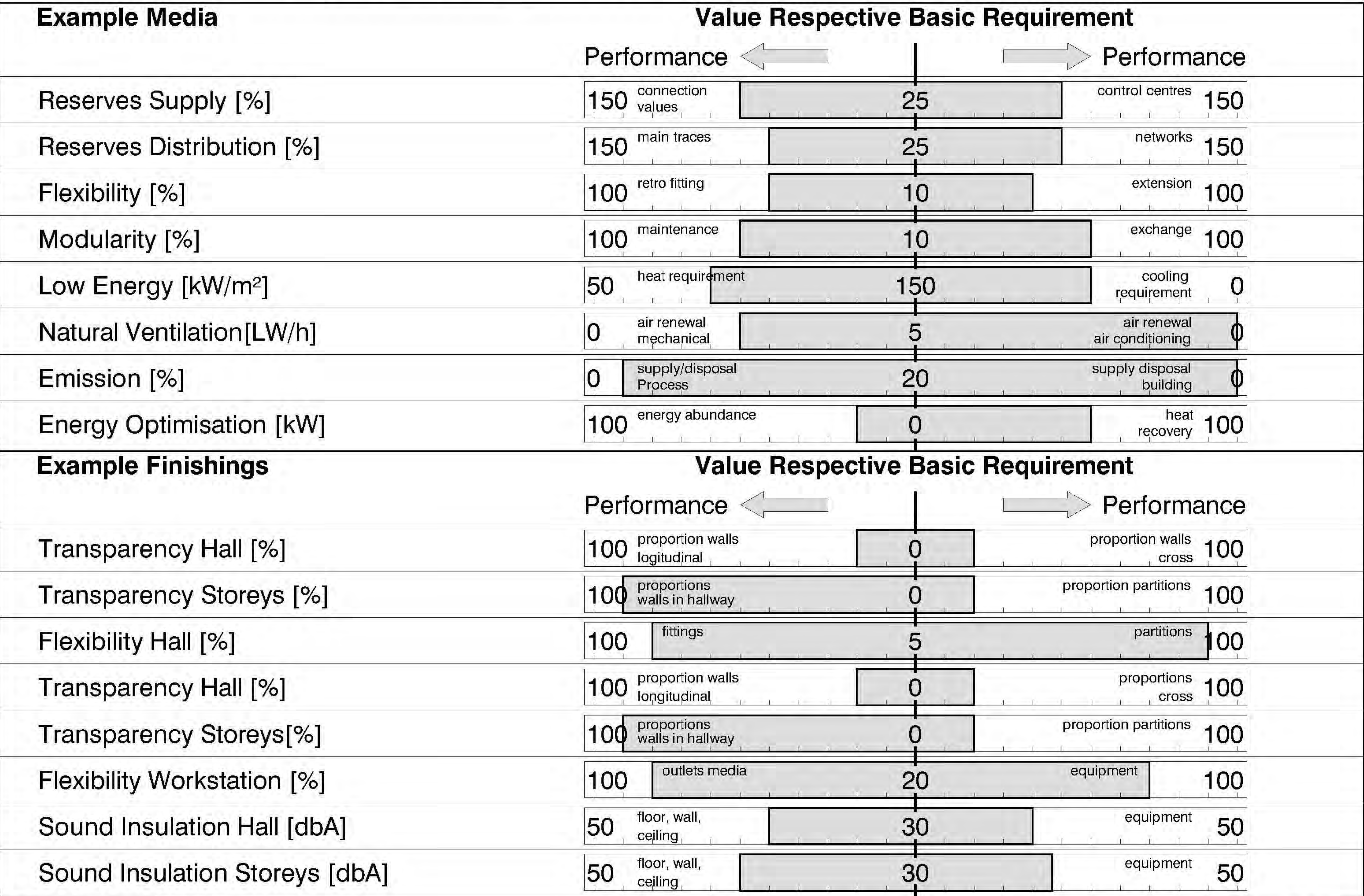
- Finishings



# Examples - Performance Diagrams Load Bearing Structure, Outer Shell

Example Load Bearing Structure	Value Respective Basic Requirement	
	Performance ←	→ Performance
Column Grid Hall [m]	60 longitudinal	5 cross 60
Column Grid Storeys [m]	30 longitudinal	5 cross 30
Live Loads [kN/m <sup>2</sup> ]	3 ceiling	0.5 bottom slab 8
Special Load Areas [kN/m <sup>2</sup> ]	3 control centre	0.5 machine 8
Suspended Loads [kN/m <sup>2</sup> ]	3 media traces	0.5 materials handling 25
Clearances Hall [m]	15 bottom level	5 bottom level 15
Clearances Storeys [m]	5 load bearing structure	2.5 roof 5
Extension/Option [Direction]	hall	0 hall
Example Outer Shell	Value Respective Basic Requirement	
	Performance ←	→ Performance
Compactness	0.4 surface/cubature horizontal	0.2 surface/cubature vertical 0.1
Thermal Protection [kW]	0.4 outer shell hall	0.8 outer shell storeys 0.4
Flexibility [%]	100 gates relocating	0 windows/doors relocating 100
Daylight [lux]	1000 hall	0 storeys 1000
Smoke and Heat Venting [%]	5 hall	0.5 storeys 5
Sound Insulation [dbA]	55 hall closed	30 hall open 55
Fire Protection/Security [Min]	180 facade	0 roof 180
Ecology [%]	100 green façade	0 green roof 100

# Examples - Performance Diagrams Media, Finishings



FM - figure 2.26



# Distinction of FM-Data, Examples

[ according to GEFMA 400 ]

