NEW DESIGN TECHNOLOGIES: USING COMPUTER TECHNOLOGY TO IMPROVE DESIGN QUALITY

JOHN PEPONIS, Ph.D.,
with CRAIG ZIMRING, Ph.D.
MOLLY M. SCANLON, ASSOC. AIA

PART I: Designing Friendly Hospital Layouts — the Contributions of Space Syntax

Editor's note: This section, contributed by John Peponis and Craig Zimring, is based on Dr. Peponis's talk at the Eighth Symposium.

Peponis/Zimring: Building design, and more specifically spatial layout, offers powerful messages about an organization's culture and values, over and above enabling efficient functioning and use of space. This statement is commonplace in the case of design for normal work environments (Duffy 1976; Peponis and Stansall 1987); however, until recently it has been less pressing with respect to the design of large medical buildings. In contrast to smaller healthcare buildings, where confidentiality, privacy, or other patient-related considerations have long informed major design decisions (Cammock 1974, 1981), the design of hospitals would seem to depend more heavily on the resolution of complicated functional and technological requirements. This has changed somewhat in recent years. Medical care has focused more on the needs and experience of outpatients, and competition among healthcare providers has accelerated; as a result, healthcare facilities are attempting to develop organizational cultures more sensitive to patients. Yet, medical planners and designers have often lacked theories and technologies to make practical decisions about how layout affects the experience of patients. In this article, we discuss an emerging theory and computer-based method called "space syntax" and show how it has been used to study and plan two healthcare facilities. The aim is to allow planners and designers to address the intelligibility, welcoming nature, and functional efficiency of a plan with the same rigor that they normally devote to functional planning and design.

Intelligibility is linked, but is not equivalent, to efficient wayfinding. *Wayfinding* normally refers to the ability to find specific destinations, such as a departmental reception, from specific origins, such as the hospital entrance, or the elevator core (Passini 1984; Carpman, Grant, and Simmons 1986; Sharkawy and McCormick 1995). *Intelligibility*, as we use the term, refers to the overall structure of the building and the ability to maintain a sense of orientation with respect to entrances, major corridors, atria, lounges, or other spaces that may collectively act as a system of reference. Indeed, intelligibility can be discussed as a function of spatial structure (Weisman, 1981). Wayfinding depends on the intelligibility of the building layout, but also upon the distribution and location of destinations and the clarity of the system of signs, the ability of staff to give clear verbal directions, and so on (Carpman et al. 1986; Peponis, Zimring, and Choi 1990).

The ability to identify reception and information points visually, the presence of other people who can act as potential sources of information or assistance, the density of movement, and alternation of lively and private spaces, in short, all the factors that comprise the pattern of space use of the most public areas of hospitals contribute to the quality of hospital buildings as they are experienced by clients. In particular, these factors contribute to the general impressions, sense of reassurance, and sense of confidence that complement the quality of direct encounters with medical providers and the degree of satisfaction with the quality of care received. It is evident that intelligibility is not the only factor that makes layouts feel welcoming; however, the pattern of space use of the most public spaces of a hospital is related to intelligibility. Research has shown that hospital layouts affect the distribution of movement and the pattern of presence of people, over and above the effect of functional flows or the spatial allocation of activities (Hillier, Hanson, and Peponis 1984). Thus, layouts affect the impressions that different hospitals make as functioning organizations and as spatial institutions.

In order to control the development, implementation, and modification of layouts according to organizational aims, hospital planners, designers, and administrators must know what properties of layouts have the greater impact on intelligibility and space use. This is where a particular line of recent research called *space syntax* becomes particularly relevant, by linking theory, empirical field studies, and applied projects to the development of new computer-based tools aimed at supporting design decisions.

Space Syntax

Our ordinary experience of buildings is affected by the way in which spaces are connected, the changes of direction imposed by the circulation system, the creation of room sequences, the distribution of branching points, the availability of alternative routes, and the relations of visibility between and across spaces. These properties, which can be described as configurational, are critical to good layout over and above the metric distances, area allocation, and functional adjacencies that are more usually taken into account in functional planning. Space syntax is aimed at providing a systematic and quantitative account of building configuration, to assist our understanding of how buildings function as organizational resources. Space syntax was originally developed at University College, London, under the direction of Professor Bill Hillier; our current work at the Georgia Institute of Technology is aimed both at exploring the applications and at extending the analytical techniques and theoretical ideas associated with the syntactic analysis of architectural space.

