The special needs of the computer programmer in terms of working space, furniture design, access to terminals and conference rooms, and overall working environment led IBM to construct a facility intended to enhance programmer productivity in a development environment. That facility is the Santa Teresa Laboratory in San Jose, California, designed by MBT Associates of San Francisco. This essay discusses the programmer's needs, how they were perceived, and the process by which they led to unique design concepts, as well as the architectural philosophy underlying the design process.

IBM's Santa Teresa Laboratory—Architectural design for program development

by Gerald M. McCue

Computer programming normally is performed in work areas intended for other uses—typically in offices designed for business. As a result, programmers have had to contend with a number of practical problems, such as the need to work with and store items of unusual dimensions. Program listings and punch cards, in particular, pose special problems in desks and cabinets and on shelves intended for the standard size documents of the business world. In addition, there have been significant changes in the way programming is practiced. More and more programs are developed on line at computer terminals, and concepts such as the chief programmer team have been introduced. These changes have altered the programmer's working environment, creating a need for ready access to terminals and conference rooms, for example.

Recognizing these requirements, IBM commissioned MBT Associates, a San Francisco architectural firm, to design a building and interiors intended specifically for program development. That facility, opened in 1977, is the Santa Teresa Laboratory of IBM's General Products Division. Located in San Jose, California, it provides the working environment for 2000 people engaged in systems and applications programming. Although IBM has many programming facilities throughout the world, this is the first designed specifically for the activities involved in program development.

This essay is concerned mainly with the special needs of the computer programmer, how those needs were perceived, and the process by which they became generators of design concepts. The design challenge was to bring a large number of people together into a close-knit working community and at the same time create an environment conducive to enhanced programmer productivity through team interaction as well as individual concentration.

The work environment of the programmer is emphasized, although the requirements of the laboratory's computing center and of personnel working there also were important design considerations. The computing center supports the General Products Division's West Coast data processing network as well as all on-site processing. Other planning and design factors, such as energy conservation and seismic provisions, were major architectural considerations but are not discussed here in order to focus on the programmer's work environment.

The essay includes three sections. *Defining the work environment*, *Designing the site and building complex*, and *Furnishing the individual work area*. These sections are presented in approximately the order of the actual design steps and are preceded by a description of the architectural design process.

Architectural design

In many respects, architectural design follows a standard three-step problem solving model:

- identification of needs and objectives
- design concept (generation and evaluation of alternatives)
- design development (refinement of the selected solution).

These steps normally are taken in sequence, but in the designing of Santa Teresa, the identification of needs and the generation of alternatives were combined, permitting a better collaboration between programmers and designers and providing greater opportunity for innovation.

Innovative design is often derived from a careful analysis of the issues that influence the solution. Needs are identified, prototypical solutions evaluated, and new approaches considered. The design process is one of synthesis, where optimal designs for different issues are combined in an attempt to meet objectives.

The process is not linear, but proceeds in cycles, each cycle building upon knowledge gained from the previous one, so that successive design concepts can be responsive to a greater number of relevant issues. The designer is called upon to consider a large number of variables simultaneously, and complete synthesis is rarely possible because of the number of often conflicting requirements. Consequently, early design concepts usually are advanced to satisfy the most fundamental objectives, and these approaches are evaluated with respect to other requirements. In the designing of Santa Teresa, consideration of the work environment was perceived as the fundamental need, and it served to generate the form of the complex as a whole, as well as the individual work space.

The process does not proceed from major considerations, such as building form, toward details such as the form of individual rooms. Instead, initial studies attempt to identify both the detailed and the more general requirements for an ideal solution. The first studies for Santa Teresa, for example, concurrently explored the needs of the individual project work areas and the characteristics of the site environment, as well as the needs of the building complex as a whole.

Different issues often suggest conflicting spatial solutions, and resolution of conflict may offer the greatest opportunities for innovation. An apparent conflict between the need for interior planning flexibility and the desire for outside awareness (that is, visual contact with and proximity to the natural environment) brought forth the unusual design solution that gives Santa Teresa its distinctive character.

The design process is laden with value judgements, first as to which needs and preferences are considered, then as to the relative priority to be given different needs when conflicts arise. Attempts to make such judgements more explicit through cost benefit techniques usually are not credible for problems with so many variables. Similarly, decomposition methods, which build decision networks based on minute detail, are tedious, and the results rarely warrant the laborious process. Thus, in most cases, design is essentially the systemic revealing of relevant considerations and the formulating of design solutions that reflect the specific needs and relative values among the many objectives.

The personal values of those who participate have a critical influence on the solution. The Santa Teresa Laboratory is significant, in part, because of the active participation of user groups—programmers, program managers, and several levels of IBM management. Communication among these groups, IBM's Real Estate and Construction Division, and the designers of MBT Associates, achieved an iterative design process. Through continued dialog, needs were identified, compatible solutions sought, and different values respected. Alternatives were explored that otherwise might have been precluded. Interaction during the problem identification and design concept steps proved invaluable, permitting subtle qualities of the programmer's needs and preferences to be incorporated into the final design.

Defining the work environment

The first IBM statement of requirements for Santa Teresa was in two parts, a summary of building requirements, and a description of the programmer's activities and preferred amenities (see Appendix A). Both documents tended to be statements of objectives rather than prescriptive solutions. The programmer's activities are described as primarily "project work" in which system and application programs are designed, coded, documented, tested, and supported. Specific development projects range in length from one to three years. The typical development programmer performs intensive and creative work as part of a project team of two to five persons. Two to four teams, with a secretary and manager, form the typical department of ten to fifteen persons.

According to information provided by an IBM User's Study Group, about 30 percent of the individual programmer's time is spent working alone, about 50 percent with groups of two or three, and the balance with larger groups, in travel, or handling other responsibilities. The programmer's role is dynamic, for programmers may be moved and regrouped as required for specific project teams. These activities are defined below in terms of functional requirements and qualitative preferences.

functional requirements

Consideration of the needs of both the programmer and the programming center resulted in a summary of specific requirements (see Appendices A and B). Programmers perceived the following as most essential for individual work areas:

- a private, personal work area that permits intense concentration, screens distractions, and discourages interruptions, with connections for a computer terminal and adequate space to lay out and store large quantities of paper goods;
- proximity to common terminal rooms for team programming work and small meetings, as well as for additional layout space and storage;
- proximity to conference rooms and classrooms;
- access to the computer room, library, and food service area, preferably under cover;

- furniture designed to reflect the programmer's special layout and storage needs (detailed requirements, prepared at a later stage in the project, are discussed in the last section of the essay).

