Healthcare Facilities from Planning to Design

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Abstract

This paper defines guidelines for architects involved in the design of healthcare buildings featuring different degrees of complexity. As most complex buildings lifetime is less than 30-50 years, we argue that future building projects should allow for innovation, especially as far as diagnostic-curative technologies are concerned. The methods we have used for our guidelines draw upon State and international agencies research data such as demographic-sanitary expectations as well as surveys undertaken by bio-tech experts, by teams of equipment and diagnostic-curative system's designers and project managers. As a result, we illustrate possible scenarios of future demand for health treatment, formulated on the basis of health needs placed on an importance scale. Finally, we translate health needs into 'guidelines and standards' to shape future planning by planners and architects.

1. The reference model

The health sector is marked by a constant phenomenon of diagnostic and therapeutic innovations, largely stemming from other areas. This involves an increase in the struggle between the technology of diagnosis and care and the spatial organisation of the hospital, between the "container" (the hospital) and its "content" (the technologies and the medical knowledge that revolve around them).

This requires a review of the planning approach that re-evaluates the planned introduction of the hi-tech biomedical equipment. This modifies the traditional typological and organisational models of the hospital and of other parts of the national health system, providing greater effectiveness of the services and of the running costs. There exists, therefore, a strict interrelationship between technological innovation and the evolution of the organisational model of the hospital. Among the fundamental principles of a hi-tech and high-care hospital we find "humanisation" and "innovation". "Humanisation" means a hospital focussed on the patient where a central role is assumed, from the outset, by ergonomic planning, understood as the correct interaction between users of the service (staff, patients), equipment and environments. "Innovation" means the possibility for the hospital to deal with ongoing technological innovations, by means of its own internal and external (structural, functional and planning) flexibility.

The redrawing of the basic hospital network is one of the prime purposes of the Italian National Health Plan (2004-06). This which defines the role and activities of the para- and pre-hospitalisation health centres. It also identifies the scientific and technological parameters of the hospital system of excellence with a strong element of super-specialisation.

Among the subsystems, a decisive role in reducing hospitalisation is the realisation of short-stay extra- (intra- or para-) hospital subsystems: from the out-patients clinic, to the multi-specialty or single-specialty day hospital, to the general or specialist day surgery. All diagnosis and related pre-hospitalisation could be dealt with outside of the hospital. The hospital has to assume more and more the character of a structure dedicated to Accident and Emergency (A&E), (areas of intensive therapy, resuscitation, etc.) as well as that of treatments that cannot be carried out elsewhere. Such as the riskier hospital treatments linked to the major general illnesses but, above all, to those illnesses of a specialist nature.

In consideration of an ever-increasing elderly population, that usually presents multiple symptoms, difficulties in recuperation and consequently long recovery times, what's needed "downhill" of acute treatment, is a subsystem of health "centres" that gradually, moving from the acute phase, lose their hospital connotation. This subsystem goes from the rehabilitation hospital to domestic hospitalisation; from the RSA (Residenze Sanitarie Assistenziali - assisted health residences) low-intensity rehabilitative refuges for permanent or temporary assistance where people can continue to live in the family circle, to the hospice for palliative care.

The questions which are at the top of the planning process of health service buildings are:
1) demographic variability;
2) rationalisation of the regional health system;
3) integration of hospital work with external-hospital work;
4) use of hospitals in accordance with a standard but flexible model, without the rigidity that is usually found in the distribution and use of space.

A "technological pole hospital" (referred to henceforth as "ASL hospital") imposes an investment, towards the acquisition of diagnostic-therapeutic computer technology and spatial reorganisation within the hospital. Such a proposal is an important decision because today substantial resources are invested primarily for ensuring buildings comply with the law instead of being radically rethought for carrying out the hospital function. The national hospital system that is proposed relies on the integration of the centres and consists of two models.
1) instrumental diagnosis (bio-imaging and laboratory and endoscopic diagnosis);
2) services offered in an outpatient or day hospital context (outpatients clinic; day hospital; dialysis centre; day surgery).