## Inventory Data

- CAD - Data
- Room Specifications

## Status Data

- Operating Statuses
- Notices for Malfunction
- Danger Alarms

## Consumption Data

- Energy Consumption
- Automatic Meter Reading
- manual Meter Reading

## Performance Catalogues

- Tender for Industrial Cleaning

## Workflow Data

- Regular Evaluation of Indices

## Buisness Data

- Tenancy Agreements
- Prices for Catering

# Layer-Structure, Example

<b>Site</b>	11	Cadastral Boundaries	<u>c</u> adastral bound. / <u>r</u> equired set-rack line	<u>d</u> (Documents)	yellow
	12	Roads, Sealed Surfaces	<u>r</u> oads / <u>p</u> aths / <u>c</u> arparks / <u>f</u> encing		yellow
	13	Topographic Lines	<u>t</u> opographic <u>l</u> ines		white
	14	Building Outline	<u>e</u> xisting / <u>n</u> ew <u>b</u> uildings		cyan
	15	Plantation	<u>t</u> rees / <u>b</u> ushes		white
	16	Greens	<u>l</u> awn / <u>s</u> hrubs		white
	17	Water	<u>l</u> akes / <u>p</u> onds / <u>r</u> ivers / <u>s</u> treams		cyan
	18	Rails	<u>d</u> b / <u>p</u> ublic <u>t</u> ransport / <u>f</u> actory <u>o</u> wned		cyan
	19	Symbols			
	20	n.n.			
<b>Load Bearing Structure</b>	21	Bottom Slab/ Foundations	<u>b</u> ottom <u>s</u> lab / <u>f</u> oundations	<u>d</u> (Documents)	yellow
	22	Ceilings	<u>c</u> eilings		red
	23	Roofs	<u>r</u> oofs		white
	24	Columns	<u>m</u> ain <u>c</u> olumns / <u>s</u> econdary <u>c</u> olumns		yellow
	25	Load Bearing Structure	<u>m</u> ain girders / <u>s</u> econdary girders		yellow
	26	Walls Exterior	<u>b</u> rickwork / <u>c</u> oncrete		yellow
	27	Walls Interior	<u>b</u> rickwork / <u>c</u> oncrete		yellow
	28	External Staircase	<u>e</u> xternal <u>s</u> taircase		
	29	Symbols			
	30	n.n.			
<b>Outer Shell</b>	31	Roof Lights	<u>s</u> moke and heat <u>v</u> enting system <u>d</u> omes	<u>d</u> (Documents)	white
	32	Roof Membranes / Coverings	<u>r</u> oof <u>c</u> onstr. / <u>c</u> overing / <u>g</u> reen / proj. r.		white
	33	Facade, Closed	<u>s</u> andwich wall elements / <u>p</u> anels		white
	34	Facade, Transparent	<u>s</u> tructural <u>g</u> lasing / <u>c</u> ast <u>g</u> lass		green
	35	Facade, Windows	<u>t</u> ilt-and-turn <u>w</u> indow / <u>t</u> op-hung <u>w</u> indow		cyan
	36	Sun-Protection Devices	<u>v</u> ertical / <u>b</u> linds		white
	37	Doors	<u>e</u> ntries / <u>e</u> mergency <u>e</u> xits		cyan
	38	Tore	Gliedertore / Schnellauftore /		white

# Layer-Structure Building Services (HVAC/R), Example

		Location			
		Building			
		Function / Process			
CAD - Construction: Example Layers Industry Project		Building Services			
<b>Building Services (HVAC/R)</b>	61	Sprinkler	<u>s</u> prinkler	<u>c</u> (contr.cent.)	green
	62	Ventilation	<u>v</u> entilators, <u>s</u> upply air, <u>e</u> xtracted air, <u>o</u> uter <u>a</u> ir, <u>e</u> xhaust <u>a</u> ir	<u>t</u> (traces) <u>n</u> (networks) <u>o</u> (outlets) <u>d</u> (documents)	green red yellow green yellow
	63	Heating	<u>f</u> low, <u>r</u> eturn, <u>r</u> adiators		red blue red
	64	Waste Water	<u>f</u> oul <u>w</u> ater		blue
	65	Sanitary Installation	<u>s</u> upply <u>p</u> ipe, <u>h</u> ot <u>w</u> ater, <u>c</u> old <u>w</u> ater, installations		40 red green white
	66	Compressed Air	<u>c</u> ompressed <u>a</u> ir		red
	67	Roof Drainage	<u>r</u> ain <u>w</u> ater		160
	68	Gas	<u>g</u> as <u>p</u> ipe		yellow
	69	Symbols			
	70	n.n.			

## - Data Format

- alphanumeric data
  - documents, tables
- vector graphic data
  - 2D, 3D
- pixel graphic data  
bitmaps
  - graphics, photos,  
videos

## - Frequency of Change

- on short notice
  - notices of malfunction
- daily
  - operating hours
- weekly
  - consumption data
- monthly
  - personnel data
- regular
  - CAD  
drawing data

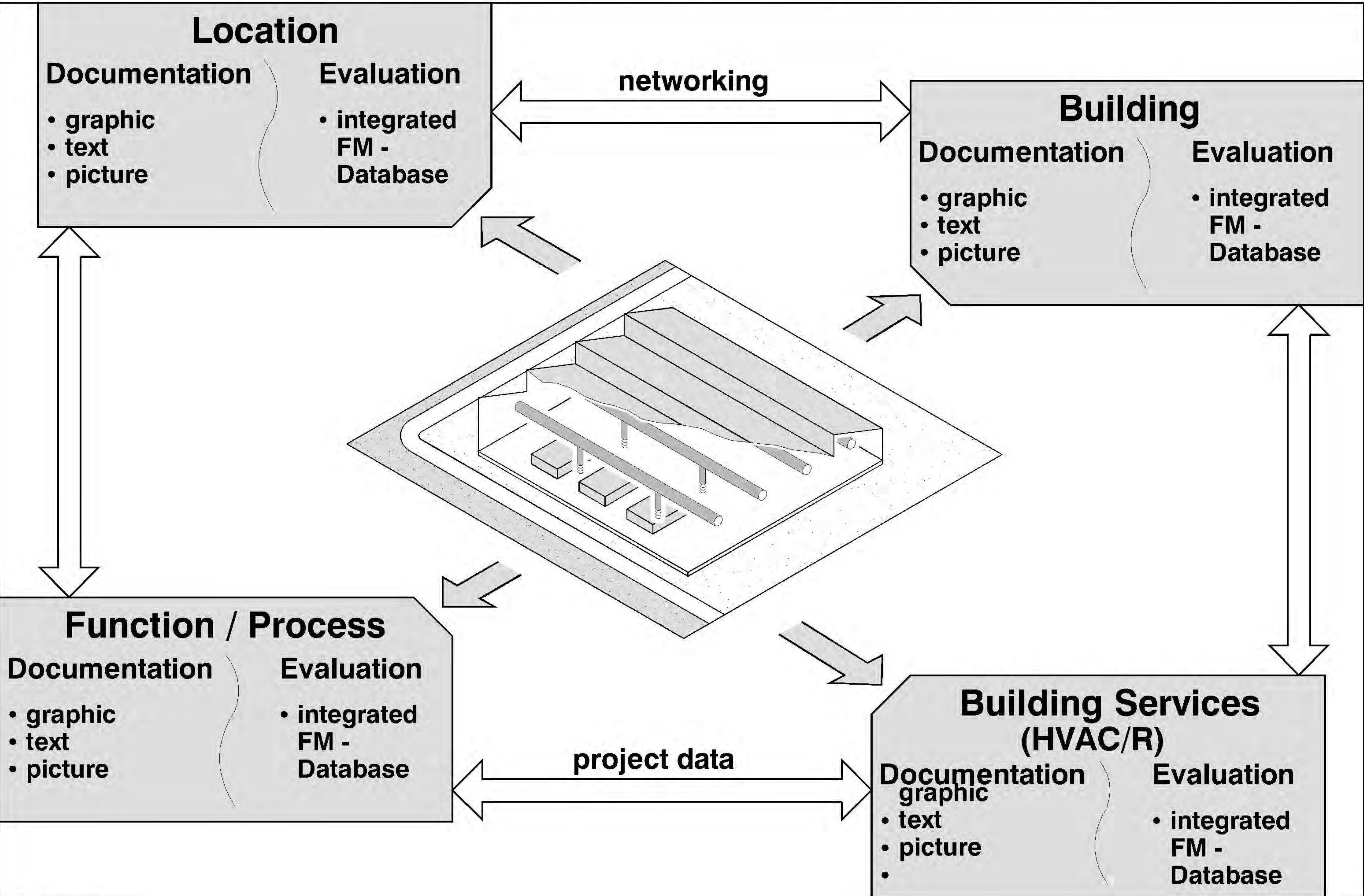
# Planning Data comprised in Room Specifications, Example