In syntactic analysis, layouts are first transcribed into appropriate representations of their spatial structure. Among these, the most critical for the analysis of hospitals is the axial map that includes the fewest and longest possible straight lines of uninterrupted visibility and movement that can cover the plan. The axial map is the most economical way of describing a layout as a pattern of potential movement, calling our attention to the changes of direction and the number of transitional spaces that are necessary as we walk between one hospital area and another.

Research has shown that from the point of view of visitors' movement and wayfinding, the most important property of axial maps is integration. *Integration* describes the relationship of each space to the rest of the layout in terms of the number of such changes in direction and transitions that are necessary in order to reach all other parts (Hillier and Hanson 1984). In other words, integration is a measure of syntactic or topological distance, rather than a measure of metric distance. Changes in direction and the presence of intervening spaces are more likely to affect our sense of orientation within a complex plan than sheer length. In the analysis of hospital plans, we are interested not only in the degree of integration of individual spaces within the system as a whole, but also in the mean integration of the system, and finally in the rank order of integration of the various spaces. The most integrated spaces of a system can be treated as the "integration core" of a plan. The integration core can be thought of as the spatial hub of the system; it contributes most to keeping the parts together, and it is likely to feature many functional transitions as people traverse the facility. As a result, designers should check whether the integration core coincides with the spaces that they intend as the most lively circulation hub of the building, and they should also pay attention to the relationship of major destinations to the integration core, as we will argue below.

"The statistical correlation between connectivity and integration is of particular significance."

Several additional measures can be calculated on the basis of the axial map, the simplest among which is *connectivity,* a direct count of the number of connections of each space. The statistical correlation between connectivity and integration is of particular significance. If connectivity is correlated to integration, then it is possible to infer the importance of a space within the system as a whole, on the basis of its immediate connections. The reliability of such inferences, which link navigation with respect to the building as a whole to the properties of the immediate surroundings, is surely one of the objective components of intelligibility. Thus, we refer to this particular correlation as *syntactic intelligibility*.

The syntactic analysis of plans involves other representations. Among these, the representation of visual fields, or isovists, has direct intuitive significance. The isovist of a space indicates all the areas of a building that become visible from it (Benedikt 1979), how extended they are, whether they are near or far, whether they constitute distinct visual segments or a continuous whole, whether they stretch linearly or extend in concentric contours, and whether they are bounded by exposed physical boundaries or indicate a potential continuity of space outside the limits of the visual field. By drawing the isovists from reception desks, nurse stations, or waiting rooms we can study how prominent these spaces are, their scope regarding visual surveillance, and the degree to which they are exposed to ongoing activities.

This article summarizes two case studies where the methods of space syntax have been used to take a fresh look at the issue of intelligibility and liveliness with regard to the hospital circulation system. The first case study leads to a diagnosis of the nature of some wayfinding problems experienced in a hospital whose design has received awards for its attention to the needs of patients. The second case study deals with the evaluation and development of alternative master plans for the expansion of a large urban hospital whose very success and growth in the past have created a rather confusing agglomeration of buildings and spread of departments, with functional problems resulting from both the spread and the occasional overlap of facilities and departments.

Wayfinding at 'Homey Hospital'

"Homey Hospital" is a 100-bed hospital for the elderly, which opened in 1986 and was designed to depart from the institutional appearance of conventional hospitals. There is an extensive use of natural light, "homelike" natural materials and colors, and symbols of home such as providing a "living room" with television. Efficient wayfinding was an explicit and major concern on the design agenda. In spite of the design intentions, at the time of our study the hospital generated a number of wayfinding problems. These were clearly indicated by the proliferation of formal and informal signs on its walls and by complaints by staff and visitors. Interviews with staff members suggested that wayfinding problems caused a considerable loss of time to those who had to escort or direct patients. Also, outpatients and visitors did not make full use of hospital amenities. For example, some patients have been unwilling to walk only 100 feet to the TV lounge or to use the halls for exercise for fear of not being able to make their way back in time. But most of all, wayfinding problems seem to prevent a carefully designed building from being used to its full potential for professional and humane care.

Our study of Homey Hospital had two aims. First, we used the building as an experimental setting in order to develop and test hypotheses about the way in which people explore new spatial environments. Second, we studied the building to provide advice on how to alleviate the most pressing wayfinding problems. Our work with experimental subjects who were not hospital clients suggested that there was a clear pattern to the way in which people with no previous knowledge of the building proceeded to explore the premises. The patterns of open-ended exploration aimed at becoming familiar with the building, and of search specifically aimed toward preassigned destinations, were consistently correlated with the syntactic properties of the layout. When exploring space freely, or when unsure about the location of a destination or the best route to it, people simply gravitated toward the integration core of the plan. In fact, the findings were so telling that the work on Homey Hospital influenced the development of our ideas about the intelligibility of space and about wayfinding as a function of intelligibility (Peponis et al. 1990).

