Flexibility and adaptability in buildings

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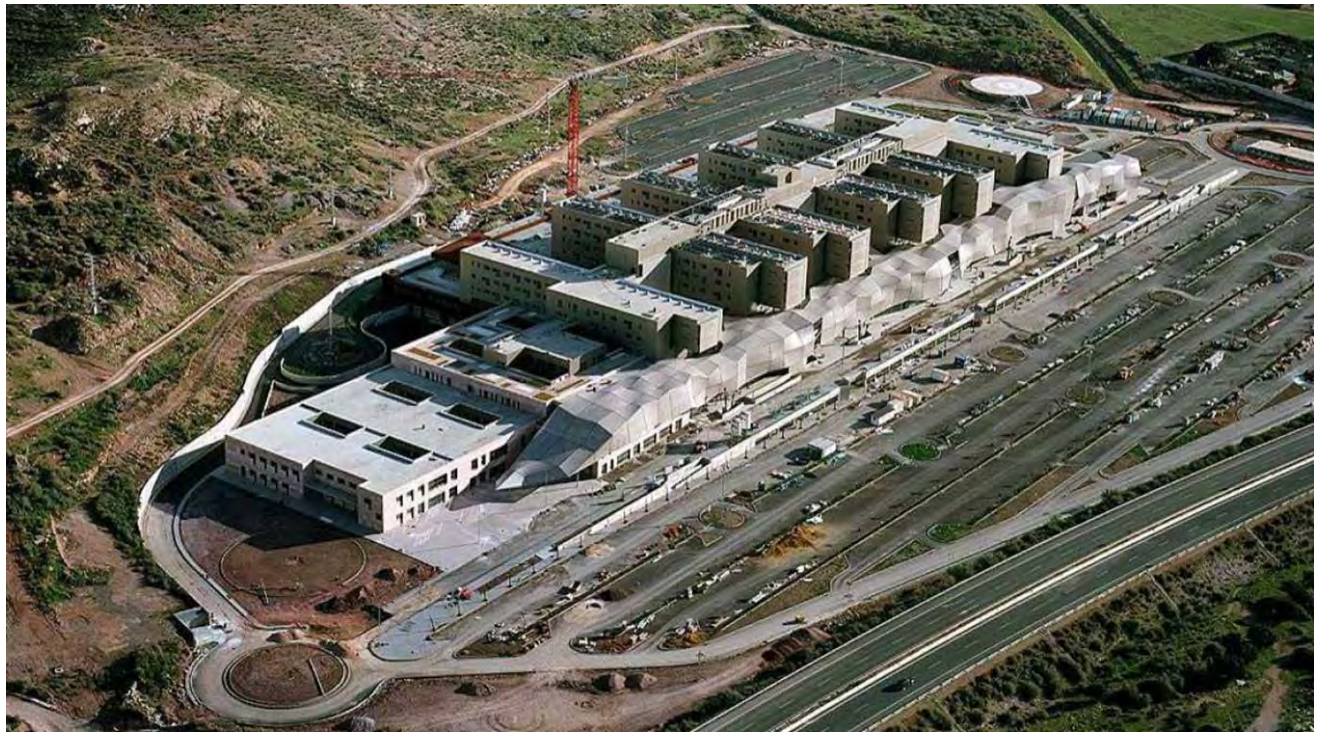
Engineering for high complexity buildings

ingenieros JG

	Established in 1970
Offices in Spain:	Barcelona, Madrid, Pamplona, Seville, Zaragoza
International offices:	Morocco, Panama, Peru and Chile
Partnerships:	EU (First Q Network), Costa Rica, Colombia, Bolivia
Services:	Feasibility studies, design, site supervision, commissioning, operations and maintenance consulting
Activity 2023:	170 professionals, 20% international

References



References

References

Introduction

Design for flexibility:

- Accesses and logistics
- Structural criteria
- Building systems criteria

Case studies:

- Experience from Covid 19
- From hotel to hospital
- From offices to hospital

Conclusions

Organisation of accesses

Staff and visitors

- Independent access to staff, visitors and supplies
- Size the parking lots, waiting areas and taxi stands
- Locate car parks outside the building's footprint

Supplies and waste

- Size accesses and loading and unloading area
- Separate the area for supplies from waste
- Loading/unloading in the basement: Sufficient dimensions (width, height, slope, overload...)