Functional requirements for programming teams and for site support, reflecting management's concern for communal needs, were perceived as follows:

- encouragement of effective communication and interaction within teams and departments, and with other groups;
- flexibility of spatial arrangements to facilitate reorganization of teams and departments and adjustment to changes in technology;
- integration of the manager's office, secretarial area, and common terminal rooms with programmers' work areas;
- proximity of project work areas to the computing center, library, business center, and other support services;
- efficient paper handling techniques and adequate service access to all work areas;
- a high level of security.

Functional requirements expressed by IBM's Real Estate and Construction Division stressed issues affecting capital investment, operating costs, and long-range flexibility. They included:

- a modular building plan with mechanical services designed to accommodate either open-office planning or subdivision into separate offices;
- flexibility in office groupings so that programmers and departments can be regrouped without moving partitions and with minimal moving of furniture;
- full access for handicapped personnel;
- easy accommodation of service and materials handling;
- energy conservation and heat recovery from computers, with low operating and maintenance costs.

qualitative preferences

The designers of MBT Associates were charged by IBM to create an environment that would be "conducive to productive and creative work" (Appendix A). The programmers were characterized as being involved in imaginative synthesis and productive processes requiring personal privacy. The facility would have a large number of people, but a strong desire for a noninstitutional environment was stressed.

After privacy, the environmental amenity that seemed to be of most significance to the programmers was outside awareness. Stimulating interior and exterior spaces, with natural light and interesting colors and materials, were requested, and the ability to arrange and personalize office space was also considered highly important.

apparent contradictions

There were apparent contradictions in some of the expressed requirements and preferences:

- a desire for individual offices, and also a need to accommodate open planning;
- a desire for individually customized work spaces, and also a need for aggregate work areas and flexibility for future change;
- a requirement for closely grouped work areas near central services, also a desire for a sense of small scale and identity;
- a need to provide major centralized services for 2000 people, and also a strong desire for an informal, noninstitutional setting.

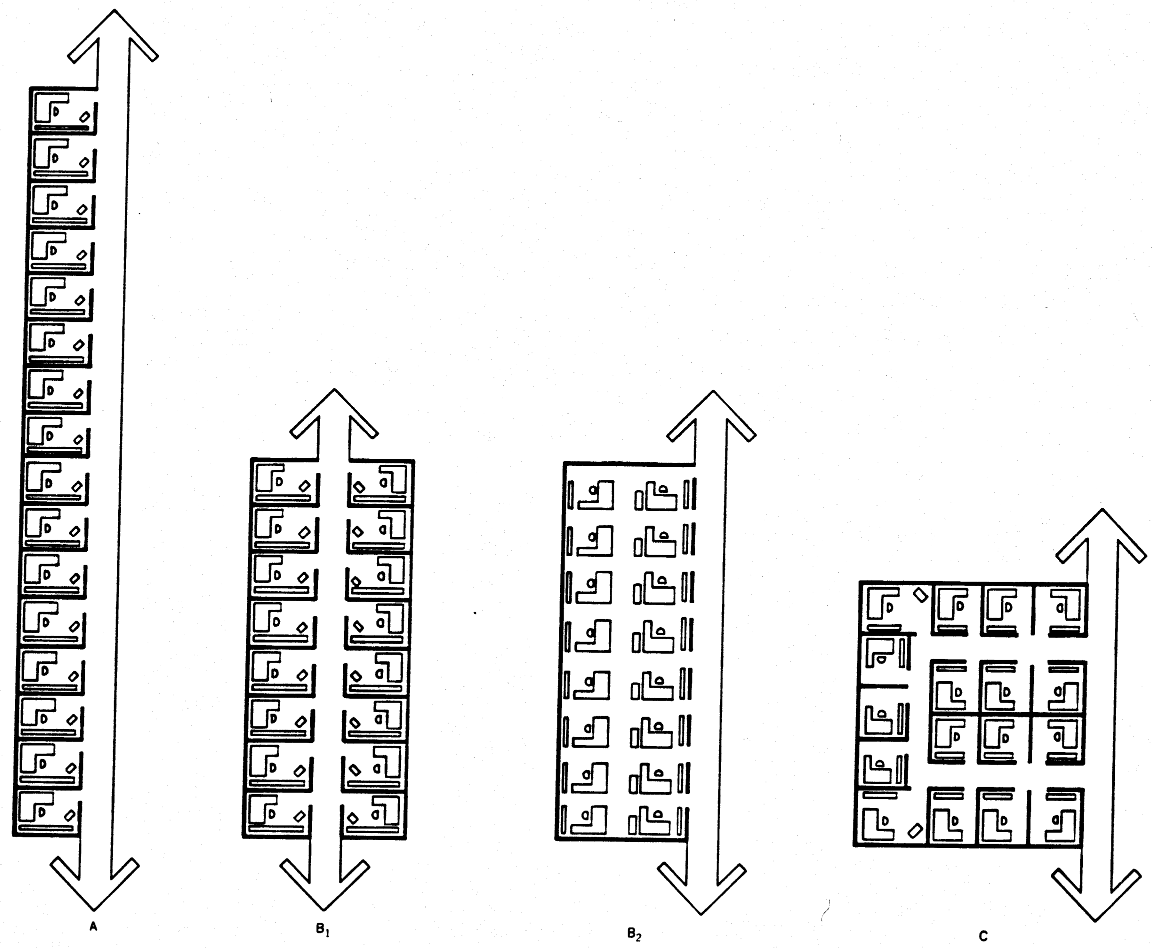
Some of these contradictions could not be resolved, but the level of success in reconciling them was one guide in evaluating alternative design concepts.

One of the first design steps was evaluating alternative designs for the project work areas, where more than 1900 people would be engaged in the primary site activity. After comparison of several configurations, the bay space labelled C in Figure 1 was selected tentatively as the most desirable. In contrast with a single-office-depth bay along a corridor as shown in A, or a double office depth as shown in B, the type C bay could accommodate several arrangements of open space planning, or it could be efficiently subdivided into offices. Its size and shape also accommodated two exits, obviating the need for either a permanent fire-rated corridor or a separate fire-exit stair within the bay. The type C bay also had the significant advantages of bringing individuals working on the same team into close proximity, and if subdivided, provided access to offices and common rooms from a semiprivate aisle. This bay appeared to meet the functional requirements as well as the desire for a sense of privacy and personal territory.