Knowing that the building fostered a clear and consistent pattern of exploration and search made the problem of wayfinding more interesting. Our observations indicated that there was a mismatch between the spatial structure of the building, as intuitively understood by experimental subjects, and the intended flow of movement of patients, as indicated by the disposition of activities and functions in the plan. Accordingly, we sought to identify the features of the plan that caused this apparent dysfunction. There were several.

First, the hospital had two visually identical and symmetrically positioned entrances. The one that was conceived as the main entrance was farther removed from the visitors' parking lot than the one conceived as an exit. Thus, many visitors who opted for the nearest entrance had to make unnecessary circulation choices before reaching the reception, and some of them got delayed because they misinterpreted the lounge by the exit as a waiting room and expected to get assistance in that location. This particular problem was easy to remedy by switching the parking lots for visitors and staff and also by adding appropriate signage.

Second, the hospital plan was encompassed between two main corridors, one circling around the entrance yard and the other running along all three sides of the back of the building. The second corridor operated as the functional spine, linking all major departments and wings. It also comprised the most integrating spaces. However, the front corridor, which made fewer functional connections, was more exposed to the visitors' approach from the parking lot and was decorated as if intended to act as the public front of the hospital. The discrepancy between the functionally and the architecturally important corridors added unnecessary confusion. Patients and visitors who "read" the front corridor as the main corridor were unable to find the key destinations in the rear of the building. One possible resolution of the problem would turn the front corridor into a gallery space, thus avoiding the unnecessary duplication of circulation links.

Third, there was a poor interface between the pattern of circulation and the design of departmental entrances. Entrances were recessed, presumably so as to suggest a threshold and to enrich the otherwise linear shape of the corridor. As a result they were not visible from corridor ends and required that people walk the full length of the corridor to ascertain the departments present. Furthermore, there were no staffed positions associated with the entrances. Thus, those who had successfully identified their destination felt unsure as to what they were supposed to do next. This problem could be alleviated by the use of signs to announce destinations from critical corridor junctions and to suggest appropriate behavior on arrival.

Fourth, the reception was poorly designed. While near the main entrance, it was not directly visible from it. While attached to the two functionally important transverse corridors that led to the major examination departments, it had no visual overview of any of the department entrances and no views of either of the two major corridors. These features reduced the potential of the reception to act as the orientation hub of the plan. The problem could be addressed by a minor alteration of the plan aimed at turning the reception into a much more central position from the point of view of both visibility and movement, first by reorienting it, and second by allowing it to span both transverse corridors.

Finally, the circulation system itself, though quite simple in its conception, seemed unnecessarily confusing when actually experienced. In the interests of eliminating length, corridors were broken into segments that reduced the extent of direct visibility of the various facilities. Corridor junctions were slightly offset with respect to each other, so that one couldn't register many connections at once. Corridors had similar width and length, meaning that they were easily distinguished. Corridors did not run through significant use spaces, which compounded the difficulty of distinguishing them. These features were so embedded in the overall design that they could not be easily changed without major alterations.

These characteristics of the building suggested that the potentially simple syntactic structure of the plan (an effectively linear spine with transverse branching corridors) was compromised. Geometric considerations, visual qualities, or instrumental requirements were allowed to work independently rather than in concordance with the propensities of spatial structure. Thus, a multitude of potentially good intentions coalesced into a less than satisfactory result.

From a more general point of view, our work at Homey Hospital suggests that efficient wayfinding systems must bring together three components. Space syntax can help not only to deal with each component separately but also to bring them under the purview of a unified and coherent approach. Good wayfinding requires the following:

- A clear and intelligible layout organized so that frequent and important destinations are associated with the most integrated spaces that attract the natural flow of movement. This means that at least some destinations are reached without special effort.
- A well-designed system of information including signage, directories, and "you are here" maps. This must work with the natural flow of movement suggested by the building to facilitate specific circulation choices. While the purpose of a clear building is to create a frame of reference for general orientation, the purpose of signage is to facilitate the transition to and recognition of specific destinations. Both aspects of intelligibility are essential to visitors' perceptions of environmental friendliness and to efficient movement.
- Properly distributed reception and information stations that collectively maintain an overview of major circulation spaces. The function of the stations includes sustaining a sense of security and reassurance over and above the provision of specific instructions. An efficient layout reduces the number of stations that are necessary to maintain appropriate levels of supervision, guidance, communication, and reassurance. It also places the stations at points that enjoy high exposure to overall circulation while occupying an appropriate position with respect to departmental operational needs.