As far as laboratory diagnosis goes, it is preferable to have a *single point of treatment for biological materials with many sampling points* throughout the region, managed directly by GPs and collected by a single laboratory. The reports can be transmitted by computer or phone to the GP who carried out the sampling.

The *Dipartimento Emergenza Accettazione* (DEA – Accident & Emergency, henceforth A&E) has to be thought of as largely autonomous of all the other sectors of the hospital with a separate staff and budget. It manages the 118 network (emergency telephone number), the patient-transport sector (helicopter ambulances and ambulances) as well as the emergency doctor services, providing for their training and their professionalism. The A&E of an ASL is the crux of the network of regional A&Es and it utilize, through agreement, specialists of other ASL hospitals and firms to guarantee a qualitatively correct response. Specifically, the A&E, in relation to its position, can be characterised

Relief level	Territorial areas	Structures	Health referring operators
1st level "Generic"	Basic regional	- private clinics - public clinics of the regional unit of primary assistance (UTAP)	- general practitioners (GP) - GP's association
2 nd Level "Specialist"	Health District (DS) Regional	- Public and private outpatients clinics - Radiological consulting rooms	- Specialist physicians - Paediatricians
3 nd Level "Generic"	Health District (DS) Hospital	- Community hospitals	- GP - Professional nurses
4 th Level " Specialist "	Health District (DS) Hospital	- General day hospital - Single speciality day hospital - Day surgery general and specialist - Dialysis centres	- Specialist hospital doctors (in exceptional cases on NHS)
5 th Level "Basic Specialist "	Local Health Firm Hospital (ASL)	- support hospitals to the ASL hospital	- Specialist hospital doctors
6th Level "Basic to Medium Level Specialist "	Local Health Firm Hospital (ASL)	- Asl Hospital - Single laboratory of clinical analysis of the ASL	- Specialist hospital doctors
1st Rehabilitation level	Health District (DS) Regional	- Rehabilitation centres	- Rehabilitation therapists
2st Rehabilitation level	Local Health Firm Hospital (ASL)	- ASL rehabilitation hospital	- Medical physiatrists - Rehabilitation therapists

Table 1 *Classification of the health structures for assistance levels and regional areas*

as a "trauma centre".

Alongside the A&E module are the Unità Operative (UO-operational units) of the wards and of the intensive therapies (IT) specialties. Such a system is referred to as the "elective area". There are two aspects of the elective area:
1) *rehabilitative convalescence* within a specialised hospital;
2) *rehabilitative convalescence* at home with the help of the domestic integrated help (ADI).

The introduction of computerised biomedical technologies, day hospitalisation, and an efficient system for the treatment of emergencies, allows a reduction in the number of bed places in the UO wards. This allows a full and more rapid use of the bed places with a substantial reduction of the fixed expenses (staff, various materials). To the extent that the inpatient units will no longer be identified (that is to say assigned to a single specialty) but rather undifferentiated as "functional areas", the savings will be substantial. This is a path that could be taken by the ASL hospitals, in line with the law. It would be more difficult to apply "functional areas" to nationally important hospitals, to the institutes of recovery and care of a scientific nature - IRCCS - and to the teaching hospitals. The regional system presents itself as closely linked with the external hospital health services and with a direction that plans from a very unitary point of view. The hospital technological pole is the planning projection of itself on the other

garrisons whether they are within or without the hospital. This technical direction is unique on the part of the hospital "technological pole".
With the first results of the "human genome project" being delivered, there is underway in Italy, as well as in the more economically advanced countries, a thorough examination of the fallout of the scientific-technological innovations in biomedicine. This will effect the functional and regional organisation of the health garrisons, especially those of the hospitals and, consequently, of the effects on health expenditure.