Medical and cryogenic gases

- Separation from the rest of the entrances
- Construction conditions
- Two independent feeds could be recommended to guarantee supply
- Sufficient space for loading and unloading

Internal logistics

Main corridors

- Arrivals and waiting from the docks to the freight elevators
- Free widths: between 2,4 and 3,6 m

Freight elevators

- Location
- Number
- Dimensions
- Capacity

Final corridors

- On the floor to the service delivery point
- Optimize traveldistances
- Minimum width of secondary aisles: 1,8m

Transport systems

- Manual carts or mechanical traction
- Manual or robotic systems

Pneumatic Tubes

- Small (small material): speed of transport
- Large (waste, linen): correct design and use

Warehouses

- Central
- Distributed
- Robotic (6 m clear height)

Structural criteria for flexibility

- Floor slabs: Continuous and without beams
- Free floor dimension without pillars: From 7,5 x 7,5 m
- Façades: Facilitate the entry of medical equipment and other resources with modular facades

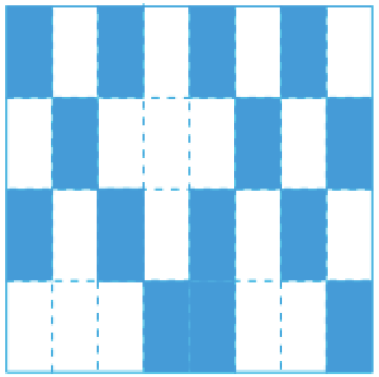
Required clearances:

- 'Soft' areas: 3,5m floor to floor: 0,5m slab + 0,2 false ceiling + 2,8 clear height in patient rooms and offices; 0,5 + 0,7 + 2,3 in corridors

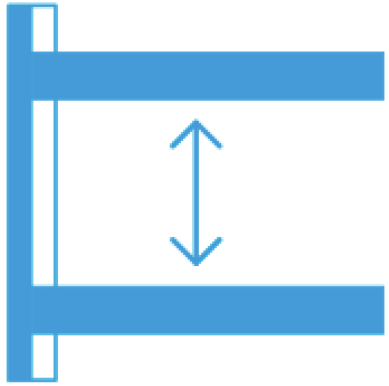
- Diagnostic and intervention areas: 4,5m floor to floor: 0,5m slab + 1,0m false ceiling + 3,0m clear height

- Technical plantrooms 4,5m floor to floor: 0,5m slab + 4,0m clear height

- Logistics areas: 6,0m of free height



FACHADA MODULADA



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Building services criteria

Plant Rooms

- Small and medium-sized hospitals: centralized
- Large hospitals: semi-centralized
- Space: 15-20% of gross area

Distribution

- Vertical risers: few, located at the ends and coordinated with elevators and stairs
- Horizontal final distribution better than vertical

Technical floors

- To house MEP systems to feed healthcare areas (operating rooms)

20% free space in plantrooms and distribution routes
20% installed power systems spare capacity

Physical flexibility: isolation and partial operation devices.
Technological flexibility: smart technologies for operation: Interoperability and scalability.

Case study: operation in pandemic condition

Conclusions as a result of Covid-19, better adaptability in:

- Large hospitals versus small and medium-sized ones
- Hospitals with large outdoor surfaces and multiple accesses
- Hospital services (intensive care, emergency) with closed boxes
- Hospitals with centralised systems better than distributed, and with sufficient reserve power

Very important is the maintenance of updated as-built information on the different systems of the hospital, and the existence of open-source building management systems

Multipurpose hospital modules

- 5x15m structural modules, 15m deep free floors without columns
- Empty areas and support areas for future expansions
- Standardization of the level of provision of MEP systems, allowing for transformation of use at minimum cost
- Buildings with differentiated accesses: staff, patients and visitors, logistical supplies

Hospital Bellvitge (Hospitalet de Llobregat)