Our next case study is intended to indicate how these lessons were applied in the context of a much more complicated design problem.

Shaping Up for Growth

The problem of growth in hospitals has attracted the attention of researchers over a long period of time (Cowan 1964) and basic hospital configurations have been evaluated from the point of view of their ability to accommodate expansion (Green

1966; Weeks 1973). As hospitals grow with success, however, the gradual accommodation of the requirements of individual departments can lead to unintelligible overall layouts and to inefficiencies of scale. This has been the case at “Urban Hospital,” which currently occupies several urban blocks downtown in an American city. Urban Hospital is currently planning to expand through the addition of a major new outpatient building but also to rationalize its existing accommodation and the distribution of functions over it. The aim is to respond to the trend toward a greater proportion of outpatient care by adapting the complex to the needs of independently mobile clients with short terms of stay and by making the premises more attractive to community physicians who will refer their patients. The urban position, near the intersection of major interstate highways, is seen as an advantage because of the enhanced accessibility that it allows. At the same time, it makes the need for renovation more pressing so that the hospital can compete with similar organizations occupying newer buildings in the more affluent suburbs.

Our involvement with the process was directed toward the development of a computer-based syntactic representation of the premises that would allow the ongoing assessment of the current situation regarding intelligibility, movement, and the functional distribution of departments as well as hospital plans for change in the future. Our immediate target was the evaluation of two alternative master plans proposed by a major specialized architectural firm and the recommendation of potential improvements from the particular perspective of our specialized concerns. To us, this represented a good opportunity for studying closely the problems associated with growth and change.

“... although the hospital occupies a prominent location near downtown, there is no clear front door ...”

Our analysis of the current situation revealed several problems. First, as the hospital had expanded across several urban blocks between two major urban streets, communication between departments relied heavily on the use of outdoor public sidewalks, despite the availability of some bridge connections. Also, although the hospital occupies a prominent location near downtown, there is no clear front door on the prominent street that runs by it. The twin street that runs parallel to the prominent street is more spatially integrated into the hospital campus so that pedestrians would not be expected to use the main street when they visit the complex.

Second, the “spatial hub of the system” — the most integrated area of the hospital and where one expects most people to traverse — is traditionally where one would like to make the most architectural investment by putting best furnishings and front-stage functions. In Urban Hospital, however, the spatial hub covers a cluster of auxiliary functions. Back-of-the-house activities occur where one would expect to find major departments. Secondary or specialized entrances are used routinely as main means of access or through movement. Thus, convenience works against the grain of the architecture. Entries intended for frequent use are arranged in a centrifugal pattern and do not attract the density of use intended.

Third, critical links between departments housed in the accretion of buildings involve many changes of direction, lack intermediate connections, and generate a sense of fragmentation and disorientation. Those three families of problems mitigate against the intelligibility of the system over and above the problems associated with the dysfunctional spread of departments and services, the excessive ranges of movement required for day-to-day operations, and the organizationally inefficient duplication of certain highly specialized and technologically dependent functions.

From our point of view, the spatial condition of the hospital was most clearly revealed by two sets of numbers. First, we computed syntactic intelligibility as a measure related to the intelligibility of the premises. As the scope of our computer representation of the system expanded to include larger buildings, groups of buildings, and ultimately the complete main level of circulation across the campus, intelligibility dropped significantly. Quite simply, while the plan of specific departments may make sense in local terms, the spatial relationships across the campus do not form a coherent pattern. Local connections give no clues about the overall logic of the plan and one’s situation in it. Problems of intelligibility were also exacerbated by weak levels of spatial integration, especially when public streets were not fully taken into account.

Second, we observed the densities of use of major circulation spaces and found very poor correlations between patterns of movement and the syntactic structure of the layout, against the expectations we might have had based on our previous studies of complex buildings and environments. We believe that the following interpretation is valid. In the case of Urban Hospital, the flow of movement is subject to uncoordinated and sometimes incompatible pressures. It is directed between functional poles of attraction. It is channeled by syntactic structure. It is repelled by the distribution of auxiliary functions. Finally, it is intersected by the public streets. The combined effect of these pressures is the creation of an overall pattern of movement that is spatially unpredictable. In other words, a visitor cannot match the observed spread of movement with the purely spatial information that is made available by the layout.

As a result of our analysis, three questions suggested themselves as more important to the evaluation of future plans: (1) whether the integration core would spread so as to reach into the various departments and bring them under the purview of a single coherent spatial framework; (2) whether the layout proposed by the master plans would succeed in creating a better match between the integration core of the system and the major categories of movement; and (3) whether the new layout would improve existing levels of syntactic intelligibility. We proceeded to compare the two master plan options against these criteria.