To formulate proposals of functional reorganisation and of regional rationalisation of a hospital network it is necessary to take into consideration numerous factors. This will include social-economic-demographic variables regarding population, health professionals, regional context, economic-functional resources, health organisation, levels of involvement and of participation of the population and of the staff and so on. This reorganisation is accompanied by a shortage of hi-tech medical-surgical garrisons that doesn't allow diagnosis and therapy appropriate to the times.

The strategic sectors of innovation are essentially: drugs, bio-imaging, life-saving technologies (resuscitation, intensive therapy, transplantation of organs and devices, etc.). Future scenarios are extremely exciting for biotechnology with applications on a large scale (e.g. stem cell research; embryos for the production of spare body parts; cloning technology); with a hi-tech that will allow thought transference by machine, both computer and robot, and, the other side of the coin, cerebral manipulation, and so on.
Undoubtedly the sector of excellence in innovation is the pharmaceutical one, both as regards therapy and in preventative medicine. It is, above all, the genetic drugs that will allow personalised and differentiated treatments. The innovation of "personalised" medicines is predicted to occur within a few years. The pharmaceutical industries predict 5-7 years as the maximum before they appear on the market. But at the present time it is the hi-tech in bio-imaging that will cause an epochal and decisive leap in diagnosis and therapy.

Innovation in this field modifies the distribution of care as well as the organisational model of the hospital itself. With scientific innovation and the massive networked introduction of the hi-tech, one could attempt that organisational-functional innovation that is the prerequisite to better quality and efficiency, at a minimal running cost. The organisational innovation will organize the hospital into three areas which may not necessarily situated in the same building, preferably adjoining, and run autonomously. The areas are identified on the basis of their diagnostic-therapeutic intensity. They can be typified as:
- A&E;
- area of elective treatment;
- area of rehabilitative convalescence.

The central pole about which the system of the "areas" rotates is that of "instrumental diagnosis":laboratories, bioimaging, nuclear medicine and endoscopy. Depending on the size of the A&E area there's no reason not to have two poles of instrumental diagnosis: one for A&E, the other for the elective rehabilitative convalescence area. The sequence of the path followed by a patient emphasises proximity and is the basis of a building programme. This will allow, in the future, the re-dimensioning of a programme of new construction or functional renovation of existing buildings adapted to hospital use. This will allow close examination of both the costs of the technological innovation as well as of the organisational innovation of the physical environments and of the management savings that might follow.

In the area of elective treatments a central role is again taken by day hospitalisation, where there are two innovative structures.

1) The day hospital widely experienced with in

the area of medical clinics, of prehospitalisation and of post-hospital day treatments, is the link with domestic hospitalisation and recovery. This structure can assume specialist or general or polyclinical characteristics. This is the illustrated case. The specialist day hospitals were initially psychiatric and rehabilitative, followed by paediatric and geriatric.

2) The day surgery is more recent, but widely experienced in different North European and North American hospitals. It is a development of a branch of outpatient surgery that with the introduction of surgical endoscopy, of partial anaesthetic techniques, of therapies for the treatment of pain of protocols of intervention at any point, and has proven to be a strong defender of the rights of the patients. They are not left to their own devices, but rather the organisation of the surgical team that operates in the day surgery is on permanent call in case of complications.

A big reduction in hospital bed places has been realised, therefore, through the innovation that it has a good selective ability and, at the same time, to the extent to which a regional system of socio-medical services is activated whose foundations are: the presence in the region of the services of the ADI (domestic integrated help), the specialist structures of prevention-therapy-rehabilitation (from family planning clinics to centres for mental health to centres for drug addicts) to the physiotherapy centres for the return to work of people who have suffered accidents (to the arms, to the hands, to the locomotive apparatus, to the brain, etc.), to the residential rehabilitative structures, such as the RSAs (health relief residences) or residential-curative (such as the hospice). It is in the measure to which the protective network is widespread and diffused that one can reasonably try to aim for a reorganisation of the number of bed places in a region, as long as in any such operation the GPs and paediatricians are strongly present and involved, as well as the doctors of the emergency doctor service and so on.