Use / Geometry		Finishings Room / Cost Group									Finishings Building Services					
Element	Sub-Elem	Fl. Area	Height	Wa. Surf	Win. Surf	Type	Opening	Floor	Wall	Ceiling	Equipment	Requir. Room	Floor	Wall	Ceiling	Equipment
	<b>Production</b>	4605,0	6,85			T 1.1		Epoxidharzbs.	St.B.Socket	Stahlfachwerk		Temp:		Bel. Tableau	Sprinkler	Zu-und
			3,50			T3.1		Gabelst. 1,5 to	Metallsandw.	Trapezblech		> 19 ° C		6x 230V / 10 A	Hallenreflekt.	Abluftanlage
						Tor1.2		Ehubwa. 1,5 to	glatte, abwas.	nachträgl.		Luftw:		6x 400V / 16 A	leuchten300lx	Normalbetrieb
						Tor1.3		desinfizierbar	Oberflächen	Einbau		V90.000m3/h		6x 400V / 32 A	Kabelbühnen	mit 100%AUL
						F1.1		Nasswischger.	Fenst.bänder	raumabschl.				2x 400V / 63 A	Notbeleuchtg	Wochenendb.
								R10, ch.Res.		Unterh.decke					Rettgs.zeichen	mit 100%UML
								Sockel 3 cm		möglich						E-Zuleitung f.
								Perimeter6cm								Fertigungslin.
								optional R.B.								
								Feinsteinzeug								
	<b>Disp.Departm.</b>	458,7	6,85			T 1.1		Epoxidharzbs.	St.B.Socket	Stahlträger	4 Thermo-	Temp:		Lichschalter aP	Sprinkler	Deckenluft-
						Tor1.1		Gabelst. 1,5 to	Metallsandw.	Trapezblech	schleusen	> 19 ° C		Zul. Torantriebe	Hallenreflekt.	erhitzer
						Tot1.3		Ehubwa. 1,5 to	glatte, abwas.		2 Thermo-	Luftw: 2-fach		Bel.über Tore	leuchten300lx	100%UML
						F1.1		desinfizierbar	Oberflächen		schleusen	durch freie		4x Netzwerkans	Kabelbühnen	1xDruckluftans.
								Nasswischger.	Fenst.bänder		Jumbo	Lüftung		4x 400V / 16A	Notbeleuchtg	1/2"
								R10, ch.Res.				(Tore)		14x 230V / 10 A	Rettgsz.eichen	
								Sockel 3 cm						8x 230vV/ 10 A		
								optional R.B.						Ans. Torabsich.		
								Feinsteinzeug						2x 400V / 32 A		
	<b>Store</b>	90,0	6,85			T3.1		Epoxidharzbs.	St.B.Socket	Stahlfachwerk	Beh.vol. 1000 l	Temp:		Lichschalter aP	Sprinkler	Zu-und
						Tor1.3		Prüfz. WHG	Metallsandw.	Trapezblech		> 19 ° C		Steckdosen	Hallenreflekt.	Abluftanlage
								Gabelst. 1,5 to	glatte, abwas.	nachträgl.		Luftw:			leuchten300lx	Normalbetrieb
								Ehubwa. 1,5 to	Oberflächen	Einbau					Kabelbühnen	mit 100%AUL
								desinfizierbar	Fenst.bänder	raumabschl.					Notbeleuchtg	Wochenendb.
								Nasswischger.		Unterh.decke					Rettgsz.eichen	mit 100%UML
								R10, ch.Res.		möglich						E-Zuleitung f.
								Sockel 3 cm								Fertigungslin.
								Perimeter6cm								
								optional R.B.								
	<b>Adaptor 1</b>	322,8	6,85			T 1.1		Stahlbeton	St.B.Socket	Stahlträger		Temp:		2x 230vV/ 10 A	Sprinkler	Deckenluft-
						Tor1.2		Flügelglättung	Metallsandw.	Trapezblech		15 ° C		2x 400V / 10 A		erhitzer
						Tor 1.4		Hartstoffschicht	glatte, abwas.			Luftw: 0,5-fach		1x 400V / 10 A	Lichtband	100%UML
						F1.1			Oberflächen			durch freie			Notbeleuchtung	
									Fenst.bänder			Lüftung				
												(Tore)				
	<b>Adaptor 2</b>	280,5	4,00			Tor1.4		Stahlbeton	St.B.Socket	Stahlträger		Temp:		2x 230vV/ 10 A	Sprinkler	Deckenluft-
						Komplettelem.		Flügelglättung	Metallsandw.	Trapezblech		15 ° C		2x 400V / 10 A		erhitzer
						T 90		Hartstoffschicht	glatte, abwas.			Luftw: 0,5-fach		1x 400V / 10 A	Lichtband	100%UML
									Oberflächen			durch freie			Notbeleuchtung	(wird von
									Fenst.bänder			Lüftung				Hochregallager