The first option consisted of placing a building across the street from the bulk of hospital accommodation, with new bridge connections. The new integration core of the campus would encompass the proposed atrium at the heart of the new building and would span across the street to form a circulation loop through the modified layouts of existing buildings. But, while the new building could stand as a clearly identifiable symbol of the new stage of growth, it would not really succeed in becoming the hub of the campus due to its off-center location and the fact that the syntactic core reaches to but not through it. Also, from the point of view of syntactic analysis, the streets would still play a major integrating role and would thus still attract substantial components of campus movement. Finally, many areas on the main levels of the hospital would remain outside the scope of the core.

The second option consisted of erecting a new building at the back of the bulk of existing accommodation, while closing a public street. The new integration core of the campus would run across the length of the new building and it would be likely that the new building would function as the hub of the system as a whole. Reliance on public streets would be considerably reduced. The major disadvantage is the failure of the new core to reach into the existing system, which might, therefore, remain substantially unaffected by the addition, from the point of view of intelligibility, unless other conversions of the layout were envisaged.

We proceeded to examine the second option more closely, since the proposed location of the new building seemed to create the greatest opportunity for improvement of the existing structure of the campus as a whole. We evaluated diagrammatic representations of alternative solutions on our database. Finally, we came to propose a modified version of the second option, where one of the major corridors of the new building is slightly rotated and then extended to form a "pedestrian arcade" as the circulation core of the campus as a whole at ground-floor and first-floor levels. This solution has two kinds of advantages, internal and urban.

First, it draws a clear distinction between the primary circulation structure, which links the hospital complex into a coherent whole, and the departmental circulation structure, which is associated with specific functional and operational requirements and the creation of a primary interface between clients and medical providers. An intelligible layout requires that each level of circulation works well in its own right but also that the interface between the two levels is clearly articulated. In this proposal, it would be possible to establish the arcade as the circulation spine and the space that establishes the identity of the campus while preserving considerable flexibility for relatively independent adaptations of the internal layouts of existing buildings. Furthermore, the linear quality of the arcade would make it easy and economical to survey, thus enhancing the sense of safety.

Second, it draws the best advantage of the urban context. The several parking structures around the campus would be directly linked with the campus core. Sites on both ends of the campus would be brought under the purview of the arcade in anticipation of future stages of expansion. Major entrances would be created to take advantage of the most important urban streets. Pedestrian access from metropolitan transit stations nearby would be facilitated, if so desired, in the future. Over and above those internal benefits, the hospital would make a clear contribution to enhancing the quality of the urban surroundings because the new building would front a major urban street and also because the arcade could culminate in attractive open spaces at both ends.

These advantages were consistent with very noticeable improvements in the syntactic structure of the campus. Syntactic intelligibility is improved not only in comparison to the existing situation but also in comparison to the second option. The same applies to syntactic integration. Taken together, these two sets of figures suggest that the proposed arcade will make the campus much more coherent and intelligible to its clients. The proposed arcade would clearly be the most integrating space of the complex. Depending on the exact design of connections, and possible reconfigurations of circulation, it would be possible to spread the core toward the various departments not only in the new building but also in existing ones. This would assist the creation of smooth transitions from the more public circulation to the primary departmental interfaces between healthcare providers and their clients.

It must be emphasized that the proposed modification was based on considerations of intelligibility and flow of movement and did not address the many constraints, both technical and financial, that have to be addressed in any master plan. Should the modification be accepted, new design problems would be defined that would need to be solved at subsequent stages, including connecting across the arcade at lower levels and bridging over it at upper ones. This is in the nature of the design process and of the interaction among statement of objectives, proposal, evaluation, modified statement of objectives, and so on. The use of space syntax adds rigor and makes explicit consideration that might otherwise be lost at the earlier stages of design and dealt with as problems rather than as opportunities at the later ones.

Conclusion

Space syntax illustrates the emerging computer-assisted techniques that bring rigor and precision to the creation and evaluation of hospital plans for intelligibility and liveliness. These are characteristic of the culture of successful institutions. The convergence of such emerging techniques and the underlying trends in hospital evolution represents a promising opportunity for further enhancing the architectural quality of hospital buildings and the satisfaction of the needs and aspirations of their client users.

In particular, space syntax provides a rigorous method to answer several questions:

- Is a healthcare facility using its architectural resources most effectively by placing them where people will be found—in the integration core—and where people naturally perceive the front-stage space to be?
- Does the layout generate "internal streets" that will be genuinely lively and well populated?
- Are major public functions located where people expect them to be?
- Is the overall plan intelligible? If not, what major or minor changes will make it legible?