Studies of the individual work spaces indicated that a 10-by-10-foot space would be most versatile, so the type C bay was designed with a 5-by-5-foot grid, to accommodate 10-by-10-foot individual work areas and 10-by-15-foot or larger team rooms. It was determined that individual offices would be planned with the provision that programmers, senior programmers, and program managers all would occupy the same size offices. Thus the regrouping of teams and departments could be accomplished without having to move walls.

The C-type bay, measuring about 45 by 50 feet, was accepted tentatively as the basis for further planning because of its potential for optimal interior space planning. However, at this time there was no agreement about the manner in which the bays

Figure 1 Office layouts considered for Santa Teresa



should be grouped into a building form, or which of the edges, if any, might be exterior walls. A major concern was that modules so closely tailored to the size of a typical department might not accommodate the balancing of teams and departments. These considerations were the subject of the next design studies, which explored alternate ways of organizing the individual modules into a building form.

Designing the site and building complex

Conservation and ecological considerations were central themes in the site planning. Of the 1180-acre property, all but 271 acres is to be preserved in its natural state. The portion of the site being utilized is a 90-acre planned-development parcel, and currently only a 50-acre area is actually developed. Of this area, only about 15 percent is devoted to buildings and about 30 percent to parking; the balance is open space.

Among the many considerations that influenced the design of the site, such as topography, expense, traffic, and drainage, a major factor was the providing of building service. A study of the service requirements for Santa Teresa indicated that over 200 boxes of computer output paper will be consumed each day, requiring delivery and pick-up in bulk. Almost all of this paper will be delivered through a central service area for transfer to the computing center. Most eventually will find its way to the various project work areas and then to a shredder and back to the service area for shipping to a recycling center. The paper handling requirement is massive, involving outside service access for trucks and semi-trailers. This requirement proved to be a critical consideration in the evaluation of site development concepts.

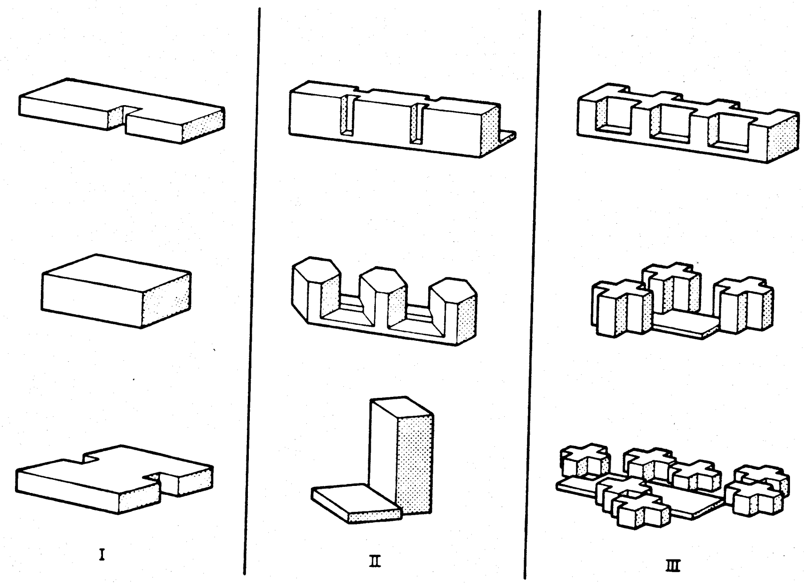
building design

Tentative acceptance of the type C bay for the project work areas, and approval of the site development concept, provided the basis for considering alternative ways of grouping spaces and organizing them on the site. Among the needs and preferences expressed by the programmers, the most influential in affecting spatial organization were aggregation of bays to achieve operating flexibility and arrangement of work areas to achieve maximal outside awareness. As a result, the design team proposed to isolate the outside awareness issue as a means of exploring organizational principles. For purposes of study, it was assumed that the generic difference between all building configurations was the extent of outside awareness that alternative grouping of the type C project work area would permit. Under this assumption, the amount of outside exposure would be the only variant, and overall building configuration, whether "lines," "elles," "U's," "O's," or other shapes, temporarily would be considered irrelevant. Though an oversimplification, this assumption permitted objective studies by which various degrees of outside awareness might be compared directly with other sought-after planning objectives.

The selected C-type bay had several work spaces in the center, so it would not be possible to achieve 100-percent outside awareness. Therefore, preliminary studies examined levels of exposure ranging from zero to 70 percent. Three alternatives, as illustrated in Figure 2, were selected for more detailed study:

- Alternative I—no project areas with outside awareness. This scheme was based on the assumption that if one person had to work in an inside space, everyone should. Type C bays would be grouped adjacent to one another in interior loft-type space, and outside awareness would be provided only from special spaces and circulation corridors located adjacent to the outside walls.
- Alternative II—30 percent of project work areas with outside awareness. In this scheme, only one edge of the type C bay

Figure 2 Building configurations considered for Santa Teresa



would have outside exposure, and the bays would be grouped adjacent to each other along one outside wall.

- Alternative III—70 percent (the maximum) of project work areas with outside awareness. In this alternative, the type C bays would be grouped in cruciform pavilions so that three edges of each bay would have outside walls.

Each alternative was evaluated with respect to the following criteria:

Functional criteria—

- flexibility in the balancing of project teams and department sizes within a series of type C bays;
- adjacency of spaces such as conference rooms, classrooms, and service areas common to several project teams or departments;
- efficiency of mechanical and electrical service systems;
- effectiveness of communications among functions;
- sufficient building access and control for visitors, employees, and service personnel.

Qualitative criteria—

- extent of outside awareness and quality of view;
- coherence and visual quality of circulation systems;
- pedestrian rather than elevator circulation;
- sense of place and orientation within the building;
- accessibility, usability, and visual quality of exterior spaces.

Efficiency and value criteria—

- efficiency of space utilization (net assignable square feet divided by gross building area);
- efficiency of the structural system (in terms of cost per square foot of building area);
- efficiency of the mechanical system (in terms of cost per square foot of building area);
- efficiency of enclosure systems (in terms of cost per square foot of enclosed wall);
- cost of total development, operation, and energy consumption.