# Contents of Building Documentation

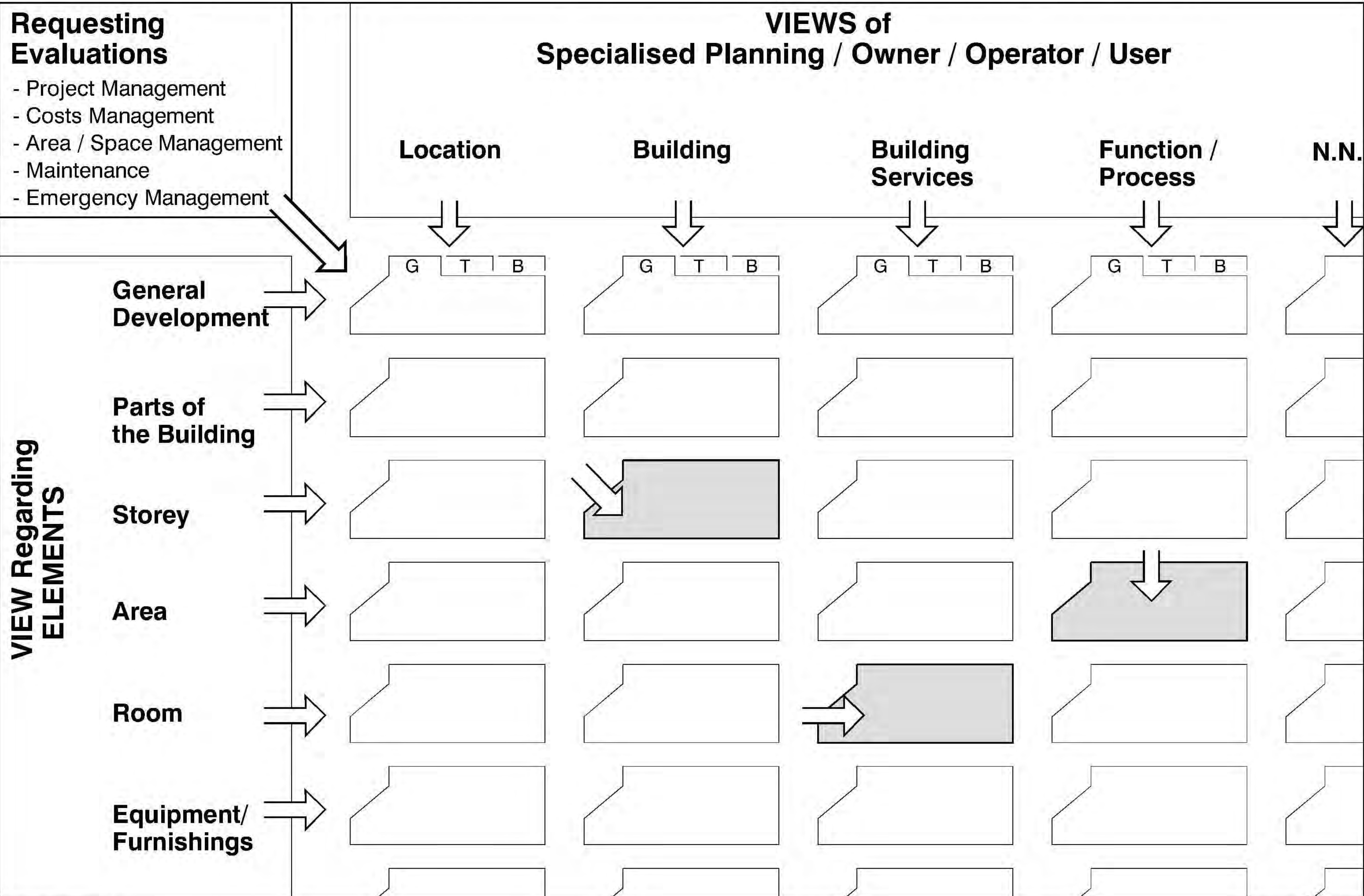
Documentations Structur	Plans, Building Model	Catalogues	Job Descriptions	Dokumentation of Procedures	Costs and Accounting
<ul style="list-style-type: none"> <li>• Directories</li> <li>• Identification Systems</li> <li>• Formats</li> </ul>	<ul style="list-style-type: none"> <li>• Location               <ul style="list-style-type: none"> <li>- land register</li> <li>- supply, disposal</li> <li>- open spaces</li> </ul> </li> <li>• Building               <ul style="list-style-type: none"> <li>- floor plans</li> <li>- sections</li> <li>- evaluations</li> <li>- details</li> </ul> </li> <li>• Building Services               <ul style="list-style-type: none"> <li>- media</li> <li>- control centres</li> <li>- traces</li> <li>- networks</li> <li>- outlets</li> </ul> </li> <li>• Equipment               <ul style="list-style-type: none"> <li>- furniture</li> <li>- process</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Room Specification</li> <li>• Calculations</li> <li>• Systems/ Equipment</li> <li>• Documentation</li> <li>• Product Datasheets</li> </ul>	<ul style="list-style-type: none"> <li>• Building Site Diary</li> <li>• Inspection</li> </ul>	<ul style="list-style-type: none"> <li>• Building Application</li> <li>• Tender</li> <li>• Quotes/ Offers</li> <li>• Audit Reports</li> <li>• Final Acceptance of Construction Work</li> </ul>	<ul style="list-style-type: none"> <li>• Final Payments for Construction</li> <li>• Payments to suppliers and Disposal Contractors</li> </ul>