Space syntax focuses with precision on one aspect of healthcare planning and design: the relationships among the three-dimensional volumes that constrain human movement and visual experience. By providing this one aspect in clear relief, it allows issues such as intelligibility and user-friendliness to be addressed precisely, with clear implications for design. The decisions it focuses on are typically *architectural* decisions. They are smaller in scale than the decisions that planners make about siting and zoning, yet less detailed than the decisions of interior designers about materials or furnishings. Yet space defined in this way links the three arenas of planning, architecture, and design. Space syntax can help clarify major planning and programmatic decisions such as whether a medical mall produces a lively interior street; it can also reveal where patients, visitors, and staff are likely to be walking and therefore where "front-stage" materials and furnishings can be placed for greatest effect.

PART II: Using Computer Animation to Enhance the Design Process — Anatomy of an Architectural Animation

Editor's note: This section, contributed by Molly Scanlon, is based on her presentation at the Eighth Symposium.

Scanlon: *Animation* is a motion picture made by photographing a series of drawings, each showing a stage of movement slightly changed from the one before so that the figures in them seem to move when the drawings are projected in rapid succession.

Public traditional perception of animation is

- movies
- cartoons
- commercials
- entertainment

Remember the cartoon booklets that you can rapidly thumb through the pages and see the cartoon appear to be in motion? Or, maybe you went to an amusement park, put a nickel in a viewfinder, turned the wheel, and watched a series of photographs flash in front of your eyes to create motion. That is animation without computers. The computer takes the place of drawing the thousands of picture "frames" needed to create that movielike motion.

The development of new technology in software and hardware for the personal computer enables animation to infiltrate our daily professions such as

- architecture
- education
- litigation
- product design
- scientific research
- training

These professions have traditionally been limited to expressing themselves in print media for centuries. Animation is an ideal communication tool for subjects that have been previously too complex to tackle.

In today's world of computer graphics, there are two terms that are associated with animation that are constantly misused.

1. *Multimedia* is what the name implies: using several different types of media within one presentation. Some of the examples discussed here are in fact multiple media. But remember that the majority of these images are a single medium called animation.

2. *Virtual reality* is being able to place yourself in a space and direct your motion within the space. Virtual reality is frequently mentioned when advanced computer graphics are involved, and they are not the same thing. Virtual reality is not marketable in professional presentations with today's technology. It is being used in entertainment and children's games.

History of Computers in Design

Two-Dimensional Computer Graphics

1979: introduced to architectural field
1985: popular trend in offices
1990: expected as part of services

Three-Dimensional Computer Graphics

1988: introduced to architectural field
1995: popular trend in the field
2000: expected as part of services

Quick Time Virtual Reality

1995: introduced to the graphic field
2000: popular trend in the field
2005: expected as part of services

If it weren't for client demands, the architectural field might not have computerized at all. But through client demands, two-dimensional (2D) computerized graphics have become the industry standard. Why? Because the client had other uses for that computerized information. The same is true for three-dimensional (3D) graphics.

Animation specifically levels the visual playing field. Architects and engineers usually think very well in 3D. The typically untrained client eye does not come to the project with that ability, yet clients are responsible for approving the project at various stages even though they often do not know what they are looking at.

Once the animation is created, it will be used beyond the design process for community relations, fundraising, physician attraction, financial investors, preselling homes, and tenant attractions. Essentially, any aspect that affects obtaining approvals or sales in a faster process will be drawn into using the method with the most powerful communication medium possible.

Animation in Healthcare

Animation in healthcare can be used for continuing and patient education; medical device design, training, sales; and facility planning and design.

Animation in the design process can be used for the following:

- space programming (judging the size of rooms)
- master planning (massing/departmental zoning)
- schematic design (exterior zoning concepts)
- design development (interior building views, medical equipment)
- construction documentation (solving details)
- final presentations (user groups/review boards, community groups, fundraising, managed care contracts, physician attraction)

An animation should be based on the message that is trying to be communicated. This should take into account (1) the audience type (doctors, community/public, city council, board of directors), and (2) an organized sequence of thoughts to create a presentation.

Defining what we are going to create involves the development of a *storyboard,* with each scene briefly described to obtain a general understanding of the scope of work involved.

If computer-generated 2D images (floorplans, elevations, sections, site plans) have been created by the architect, these can be reused in the animation efforts. All your animation consultant should need is files transferred to a .DXF extension for use in his or her system if it is different from your own.