Note: it was assumed that the cost of interior finishes would be the same in all schemes.

design development

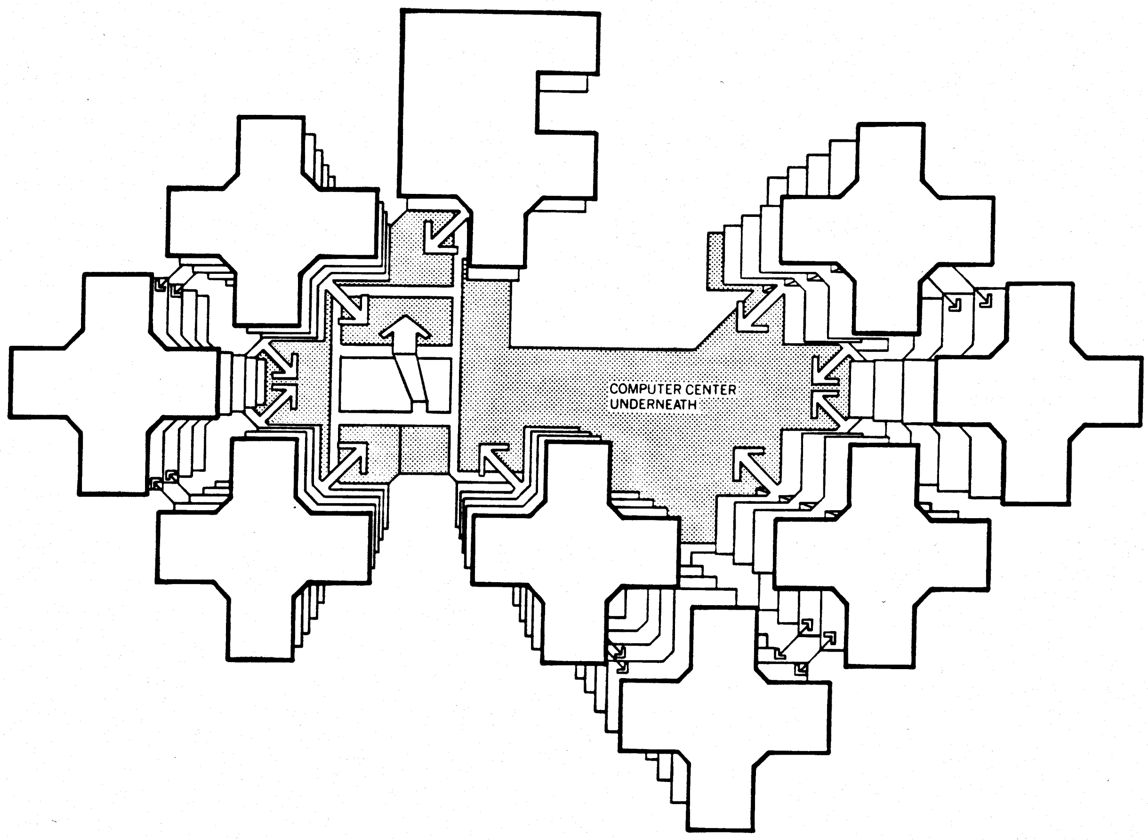
The Alternative III grouping, in which the type C bay has three outside walls, was selected as providing the best balance of expressed needs and preferences. Based on this grouping concept, several overall building organizations were explored. The approach that met most requirements for both internal arrangement and site development began as a set of separate programming buildings around a central, one-story service building. Through successive steps of refinement, it evolved to the present form—a series of pavilions integrated into a large, contiguous ground-floor area.

Two of the many objectives for Santa Teresa dominated the final solution: the preference for individual work areas with special qualities, and the need for centralized service and close communication with central facilities. In the final design, illustrated in Figure 3, several four-story programming pavilions containing the project work areas are grouped around and joined to a large, one-story central area. At the ground floor, the central area contains the computing center and other facilities. At the second level, on the roof of the computing center, there is a garden quadrangle which is the focus of the scheme. Six smaller courtyards are formed by the groupings of the individual pavilions around the central quadrangle.

In its final form, the scheme provides multiple yet differentiated access with a two-level circulation system. Visitors enter the building complex through a central lobby at ground level. From there, they can be escorted into the building at ground level or through the courtyard behind the lobby and up to the garden quadrangle at the second level.

Service access is by way of a loop road to the rear of the developed portion of the site, where the service dock is located. From the service dock there is immediate vertical access to the food service area on the second level and direct horizontal access to

Figure 3 The final design of Santa Teresa



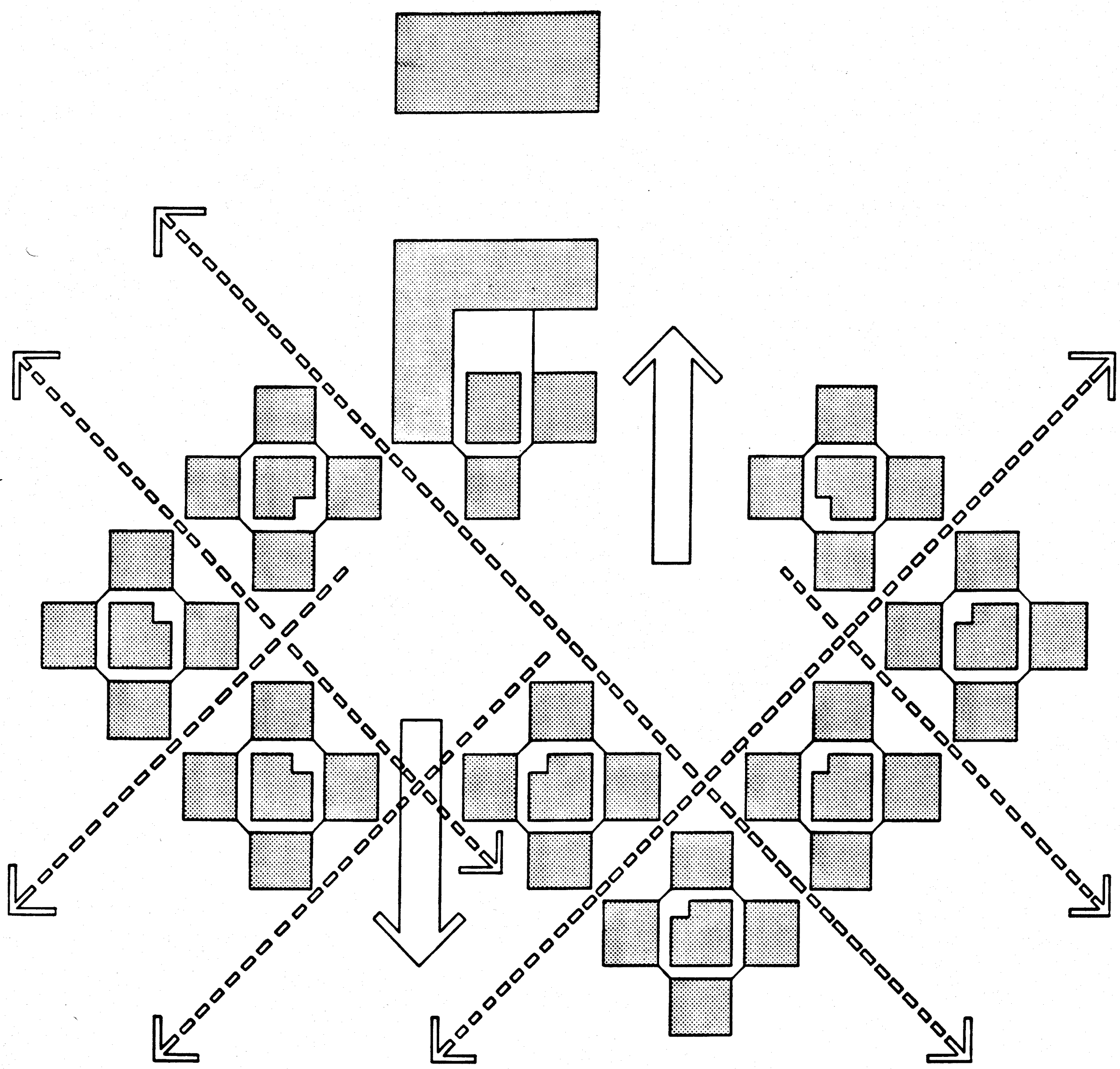
the computing center. An extended service corridor at ground level also provides access to elevators serving all programming pavilions.