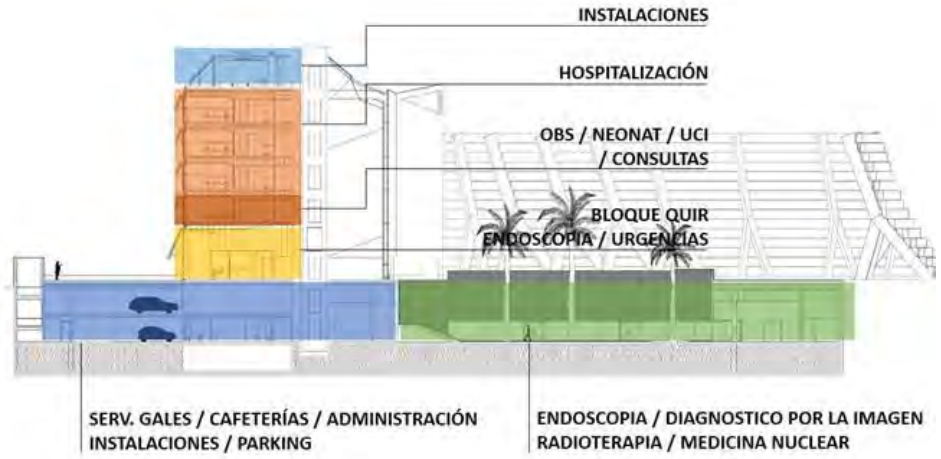
- 4.800m2, designed and built in 4 months
- Ground floor plus three floors above ground
- Prefabricated modular concrete structure of 5x15m, 14 modules per floor
- Prefabricated façades with continuous horizontal window
- Ground and first floor: Emergency room, 48 individual and isolated boxes
- Second and third floors: 14 double rooms and 4 single per floor
- Very easy possibility of reconversion

Change from hotel to hospital

Due dilligence: Transformation of a 28.000m2 hotel into a private hospital with 180 beds and 12 operating theatres:

Different feasibility studies:

- Urban: change of use, additional buildability
- Regulatory: fire, accesibility
- Functional: hospital services fit
- Technical: structural and mep constraints
- Economic: cost compared to a new facility



Change from hotel to hospital

PLAN FUNCIONAL INICIAL				EDIFICIO EXISTENTE
PLAN FUNCIONAL INICIAL	requerimientos	m2 PF		m2 existentes
PLANTA 2-3-4		7.500		6.459
Hospitalización	176 camas *	7.500		180 camas
PLANTA 1		2.587		2.153
UCI	12 camas	539		requerimientos a reevaluar
Obstetricia	4 UTPR	407		
Neonatología	8 puestos	441		
Consultas	40 locales	1.200		
ALTILLO		26		194
Administración y dirección		150		
Prevención Laboral		26		
PLANTA BAJA		4.215		3.191
Bloque Quirúrgico	12 quirófanos (11+1)	2.475		requerimientos a reevaluar
Urgencias		1.740		
SOTANO 1		3.584		3.419
Administración y dirección		1.200		a estudiar distribución en etapa de Estudio Previo
Endoscopia	4 salas	442		
Laboratorio + Toma de muestras		340		
Área de Farmacia		112		
Hospital de día quirúrgico	15 puestos	650		
Hospital de día oncológico	20 puestos	840		
SOTANO 2		11.780		12.490
Diagnostico por la imagen		1.000		a estudiar distribución en etapa de Estudio Previo
Radioterapia	1 acelerador	400		
Medicina Nuclear	1 PEC CT	300		
Servicios Generales		2.200		
Cafetería Paciente		350		
Cafetería Personal		180		
Equipos electromecánicos		1.950		
Parking		5.400		
Total superficie construida m2		29.692		27906