# FM Location, Building, Building Services (HVAC/R), Equipment, Specialised Views



FM - figure 3.07

# Integrated FM-Data Model, Filing and Evaluation according to Views



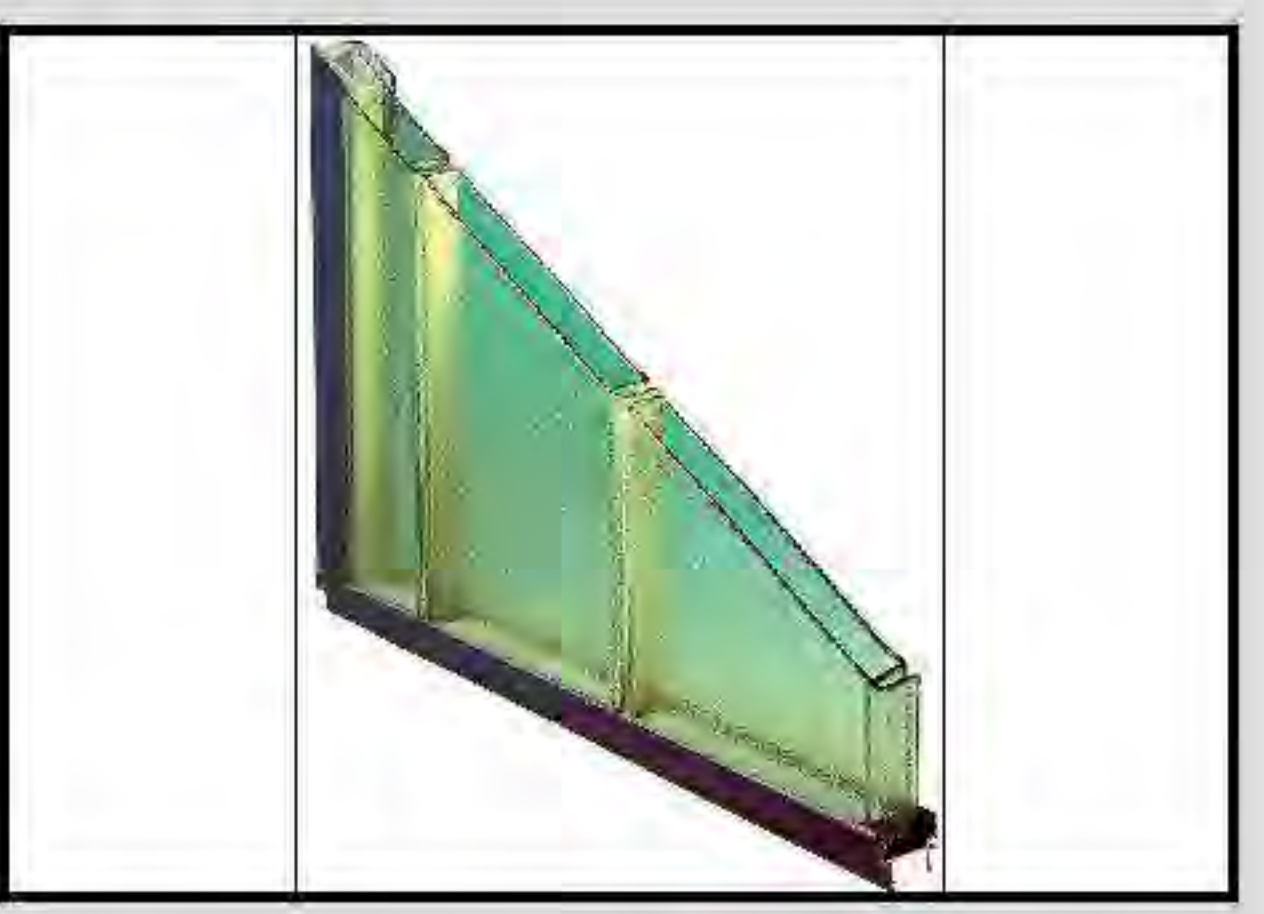
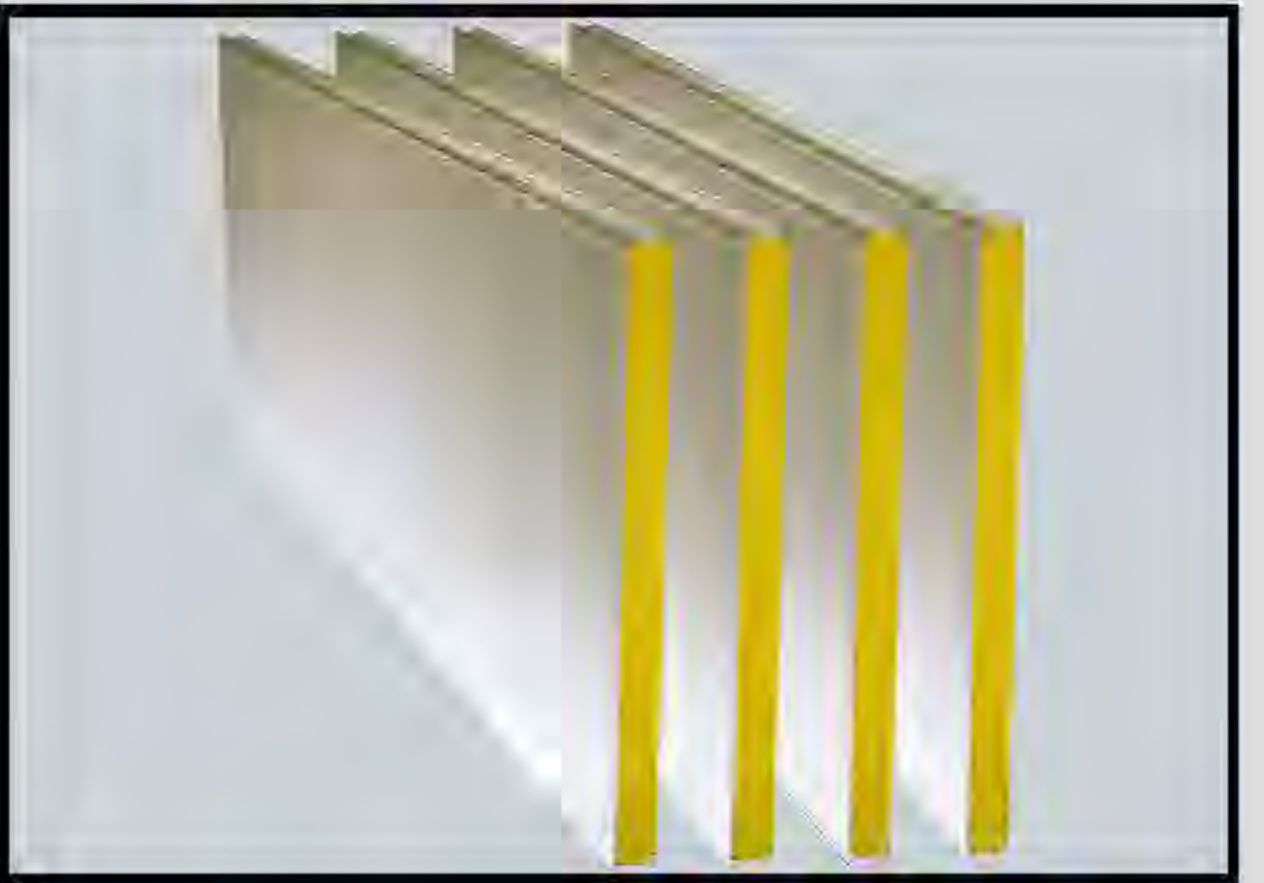