IBM personnel enter the building complex through the courtyards between the programming pavilions. From the courtyards they move up one level to the main circulation level in the garden quadrangle. All programming pavilions and the food service facility are accessible at the garden level. The pedestrian scale of the complex is enhanced by this arrangement, since other floors are only two stories up or one story down from the garden level.

Geometric ordering of the complex is achieved by a "tartan grid," the C-type bay being separated on all sides by a narrow band of space. Except at ground level, the narrow spaces are always open, either as exterior spaces or as interior corridors. Thus each pavilion presents the visual appearance of four separate project work areas. This coherent system of open spaces provides a sense of orientation and a close relationship with the exterior.

Figure 4 illustrates the spatial organization and suggests the sense of openness and contact with the outside as one moves through

Figure 4 Plan diagram showing views from interior courtyards

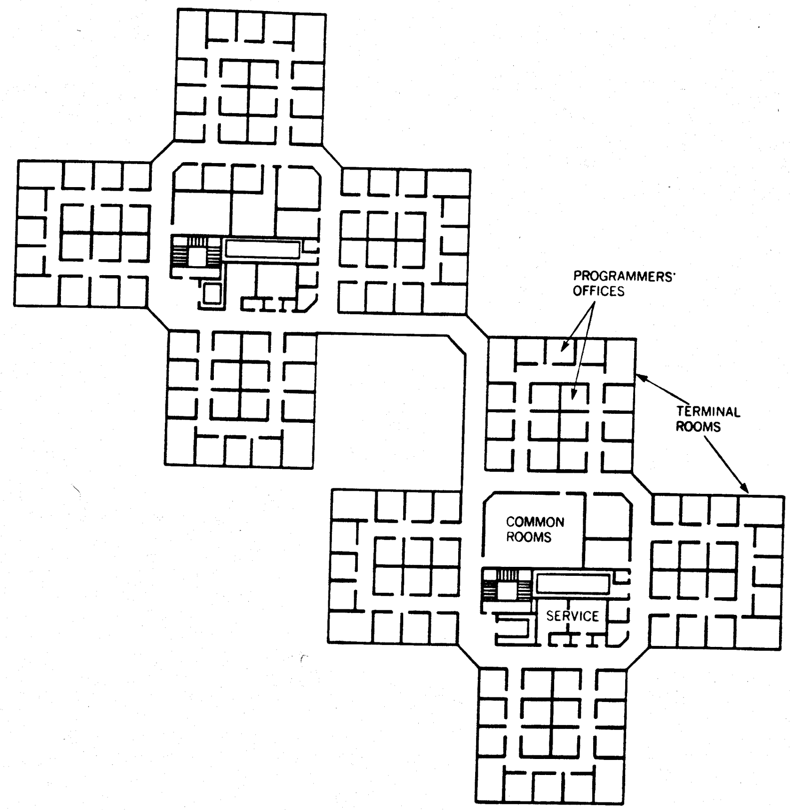


the buildings. On the second, third, and fourth levels this spatial system provides views from all corridors, not only into adjacent courtyards, but through and into the next pavilions and into the countryside beyond.

Furnishing the individual work area

Two adjacent programming pavilions are linked to form a contiguous work area on each floor. A typical building module is shown in Figure 5. One stair in each pavilion provides the two exits required by code for each floor, and one service elevator serves two pavilions. A pavilion of four bays provides about

Figure 5 Typical building module, showing how two programming pavilions are linked