ESTIMACIÓN DE COSTE					
	m2	€/m2 obra nueva	.000 € obra nueva	reforma/ nueva	.000 € reforma
PLANTA 2-3-4	180 camas		9.689		4.844
Hospitalización	6.459	1.500	9.689	50%	4.844
PLANTA 1	2.154		3.878		2.963
UCI	449	2.000	898	80%	718
Obstetricia	339	2.500	848	80%	678
Neonatología	367	2.000	734	80%	587
Consultas	999	1.400	1.399	70%	979
ALTILLO	194		252		177
Administración y dirección	165	1.300	215	70%	150
Prevención Laboral	29	1.300	38	70%	26
PLANTA BAJA	3.191		8.535		7.484
Bloque Quirúrgico	1.874	3.500	6.559	90%	5.903
Urgencias	1.317	1.500	1.976	80%	1.580
SOTANO 1	3.419		5.007		3.707
Administración y dirección	1.145	1.300	1.489	70%	1.042
Endoscopia	422	1.500	633	90%	570
Laboratorio + Toma de muestras	324	1.500	486	80%	389
Área de Farmacia	107	2.500	268	80%	214
Hospital de día quirúrgico	620	1.500	930	70%	651
Hospital de día oncológico	801	1.500	1.202	70%	841
SOTANO 2	12.490		14.576		9.062
Diagnostico por la imagen	1.000	2.500	2.500	80%	2.000
Radioterapia	400	3.500	1.400	80%	1.120
Medicina Nuclear	300	3.000	900	90%	810
Servicios Generales	2.200	1.300	2.860	70%	2.002
Cafetería Paciente	350	1.300	455	70%	319
Cafetería Personal	180	1.300	234	70%	164
Equipos electromecánicos	1.950	1.000	1.950	70%	1.365
Parking	6.110	700	4.277	30%	1.283
Total superficie construida m2	27.907	1.503	41.936	67%	28.236

Change from hotel to hospital

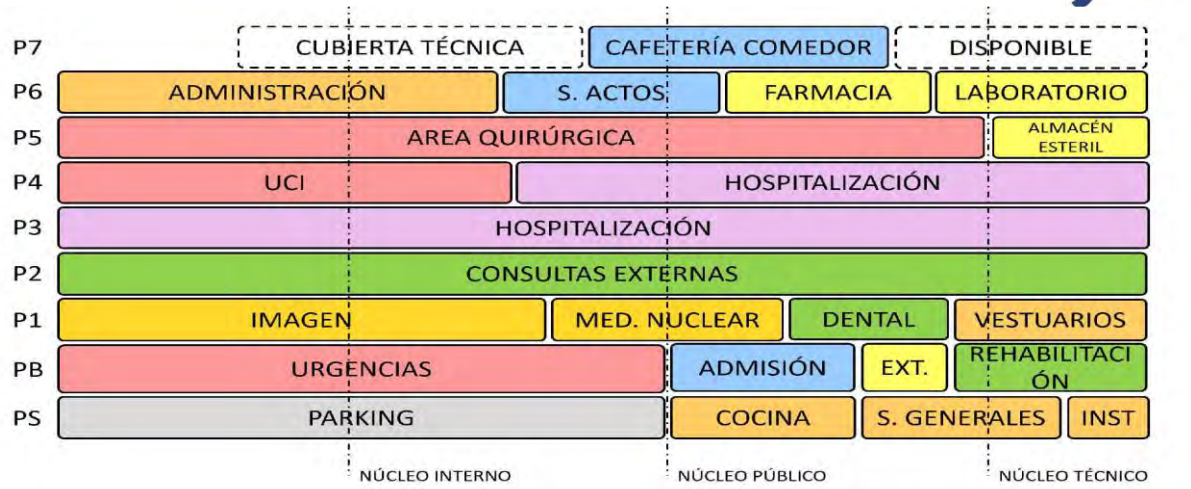
Conclusions:

Functional viability as a hospital, with inefficiencies due to free heights.
Location of diagnostic services in basement 2.
Savings of 30% compared to a newly built hospital.
Complexity of the licenses because it is a culturally protected building.
Potential risk of flooding of basement 2 due to proximity to a river.

Finally, the work was not carried out. The client was unwilling/unable to take the last two risks.

Change from offices to hospital

Preliminary study: Transformation of an 18.000m2 office building into an urban hospital with 80 rooms, 7 operating theatres and 60 consultations.



Difficulties:

- Free heights below beams in slabs: multiple risers and OT on the top
- Thermal and acoustic insulation not up to standard: slab screed increase
- Structural reinforcement for heavy equipment
- Facade solution from open plan to multiple rooms
- Parking spaces reduction by 30%
- Medical gases equipment placing.
- Evacuation: add stairs and enlarge existing.
- Transportation: new bed size elevators

Conclusions

1. Prioritize criteria that offer the greatest value for money invested:

- Logistics
- Structure
- Building services

2. Considerations when adapting buildings for hospital use:

- Legal aspects
- Technical aspects
- Economic aspects

Flexibility = Space reservations + consistent modularity + redundancy in the facilities

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