The steps illustrated above are particularly important in the vision of a process that realises "new hospital armour" characterised by a concentration of biomedical technologies, of appropriate professionalism and of a low number of bed places, on which the A&E system is based, so as to stop - if not reverse - the migratory hospital flows in direction of the better-equipped centres in the North.

The other operation is the downgrading of the scattering of "unsafe" hospitals, from the point of view of the patient, in extra- and para-hospital structures strongly anchored in the region, in accordance with a plan that foresees: outpatients - day hospital, day surgery - instrumental diagnosis, connected functionally, as well as by computer, with the hospital of reference of the region, that will furnish - on the basis of coordinated planning - the specialists and the other personnel necessary for the carrying out of the health functions, and this will guarantee the turnover. This structure, looked at again like this, will be the hinge between a strictly hospital system and a system of para-hospital garrisons of high health value, such as the "rehabilitation centres", post-acute phase, with medical-surgical wards or RSA (Residenze Sanitarie Assistite - assisted health residences) for patients who, because of age or impairment, or because of a prevailing illness of a degenerative character, need help and supervision for long periods, or brief periods, depending on their family situation.

2. The planning of the network

The hierarchical system foresees three levels of acute care:
1. zonal or basic
2. provincial
3. regional

Such levels refer to the "population basins":
1. zonal or basic hospital from 25,000 to 50,000 inhabitants
2. provincial hospital from 300,000 to 400,000

inhabitants
3. regional hospital from 800,000 to 1,000,000 inhabitants
The specialties present, in accordance with the classification contained in the law, go from those considered more frequent to those considered rarer.

The specialised hospitals, with standards of reference relative to population that are double that planned for the acute hospitalisation, in turn are defined as:
a) provincial
b) regional
Over the years other standards have been established, for example of hi-tech diagnosis. The reference point is always the population (ministerial decree [DM] 29 November 1985; DM 2 August 1991).

Subsequently, standards were proposed relating to the functional system of the A&E, both of the 1st and level 2 (DPR [presidential decree] 27 March 1992). In this case one passes to the obligation of functional systems. The population parameter is acquired indirectly and derives from the obligation that there be present in the emergency system some of the specialties that were characteristic of the ex-regional hospitals, that have population basins of about one million inhabitants.

Another set of standards referring to population basins was proposed by the DM of 29 January 1992 on medical-surgical specialties. The "hinge" between the hospital care system and that of healthcare and welfare is, without doubt, the "regional para-hospital service" that encompasses:
1. primarily diagnostic functions of specialist medicine. The structure of reference is the *outpatients clinic*;
2. primarily therapeutic functions of specialist medicine. The structure of reference is the day hospital (DPR 20 October 1992) in its variations of polyclinic day hospital; of rehabilitative and back-to-work day hospital (*); of psychiatric day hospital; of general and specialist day surgery;
3. functions of instrumental diagnosis (clinical

LEVEL	DENOMINATION	HEALTH DIAGNOSTIC-CURATIVE FUNCTIONS								
		WITHOUT HOSPITALISATION					WITH HOSPITALISATION**			
		Outpatients clinics	Day Hospital * Day Surgery	Dialysis centres	Laboratories	Bioimaging	A	B	C	D
1st	GP surgery									
2nd	Outpatients clinics	■								
	Bioimaging					■				
3rd	Community hospitals		■ opz.				■			
4th	Day Hospital		■							
	Day Surgery		■							
	Dialysis centres			■						
5th	Support hospital to the ASL hospital	■	■	■		■		■		
6th	ASL hospital	■	■	■	■	■			■	
1st	Regional rehabilitative centres		■*							
2nd	Rehabilitative hospital		■*			■				■

Table 2 *Presence of health functions in the structures*

bioimaging and analysis).The structures of reference are the *radiological clinics* and *the laboratories of clinical analysis*.