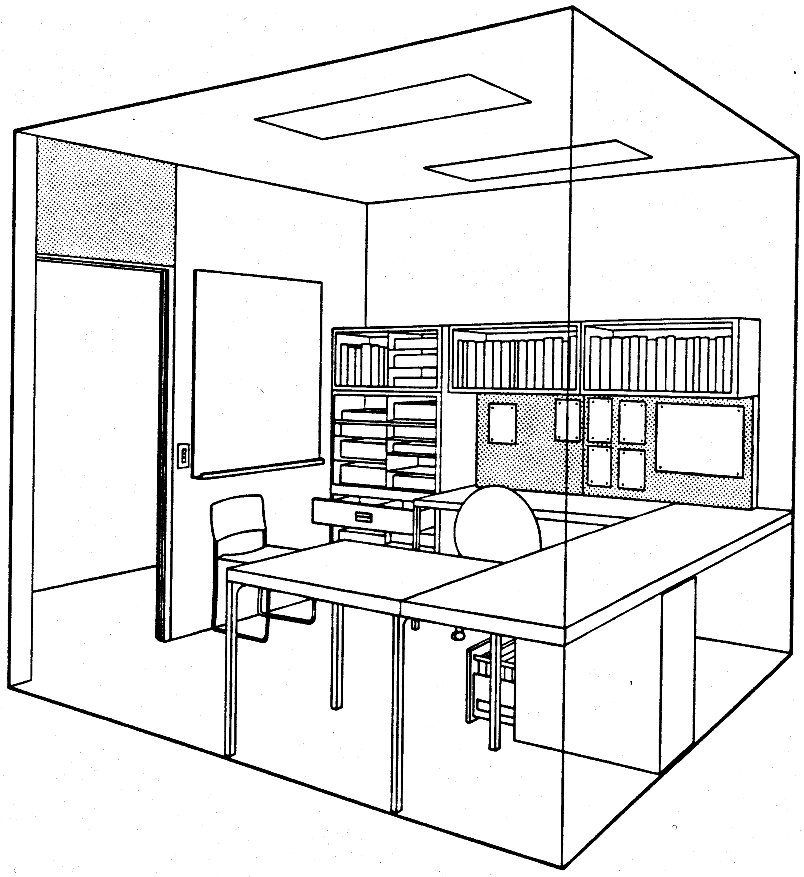


10 250 net assignable square feet in a gross building area of about 13 200 square feet per floor and will accommodate about 70 people. Figure 5 also illustrates a typical interior space planning layout, with individual offices for programmers and managers, common workrooms and terminal rooms, conference rooms and classrooms, and other jointly used services.

As a prelude to interior and furniture design, additional studies reconfirmed the principles established earlier—the need for private individual work areas, the desirability of the 10-by-10-foot enclosed office as the basic work area, and the adaptability of the 45-by-50-foot bay. In addition, the following more detailed requirements were established for the individual work areas:

- a standard set of movable furniture components, intended to remain in an office when programmers or managers are transferred from one office to another;
- efficient work surfaces both for individuals and for programming teams;

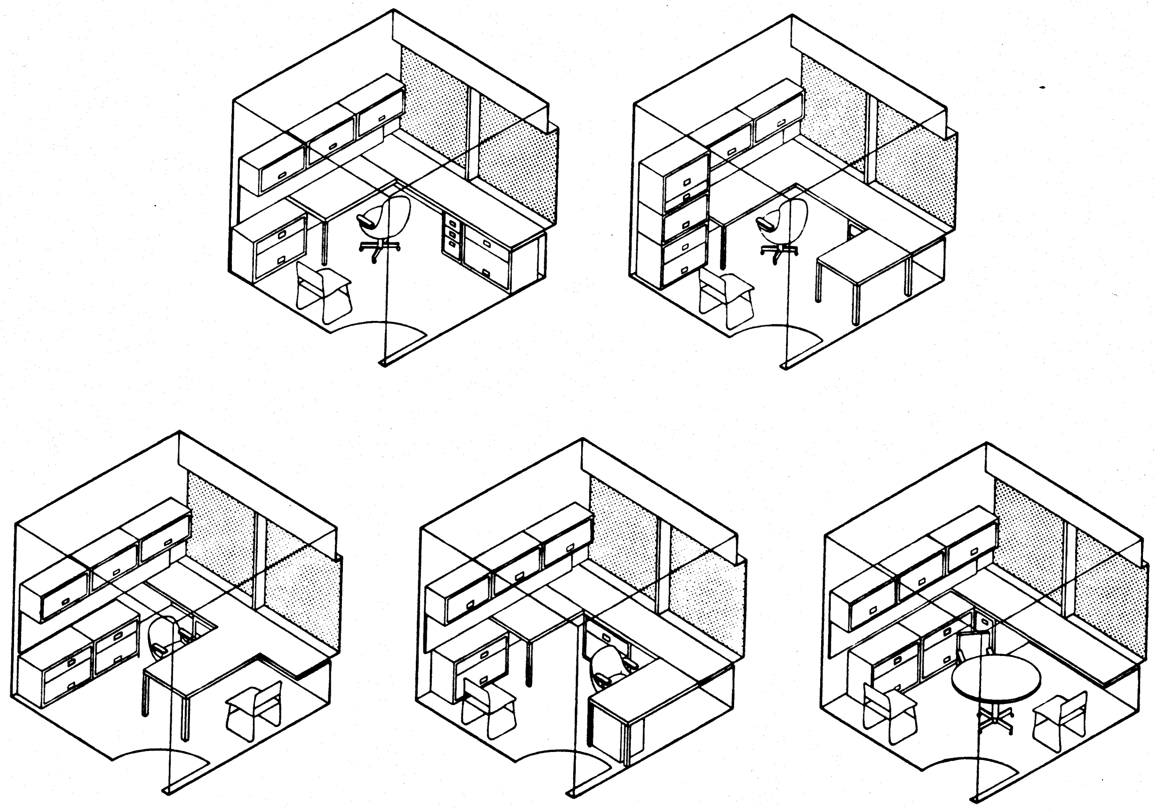
Figure 6 Typical interior of a programmer's office



- a flexible environment conducive to individual expression;
- furniture components that can be rearranged to accommodate individual work styles;
- storage units for program listings and standard-size office paper;
- large quantities of lockable storage that can be expanded incrementally;
- generous work surfaces without leg obstructions and deep enough to accommodate program listings;
- comfortable seating.

The requirements for large storage units and generous work surfaces were the most critical for the programmer's daily efficiency. These requirements could not easily be met by existing office furniture, so users and designers collaborated to modify standard furniture and design some new items. Perhaps the most unusual aspect of this design effort was the testing and evaluation of prototypes, or mock-ups, under working conditions. At two programming locations not far from the Santa Teresa Laboratory,

Figure 7 Design options for programmers' offices



IBM prepared 12 offices to resemble those intended for the new laboratory. The prototype furniture was installed and used under a full range of working conditions for several months. The programmers using the offices were interviewed, and many of their suggestions were incorporated into the final furniture design (see Appendix C).

Final design options are illustrated in Figures 6 and 7. The only fixed features of the furniture arrangement are wall-hung units and a 24-inch-deep counter under the window. The primary work surface, 30 inches deep, can be attached to the fixed counter in any of several places, yielding a number of possible furniture arrangements. Leg obstructions and left- or right-hand bias have been eliminated. Lockable storage units can be slipped under the work surface or stacked to form a storage wall. A pedestal unit with a lockable file drawer and box drawers is also provided. All storage units and work surfaces are dimensionally coordinated to permit a variety of arrangements. Figure 8 shows the interior of a typical office.