# Integrated FM-Data Model, Example of File Module, Graphic, Text, Picture

- access / evaluation at any time  
to up-to-date graphic / text / picture  
filing module FM-Database

## Picture

e.g.  
pictures, bmp  
product datasheets



## Text

e.g.  
text  
Word / Excel

	A	G	S
1. Beschreibung	20	40	50
2. Material	---	---	---
3. Maße	40	50	60
4. Gewicht	10	20	30

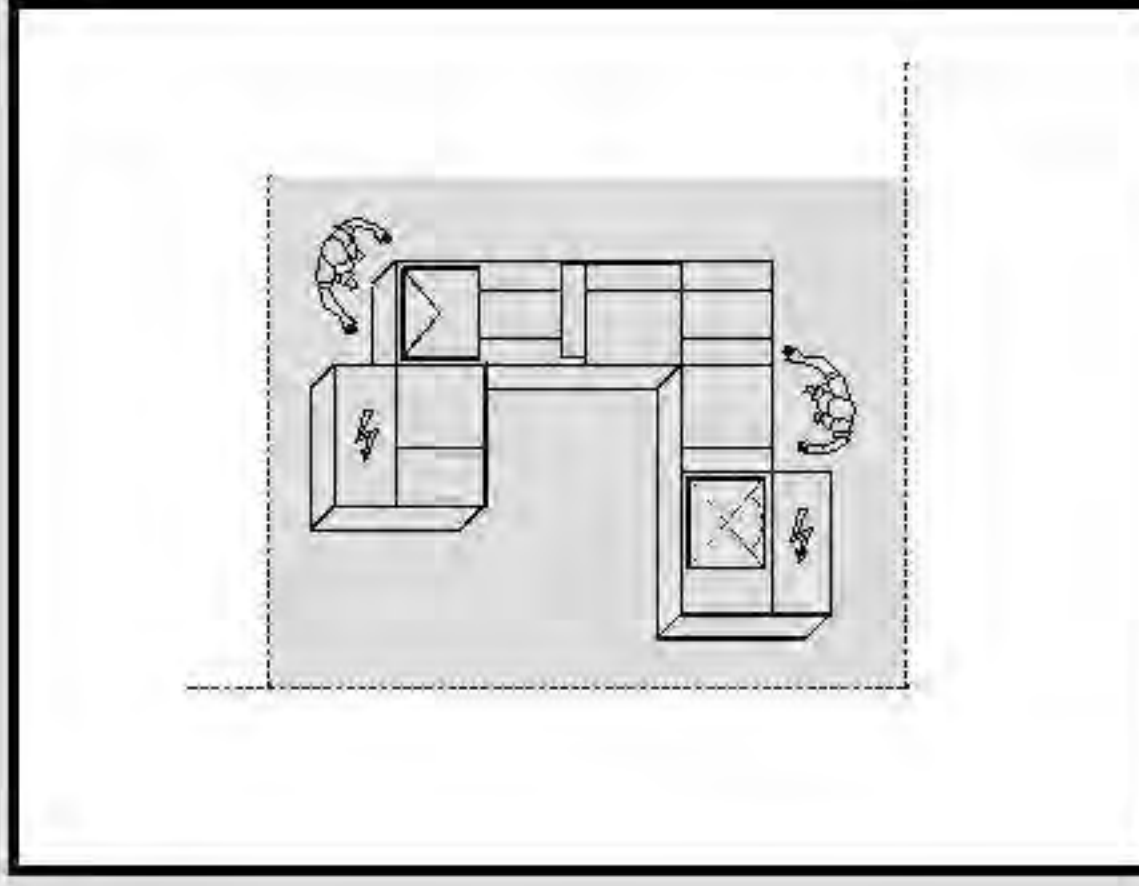
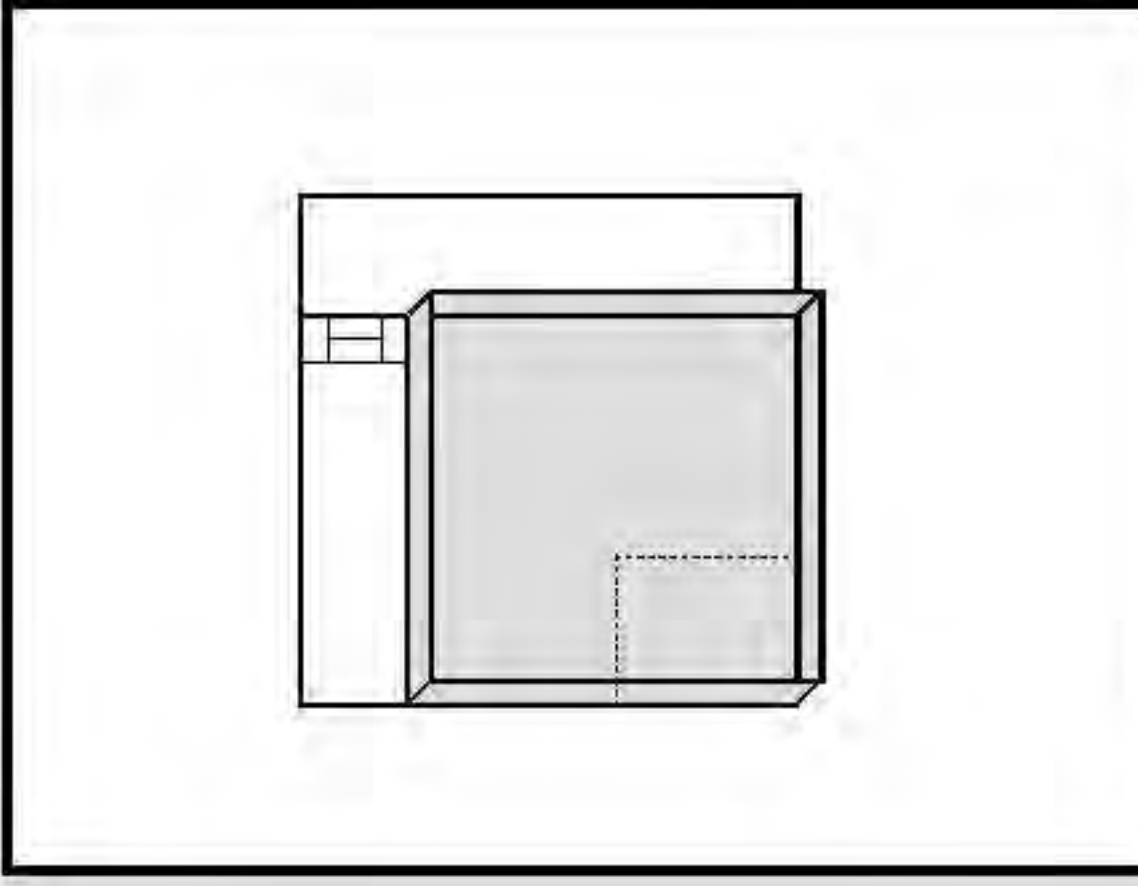
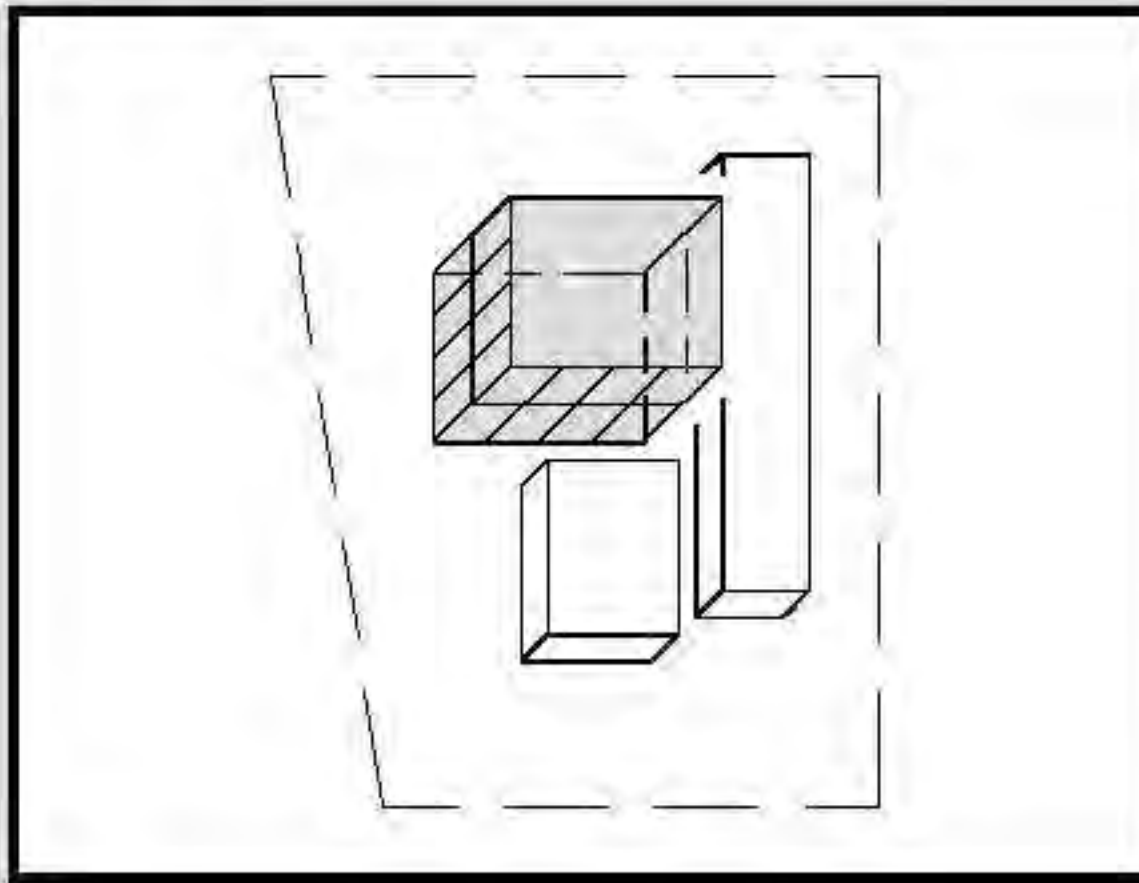
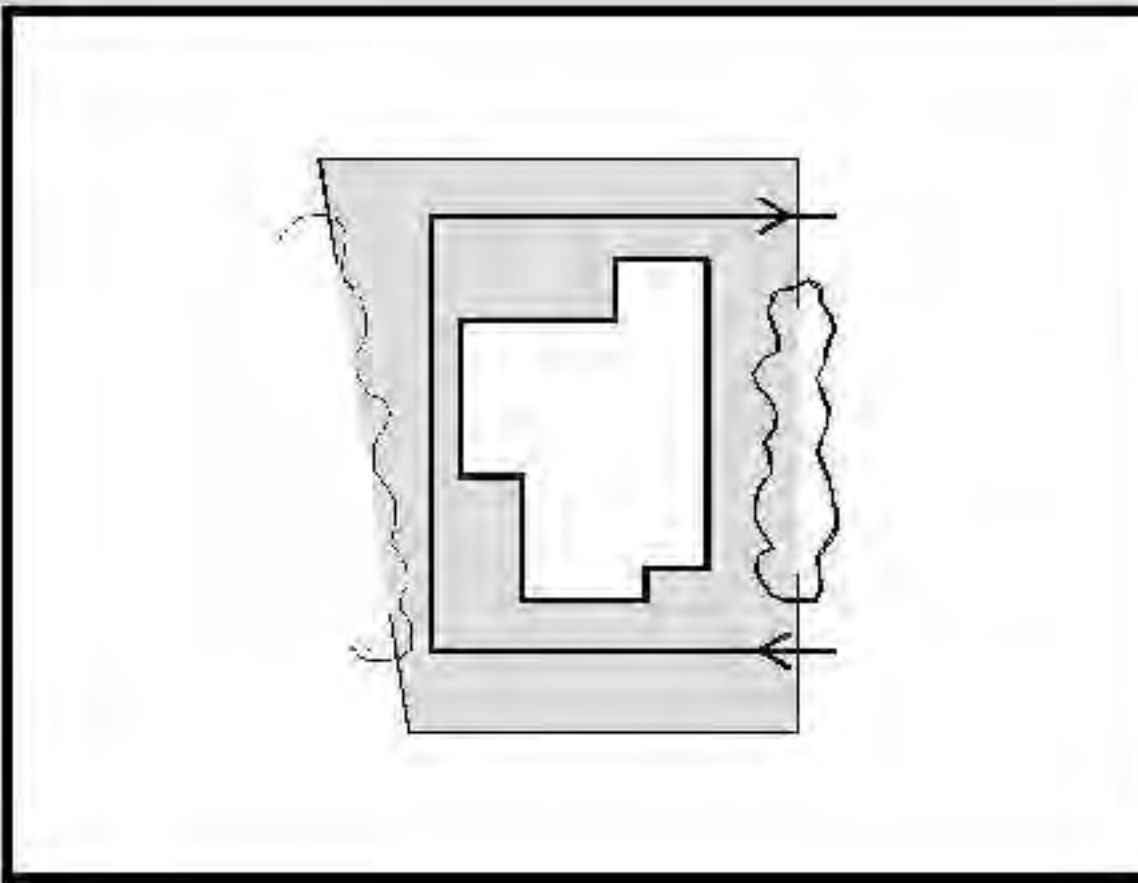
Text description of a component, detailing its function and specifications.