3. Planning of the physical structures: the ASL hospital

The specialist literature of planning and designing breaks the hospital organism down to the level of "system" in three sectors – hospitalisation (wards), diagnosis and therapy (health services), and general services - and it is at the level of "subsystems", in functional areas, that the totality of the basic spaces can be identified – closely related to each other by specific spatial, functional and organisational relationships

LEVEL	DENOMINATION	LEVEL OF CARE			LEVEL OF EQUIPMENT			PROFESSIONAL MANAGEMENT	
		LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	MEDICAL	PROFESSIONAL NURSES
1st	GP clinics	■			■			■	
2nd	Outpatients clinics		■			■			■
	Bioimaging		■			■		■	
3rd	Community hospitals	■			■				■
4th	Day hospital		■			■			■
	Day surgery		■			■		■	
	Dialysis centres		■			■		■	
5th	Support hospital to the ASL hospital	■			■			■	
6th	ASL hospital			■			■	■	
1st	Regional rehabilitative centres	■			■				■
2nd	Rehabilitative hospital		■			■		■	

Table 3 *Intensity of care and the biomedical equipment present in the strctures*

LEVEL	DENOMINATION	POPULATION BASIN	THEORETICAL NUMBER OF BED PLACES	THEORETICAL REQUIREMENTS FOR AN ASL *	
				PHYSICAL STRUCTURES	BED PLACES
1st	GP surgeries	1.500	…	134	…
2nd	Outpatients clinics	40.000	…	5	…
	Bioimaging	40.000	…	5	…
3rd	Community hospital	40.000	20	5	100
4th	Day Hospital	40.000	8	5	40
	Day Surgery	40.000	8	5	40
	Dialysis centres	40.000	4	5	20
5th	Support hospital to the ASL hospital	100.000	100	2	200
6th	ASL hospital	200.000	200	1	200
1st	Regional rehabilitative centres	40.000	…	5	…
2nd	Rehabilitative hospital	200.000	60	1	60

Table 4 *Theoretical standard of population ande bed places in relationship to the levels of health structures*