Selection of colors and materials was central to the space planning and furniture design. Finish materials are related to both functional and aesthetic values. To add variety and aid orienta-

Figure 8 A programmer's office at Santa Teresa

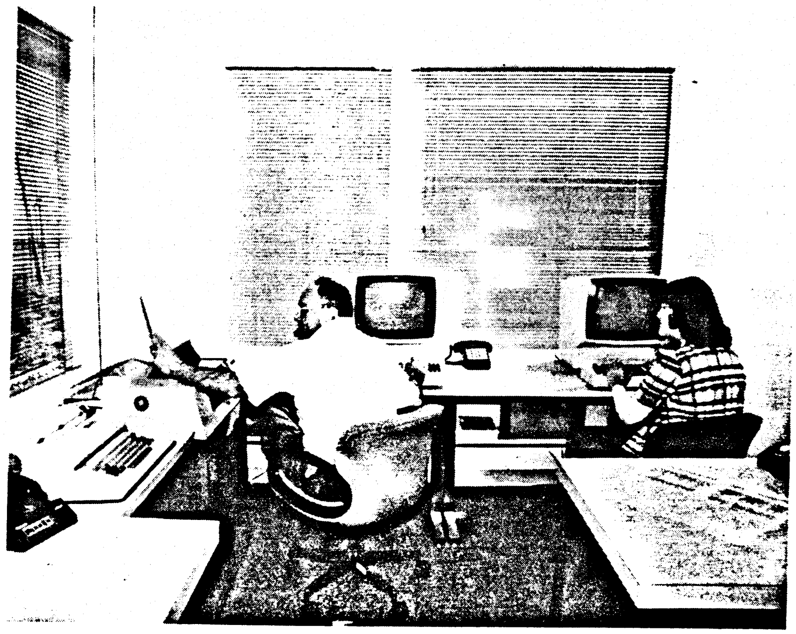
tion, the small courtyards and the walls of the central core of each pavilion are color coded. The doors and window blinds in the project work areas in each pavilion recall the same colors. The floors of the main corridors are hard surfaced to accommodate heavy paper carts, and the aisles and work areas are carpeted. The change in floor material further enhances the sense of privacy in the work areas. To accommodate individual expression, fabrics, finishes, and colors are coordinated to provide variety within the context of a neutral background.

Summary

The design of the Santa Teresa Laboratory is derived from both the functional and qualitative needs of programmers. On the functional level, the building brings 2000 people together in close working proximity. A number of design features have been combined to promote centralized convenience and easy communication. For example, interior circulation connects all central facilities at the ground level, and pedestrian access is encouraged from floor to floor and from building to building.

Qualitatively, the laboratory provides personal scale and outside awareness. The low-rise, four-story buildings, the identifiable programming pavilions, and the interior work bays all tend to provide a sense of personal space. (See Figures 8 and 9.) The geometry of the formal organization provides a high degree of outside awareness. Above ground level, for example, no place is more than 25 feet from a window.

Figure 9 Programmers at work in a terminal room

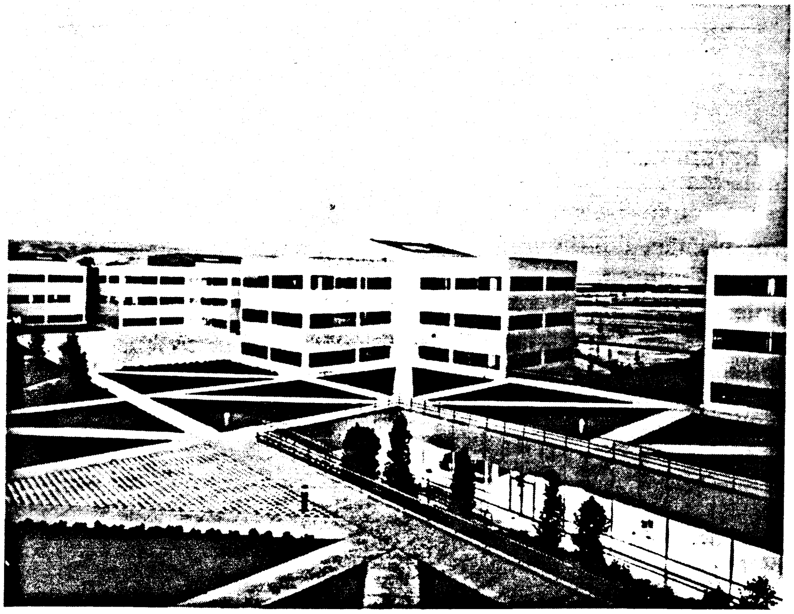


The Santa Teresa Laboratory is not designed merely to fulfill functional and qualitative needs. A building complex such as this, with small increments of highly flexible space, must have some fundamental elements that are strong and seem permanent. At Santa Teresa, a few such elements can be traced to historical images. Three may serve to illustrate this point. The first is the relationship between the complex as a whole and its setting; it has sharp, specific edges and is contained at the side of a valley. This relationship is almost monastic in concept, in that the buildings are sheltered and withdrawn from the surrounding countryside, yet they maintain a direct view toward the outside world.

The second element is the garden quadrangle, which, in the absence of a large interior space, becomes the focal point of the complex. This central plateau, though surrounded by buildings, provides a sheltered place with views of the distant hills. (See Figure 10.) Third, the interior circulation system provides logic and organization for the interior spaces; it provides continuous orientation and visual links to the site and the central garden.

Fundamental elements such as these bind the Santa Teresa Laboratory to the timeless tradition of man's careful attention to tools and habitation. Although the design is derived from specific needs and objectives, it expresses spatial relationships that have always brought meaning and interest.

Figure 10 Programming pavilions surround a central garden quadrangle, with the computing center underneath



Appendix A

Adapted from IBM's *Statement of Requirements, Santa Teresa Laboratory*, July 16, 1974.

Building requirements

A campus-like cluster of identifiable buildings is desired that blends with the natural environment in a pleasing and reserved fashion. The offices should be conducive to productive and creative work.

Programming project work is the major activity to be performed at the site. System and application programs will be designed, coded, documented, tested, and supported. Programming project areas will be used by functional and project teams to carry out these activities. Teams will consist of two to five individuals organized into departments of two to four teams, plus a manager and a secretary. Extensive computer services and flexible use of internal space will be required.