Material	Maße	Gewicht	Preis
Alu	100x100	10	50
St	100x100	15	60
K	100x100	20	70

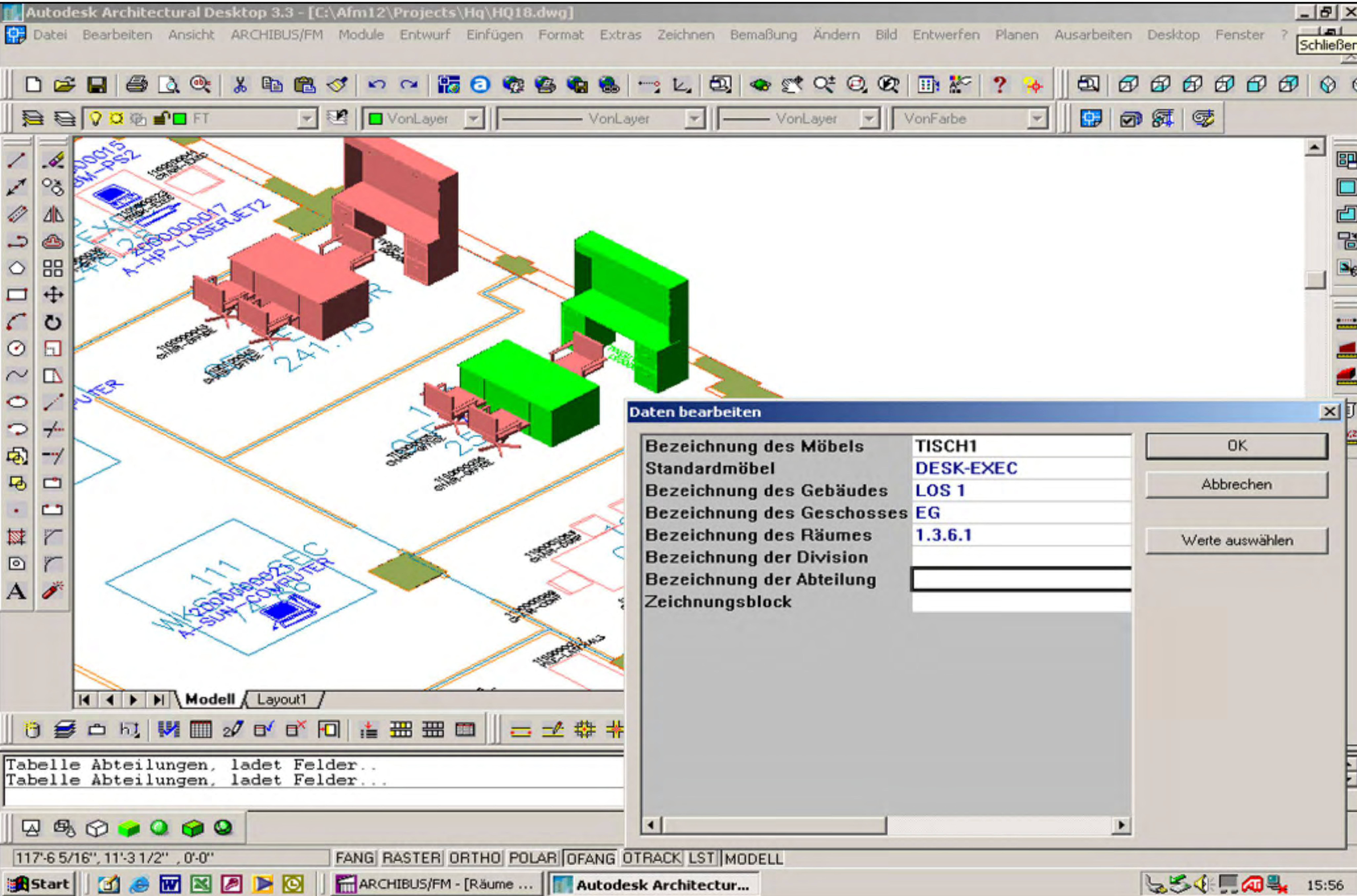
Material	Maße	Gewicht	Preis
Alu	100x100	10	50
St	100x100	15	60
K	100x100	20	70

## Graphic

e.g.  
data dwg / dxf  
2D / 3D



# Archibus/FM, Integration of AutoCAD via Overlay Function



FM - figure 3.10