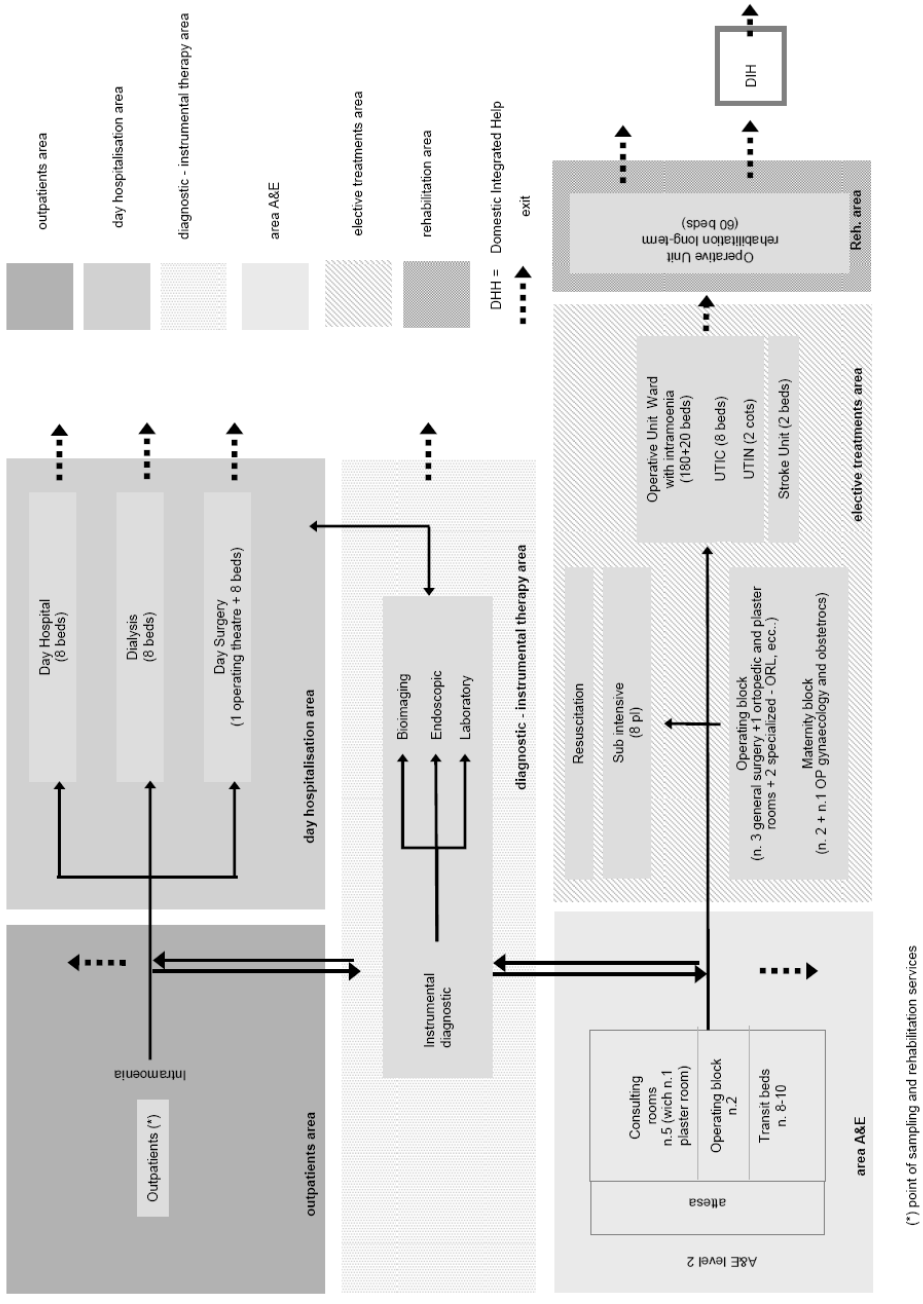

Table 5 *Functional scheme – population basin 200.000 (242 bed places which 24 are day places, 200 normal and 18 intensive/subintensive resuscitation bed places)*

SECTORS	FUNCTIONAL AREAS		SPATIAL UNITY
WARDS	wards	Day, ordinary, specialist, and rehabilitative	day hospital/day surgery
			specialist
			ordinary
			rehabilitative
		Intensive care and supervision	intensive/sub-intensive
			infectious
			resuscitation
SERVICES OF DIAGNOSIS AND THERAPY OR HEALTH SERVICES	surgical area		day surgery
			surgical block
			maternity block
	diagnostic instrumental area and laboratories		analytical laboratory
			hystoanatomical pathological research
			research laboratories
			functional and endoscopic examinations
			diagnostic imaging
	outpatients		dialysis
			surgery
			radiotherapy
			day hospital
			transfusion centre (blood bank)
			sampling centre
	emergency and first aid area		A&E level 1
			A&E level 2
			first aid point
GENERAL SERVICES	administrative services		Admission
			general computer service
			health administrative offices
	social services and other		Chapel
			cafeteria and social areas
			rehabilitation services (gym, swimming pools, etc. where anticipated)
	services of support		pharmacy
			sterilisation and disinfection
			mortuary service
			changing room
			cleaning services rooms
			stores
			kitchen
			laundry
	technological plant		heating system
			cooling system
			water system
			fire prevention system
			electrical substation
			distilled water production
			sterilisation system
			disinfection system
			elevators, etc.