Primary considerations are as follows:

- Outside awareness is essential for as many offices as possible. Natural lighting is highly desirable for all work areas.

- Emphasis should be placed on soundproofing, particularly between adjacent offices.
- Maximum flexibility is desired for placement and use of computer terminals and associated work space.

Programmers' requirements

The primary mission of personnel at the site will be programming. Several different programming projects will be active at any given time. A typical programming project goes through a sequence of phases, and many persons participate at various times. Effective interaction among these individuals is the most important ingredient in the success of a project.

Care must be taken in the design of the buildings and site to provide the environment and tools required for programmers to perform their tasks. Special consideration should be given to the following criteria:

- Communication. The primary consideration in designing the offices, buildings, and site must be ease of communication. Team members will have to communicate within programming teams, with other teams on the same project at the site, and with teams at other sites, worldwide.
- Privacy. Each individual will require a personal work area with an environment that supports the intensive concentration needed for high quality problem solving. Acoustical isolation, adequate ventilation, and individual control of the office environment are key design considerations.
- Furniture. The architect should make a special study and recommend office furniture and fixtures that will be effective for many different tasks. The programmer's basic document is a 15-by-11-inch fanfold program listing which opens to 15 by 22 inches. Work surfaces that can accommodate several listings simultaneously, and lockable storage that can accommodate these documents in hanging vertical files, are required.
- Computer connections. A most essential tool of the project programmer is computer time. Access to the computer must be provided throughout the project areas for video, high-speed, and low-speed communication facilities. Remote job entry stations and printers should be provided, and every office should have terminal connections.
- Security. The site and, in particular, the data processing and project buildings must be secure.
- Technology. Design flexibility should be maintained with regard to current and future programming technology.

Appendix B

Adapted from IBM's *Santa Teresa Laboratory Interior Design—Programmer Function*, June 19, 1975.

Space utilization

In programming areas, occupancy requirements per floor will be 60 people, four terminal rooms, four structured-programming-control rooms, one conference room, one remote-job-entry room, and support areas for mail, reproduction facilities, etc. A typical mix of employees on a floor will include 44 programmers, six senior programmers, six managers, and four secretaries.

Programmers' requirements

work surfaces

The programmer's work area will include one 30-by-60-inch surface and one 24-by-60-inch surface. These surfaces are to be table-like, without leg-room obstructions, and they are to be movable. They should have a nonreflecting matt finish. Their height is to be standard, but one section of the 24-inch surface must be adjustable in height to accommodate a terminal. Surface arrangements should not exhibit left- or right-hand bias. These surfaces are intended to accommodate two open program listings, bound or loose, as well as bound reference material.

storage facilities

Type A storage (averaging 8 linear feet) is intended to accommodate loose-leaf binders containing IBM System Library publications, functional specifications, development guides, etc.

Type B storage (averaging 8 linear feet) is intended to accommodate bound computer printouts used for reference.

Type C storage (one drawer) is equivalent to the common desk file drawer. It is combined with two box drawers to form a mobile pedestal that can be located beneath the work surface.

Type D storage (four box drawers) is equivalent to storage in common desk drawers. Two drawers will be hanging file space (Type C), combined to form a mobile pedestal that can be located beneath the work surface. The remaining box drawers will be located within a storage unit.

Type E storage (adjustable pigeonholes averaging a total of 36 cubic feet) is intended to handle the programmer's working paper, including program listings, punch cards, magnetic tape, and miscellaneous notes and forms. The lack of this type of storage is a principal deficiency in the traditional programming environment.

Type F storage (ten drawers) is to be used for microfiche cards containing program listings or computer printout.

Approximately 100 cubic feet of storage space will adequately support programming, programming management, and staff assignments, but specific storage requirements vary greatly. Therefore it is essential to have basic storage areas with modular components designed specifically for each kind of material. These components will be combined according to each individual's requirements. In addition, chalkboards, tack-boards, and flip-chart holders will be available for each office.

services Each individual will have a telephone with a cord of sufficient length to reach his work surfaces.

At least three double-plug power outlets must be available to each individual. Some of these must be just above table height, and at least one must be next to a coaxial terminal cable outlet. Each programmer must be able to use a terminal in his office.

Additional terminal rooms will be located in each wing of each floor. Keypunch and computer services, as well as copying equipment, will be available on each floor.

Appendix C

Adapted from MBT Associates' *Mock-up Evaluation Report*, April 15, 1977.

Evaluation of mock-up offices

Twelve mock-up offices were constructed to simulate the office configurations and furniture components specified for the Santa Teresa Laboratory. Eight mock-ups in IBM's Palo Alto facility and three in San Jose were in daily use for five months. The 12th mock-up was on display in the cafeteria at the Palo Alto facility during the same period. Key components of the mock-ups were the 10-by-10-foot office size, the office furniture, column locations, and power and terminal outlets.

Ten IBM programmers, involved in various phases of program development, were chosen to participate in evaluating the mock-up offices. Each selected the office arrangement he preferred, and the office components were installed according to individual preference.

MBT Associates interviewed the programmers shortly after they had occupied the mock-up offices, and further interviews were conducted during the following months. Based on the programmers' suggestions, a number of refinements were made in the design of the office components.

work environment

All programmers preferred the new office arrangements for a number of reasons. Most important, the large work area allowed them to lay out and maintain several tasks at once and to organize materials according to individual work styles. The lack of legroom obstruction facilitated small group working sessions. In addition, the ample storage space permitted efficient organization of paper work.

flexibility

The flexibility of being able to move personnel from one office to another was not tested with the mock-ups, but flexibility within individual offices was tested by most of the programmers. At least three tried more than one space plan arrangement, and most of them modified the storage arrangements within the components.

incremental growth

Most programmers required additional storage for 8 ½-by-11-inch paper, filing, and hanging program listings. This need was accommodated by redesigning one of the two-high lateral files to accept a hanging file drawer and a smaller bin unit. The space planning standard permits the installation of another unit, if needed, for heavy storage.

summary

The reaction to the office environment was highly favorable. The increased work surface, the work surface arrangement, and flexibility in arranging the office components appeared to be key elements. The programmers' comments indicated that the space standards, as tested in the mock-ups, satisfied their operational criteria.

PICTURE CREDITS

Page 19, Jon Brenneis; Page 20, Gene Antisdel; and Page 21, Jeremiah O. Bragstad.

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