Even with the availability of this information there is still significant effort necessary to evolve this into a 3D model. If no files are available, then the animation consultant will input that information from a set of blueline documents, photographs, sketches — any information that is available to describe the project.

Using the floorplan as an example, each point on the plan also has a corresponding vertical dimension that, when inserted, will create a 3D wireframe. The total wireframe model is composed of a series of "faces" that now have volume.

The faces are assembled into "object" groupings. Each object is assigned a color, texture, and reflectivity. These specifications can be assigned differently to each face within an object, but this is typically not necessary.

Once the model is built and color mapping is assigned, it is time to experiment with lighting. In computer modeling, numerous lights can be cast onto an object to create a desired effect. Knowing how to control the lighting and simulate shadows brings the animation into another level of development. Poor lighting will cause undesirable effects to the color mapping and particularly the reflectivity, which may mean going back and adjusting the previous object attributes.

Modeling programs contain a limited library of accessory objects used to add life to the animation, including people, landscape, cars, planes, trains, helicopters, and furniture. Add-on libraries are available.

However, you can glean some knowledge of your animation consultant based on how flexible he or she is with these items. If an animation consultant has done numerous jobs, he or she will have a more developed library of objects from which you can pick and choose. If something is especially important to you in this area, you need to make this known during the storyboard creation so time can be allowed to modify these objects to fit your animation.

In the previously agreed storyboard phase, the computer camera's path of travel has been defined so that the computer modeling is detailed out in these areas. This camera motion from point A to point B is called a *motion path*. Assuming that has been done, there are some basic elements of motion paths that must be outlined:

- Frame: A single frame of animation is equivalent to one photograph or one sketch within a cartoon.
- 30 frames per second: In order for your eye to see animation without interruption (flicking, pausing, space between images), a sequence of 30 frames must flash onto the screen per second.
- 10 minutes per frame: Using professional animation services, one can create images that take anywhere from 10 to 30 minutes per frame. We will use 10 minutes for our example equation, knowing that increasing the time simply lengthens the example.

A motion path is defined to be 20 seconds long across the front of a building. A motion path of this type using a pentium @ 90MZ with 32 megabytes of RAM computer processor equals:

- 20 sec. animation x 30 frames per second = 600 frames
- 600 frames x 10 min./frame = 6000 minutes
- 6000 min. (60 min./hour) = 100 hours
- 100 hours (24 hours/day) = 4½ days
- 4½ days with one machine
- 1 day with four machines
- .15 day or 4 hours with 25 machines

Now let's examine that same time for the entire animation sequences, which, for most projects, tend to run four to five minutes:

- 5 min. animation x 60 sec./min. = 300 sec.
- 300 sec. x 30 frames/sec. = 9000 frames
- 9000 frames x 10 min./frame = 90,000 min.
- 90,000 min. (60 min./hour) = 1500 hours
- 1500 hrs (24 hours/day) = 62.5 days
- 62.5 days with one machine
- 15.6 days with four machines
- 2½ days with 25 machines

This example does not include any time for test rendering time to check the camera path, taking machines away from rendering time for person hours to build the computer model, having the client want to make changes to the computer model, thus creating a need to "rerender" the animation.

Evaluating Animation Services

This is such a new industry that most companies have little idea what to give to the animation consultant for creating a proposal and have no expectation of what to expect in return.

Here are some guidelines you may want to review when considering animation services:

1. *What does an animation consultant need to know about your project?*

- purpose/audience/why animation
- outline story in paragraph form or a series of thoughts about the important points to communicate to the audience
- whether any 2D computer files available
- current design phase of the project
- schedule and project deadlines
- level of desired detail (massing vs. high-end detail)
- number of exterior views
- number of interior views
- whether there is a budget range for presentation materials
- whether any photographs, live video footage, or still information will need to be incorporated into the animation

2. *If you were writing an RFP for animation services, what types of questions should be asked?*

- How many years of experience does the firm have in animation?
- What is the background of the "key staff" involved in the process?
- Does the consultant have previous work experience in that professional arena — architectural, legal, healthcare?
- Briefly describe the process and interaction between the client and your animation firm.
- How easily will changes be made and will this incur additional fees?
- How often will we be involved in progress/approval review meetings?
- How will we receive progress information and in what form?

- What type of hardware or software will we need to review and/or ultimately view the animation?
- Is any of the hardware or software proprietary information from your firm (i.e., are we obligated to buy or rent any of these items from your firm)?
- What is the final product that we receive?
- What is the rendering frame capacity of your system per day?
- Does your firm have in-house capability to incorporate other images into the final animation video such as video footage, color photographs, sketches, etc.?
- Is your firm capable of producing an animation with script writing, music, and voice narration?
- Are these above special items performed by your company or subconsultants?
- Who is responsible for managing and coordinating this process with us?
- How extensive is your library of "plug-in" entourage — people, cars, trees, furniture? How will you customize the things we need for our animation?
- Does your firm have color plotting capabilities for printing rendered still frames from an animation?