Table 6 *Sectors, functional areas and spatial unity*

SECTORS	SQARE METRES	% WEIGHT
WARDS		
- Day Hospital and Day Surgery wards	900	3 %
- Ordinary and specialist wards	7,000	26 %
- Resuscitation- intensive- sub-intensive *	900	3%
TOTAL WARD SECTOR	8,800	33 %
DIAGNOSIS AND THERAPY		
- Outpatients clinic	2,000	7%
- Operating block Day Surgery	600	2%
- Dialysis	800	3%
- Radiology – ultrasound - mammography	1,500	6%
- CAT and NMR	900	3%
- Radiotherapy - linear accelerator	700	3%
- Functional and endoscopic examinations	800	3%
- Laboratory	1,000	4%
- level 2 A&E	3,000	11%
- Operating block (6 operating theatres)	1,800	7%
- Maternity block	1,000	4%
TOTAL DIAGNOSIS AND THERAPY SECTOR	14,100	52 %
GENERAL SERVICES		
Administrative services		
- Admissions		
- General computer service		
- Health administrative offices		
Social services and other		
- Chapel		
- Cafeteria and socialising areas		
Services of support to diagnosis and care		
- Pharmacy		
- Sterilisation and disinfection		
- Mortuary		
- Changing rooms		
- Rooms for cleaning services		
- Stores		
- Food sorting room		
- Laundry sorting room		
TOTAL GENERAL SERVICES SQUARE METRES	4,000	15%
TOTAL GENERAL	26,900	100 %
Other spaces to be calculated (to be added to the supplementary total)		
Corridors, stairwells etc 15 % to the total	about 4,000	
Undifferentiated container (20 bed places)	900	
General services - technological plant	3,500	
TOTAL SURFACE AREA CALCULATED SQ.M.	35,300	
TOTAL SQ.M TO BED PLACE	145	

Table 8 *Planning quantity reference: ASL Hospital*

– aimed at the carrying out of complex activities or of a single complex activity, and articulated as a sum of elementary activities.

In the three hospital sectors, the articulation of the functional areas and of the corresponding spatial units is illustrated in Table 6. Every hospital structure is characterised, then, by a determined percentage relationship between the three sectors, thus identifying the prevailing function. Such a relationship, according to the literature, is modified in time along with the evolution in innovation of the technologies applied to medical practices and managerial models.

In relationship to the functional scheme no. 4 "ASL hospital – population basin of 200,000 inhabitants - 242 bed places", in the sphere of the hypothesis regarding the restructuring of existing hospitals or of new builds, it is thought necessary furnish signposts to the programming of the planning.

For a hospital that's defined as having a high technological content, such as that previously defined as the ASL hospital, the "optimal" percentage ratio between surfaces of the three sectors (equal to 100% of hospital surfaces), in the light of the considerations above, has to be articulated as follows:

- ward sector	30% - 35 %
- diagnosis and therapy sector	50 % - 55%
- general service sectors	15%
- total hospital surface	100%

Such a relationship underlines the heavy weight given to the services provided by the sector of diagnosis and therapy. The articulation of the theorised model is summarised in the chart below where, for the characteristic functional areas, the planning quantities have been rendered explicit.

As mentioned above, the hospital structure is characterised by a relationship determined between the three sectors that make it up. For the purposes of the proposed planning, by reuniting the functional areas within connected sectors, the percentage ratios of the hypothetical model are calculated. From the calculations it is deduced how this is characterised by a greater weight of the diagnosis and therapy sector (52%) in the total of the sectors, anticipating the ongoing tendency that sees the sector being that that is most interested in the phenomena of technological innovation, in full expansion, including dimensional, for its potential.

Conclusion

All physical places created to respond to people's health needs, which were held to be unchangeable and permanent, undergo, in time, processes of restructuring and/or transformation.

The hospital is the exemplary structure of the contradiction between the evolution of an individual's health needs, scientific progress and social-cultural processes. The text pursues the objective of providing an aid – cultural and technical at the same time – for planners so that their work may take into account three interdependent questions: the humanisation of the hospital environment (and hopefully of treatment); scientific-technological innovation both in materials and building systems and in medical equipment and the biotechnologies; planning for the building of a hospital system which will meet the needs of a population living in a defined area.