3. *When reviewing animation services you need to center your analysis on three basic areas of concern:*

- Talent: What is the graphic quality you are looking for?
- Technology: Is there enough power to generate the product in a timely manner to meet our deadline?
- Experience/results: What has this company done in the past that speaks to the result we are looking for?

The firm that confidently answers these questions to your satisfaction should be able to produce a quality animation in a timely manner.

Costs

Creating the fee structure for an animation is handled in a limited number of ways at this point in the development of this industry. You will most frequently find that fees are quoted as fixed fees in lump-sum increments. We are aware of only two methods of determining that fee:

1. quoted based on a cost per minute of animation;
2. quoted based on the complexity of the model/animation and the labor involved in developing the final product.

Method One is the more common in the market at this time, although we believe that Method Two is more ethical and eventually where the market will develop.

Without having a definitive storyboard and concept of the complexity of the computer modeling and animation scenes, it is impossible to pinpoint costs. But, we all need a "ballpark" to play in to even consider whether these services are valid for a specific project.

Some ranges of costs we typically get into in our architectural projects are as follows:

- 0 – $5,000: Short, brief, simple animation for a "snippet" or "teaser" to be used during an interview
- $5,000 – $10,000: Master planning, massing models
- $10,000 – $25,000: Exterior design models, either SD of DD level of development
- $25,000 – $50,000: Exterior and interior modeling
- $50,000 – unlimited: Large-scale projects with numerous levels of detail for both exterior and interior

The schedule is very dependent on the number of staff and computers available to do the project efficiently. In a larger office of animation (15–20 people), with a sophisticated staff and computer system, projects can range from two to eight weeks, depending on the complexity of the animation. If a project seems to take months to accomplish, review the questions set aside in the RFP section and find out the root of the problem.

If this discussion can leave you with some lasting thoughts to consider how animation will affect your industry, they should include:

- being more knowledgeable about animation as a presentation medium
- understanding that animation requires a level of talent, technology, and experience that will directly affect the aesthetic quality of the images, the time on task, and the cost. Understand that this is a custom process that can involve a level of labor to complete
- whether you decide to do these services in-house or outsource to a consultant — knowing what you are getting involved in before you make a significant monetary investment

---

Selected Bibliography (Part 1)

Benedikt, M. L. "To Take Hold of Space: Isovists and Isovist Fields." *Environment and Planning B,* vol. 6 (1979): 47–65

Cammock, R. *Primary Health Care Buildings*. London: The Architectural Press, 1981.

Cammock, R. "Confidentiality in Health Centres and Group Practices." *Journal of Architectural Research,* vol. 4 (1975): 5–17.

Carpman, J.R., Grant, M.A., Simmons, D.A. *Design That Cares*. Chicago: American Hospital Association, 1986.

Cowan, P. "Growth and Change in Hospitals." In *The Transactions of the Bartlett Society vol. 3, 1964–1965*. London, 1964.

Duffy, F. "Buildings Never Lie." *Architectural Design* (February 1996): 105–106.

Green, J. "Basic Types of Hospital Layout." *Architects' Journal* (28 December 1966).

Hillier, B. and Hanson, J. *The Social Logic of Space*. Cambridge: Cambridge University Press, 1984.

Hillier, B., Hanson, J., Peponis, J. "What Do We Mean by Building Function?" In *Designing for Building Utilization*, edited by J.A. Powell, I. Cooper, and S. Lera. London: Spon, 1984.

Passini, R. *Wayfinding in Architecture.* New York: Van Nostrand Reinhold, 1984.

Peponis, J. and Stansall, P. "Spatial Culture." *Designers' Journal* (June 1987): 52–56.

Peponis, J., Zimring, C., and Choi, Y.K. "Finding the Building in Wayfinding." *Environment and Behavior*, vol. 22 (1990): 555–590.

Sharkawy, M.A. and McCormick, M. "Wayfinding in Complex Health Care Environments: Linking Design to Research." *EDRA,* vol. 26 (1995): 43–46

Weeks, J. "Hospitals." In *Architectural Design,* no. 7 (1973): 436–463.

Weisman, J. "Evaluating Architectural Legibility: Wayfinding in the Built Environment." *Environment and Behavior,* vol. 13 (1981): 189–204.