

COMPUTER HARDWARE INSTALLATION MODEL

by

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CHAPTER 1 INTRODUCTION

1.1 Problem

The physical installation of a computer system is a complicated process that must be approached with caution. It is imperative that a manager have a plan formulated which completely defines the installation. This plan must start with the physical site preparation, proceed to the hardware installation, and end with the turnover of an operational system to the software technicians. Included in this plan should be an accurate timetable of all the key activities required during the installation process.

An installation manager will find that vendors provide little or no assistance either in preparing a facility for equipment installation or in the actual physical installation process. Normally adequate hardware specifications and environmental data are available to an installation manager; however, understanding this information and consolidating it into an installation plan can be a difficult and complicated task without guidance from an experienced person. Few organizations have people adequately prepared to smoothly install hardware.

1.2 Solution

The solution to this problem is presented as a model for a manager to use which can be applied to any type of hardware installation and which results in the detailed

activities necessary for an installation plan. The activities are grouped into three major areas--environmental, electrical, and physical installation, and are presented in the following format:

1. Lists of activities encompassing all phases of the installation
2. A detailed description and explanation of the activities
3. Activity dependencies expressed as a partial ordering of activities through a network

Additionally, the model addresses use of the activities to formulate events in the construction phase, the physical installation phase, and terminates in the acceptance of the system by the systems analysts.

The model does not include either security considerations or a budgeting, cost determination, and accounting system. However, general cost data for construction is provided in Appendix 2 to aid the installation manager in approximating construction costs in support of the computer.⁶ We are fully aware of the importance of these general management issues in such a project; however, it is felt they are beyond the scope of this project.

1.3 Intended Audience

This model is designed primarily for the use of a hardware installation manager directly involved with the

detail planning of the installation. Thus, it provides a level of detail required by the manager to relate accurately and intelligently the physical installation requirements to a construction contractor and to a hardware vendor.

The model is also envisioned to be useful as an educational tool for new managers who may become involved in hardware installation. It might also be helpful to higher level managers involved in the hardware selection process, and in determining operational dates, to gain an appreciation of the time and manpower requirements of the installation process.

1.4 Organization

This paper is organized into five additional chapters and two appendices. Chapter 2 describes the three parts of the model. Chapter 3 elaborates upon the activities described in Chapter 2 to provide specific functional details to the manager as these activities are considered. Chapter 4 presents the project management tools to implement the model in a given installation. These tools include checklists and critical path networks. The question of automation of these tools is also considered in this chapter. Chapter 5 provides the manager with an example of the use of the PERT system in a typical installation. The final chapter summarizes the results of this project and indicates areas for further development.

The model activities are presented incrementally within the text. These activities, if they are to be useful to a manager involved in an installation, need to be consolidated into partially ordered lists. Appendix 1 provides this function. Finally, estimated construction costs per square foot are provided in Appendix 2.

CHAPTER 2 AN INSTALLATION MODEL

2.1 Introduction

The chapter presents the activities (Section 2.2) and the dependencies of the events represented by the termination of these activities (Section 2.3) which comprise the fundamental components of this installation model. The presentation of detailed information necessary to understand exactly how to carry out the majority of the activities during an installation is delayed until Chapter 3.

2.2 Activities

There are four broad categories of identified activities which must concern an installation manager; these categories are environmental preparation, electrical construction, physical installation, and special considerations (see Figure 2-1). Environmental preparation activities includes the submodels--site selection, miscellaneous construction, flooring, air conditioning, acoustics, fire protection and safety. Electrical construction activities are divided into the five submodels--power requirements, cabling configuration, grounding system, equipment compatibilities and system configuration. Physical installation includes the submodels--movement planning, movement technique and hardware installation. Special considerations include those additional activities which would have to be accomplished if

Environmental Preparation
 Site Selection Activities
 Miscellaneous Construction Activities
 Flooring Activities
 Air Conditioning
 Acoustics
 Fire Protection
 Safety

Electrical Construction
 Power Requirements
 Cabling Configuration
 Grounding System
 Equipment Compatibilities
 System Configuration

Physical Installation
 Movement Planning
 Movement Technique
 Hardware Installation

Special Considerations

Figure 2-1
ACTIVITIES MODEL

an installation were not a stand-alone replacement which completely or almost completely replaced another system in a very short time-frame. Safety appears as an activity under environmental preparation but safety is an integral part of many other subarea activities (e.g., movement planning) and is included in all appropriate areas.

2.3 Submodel Definition

Each of the submodels are detailed at one additional level of detail. These submodels are presented in this section as partially ordered lists. A few of the items in these lists are either commonly understood or require specific knowledge of the organization for which the installation is being accomplished, and no further guidelines to accomplishment are provided. Based upon experience of people who have installed hardware, some activities need further clarification. These activities are detailed in Chapter 3.

The submodel, site selection, is given in Figure 2-2. It includes seventeen activities of which all are in Chapter 3 under the major paragraph headings as shown in the figure.

Miscellaneous construction is the next submodel and contains four activities of which all are discussed under one major paragraph heading (see Figure 2-3). The submodel, flooring, includes ten activities all of which are addressed under four major topic areas as shown in Figure 2-4. The

Environmental Preparations

- Establish contact with vendor and contractor

Construction Support

- Estimate scope of construction
- Establish site availability date
- Obtain fire code specification
- Determine flooring requirements
- Determine requirements for equipment access into area

Space

- Calculate square foot requirements for hardware
- Determine media storage space
- Calculate maintenance space
- Calculate space for air conditioning
- Compute total square footage required
- Calculate space for protective power system

Power

- Verify adequate power source is available
- Estimate kVA
- Estimate KBTU/HR

Clearance

- Establish ceiling clearance
- Obtain vendor and contractor approval of site

Floor Loading

- Calculate floor loading specifications

Ceiling

- Establish need for false ceiling

Figure 2-2
SITE SELECTION ACTIVITIES

Miscellaneous Construction

- Determine requirements for partitions and permanent walls
- Verify that all wall board edges under the raised floor are sealed
- Determine requirement for additional entrances and windows
- Review and approve contractors construction specifications

Figure 2-3
MISCELLANEOUS CONSTRUCTION ACTIVITIES

Flooring Activities

- Determine type floor required
- Evaluate options for raised floor
- Provide raised floor requirements to contractor
- Seal raised floor when used as plenum

Floor Covering Material

- Ground raised floor if static electricity problems are expected

Dust Control

- Seal under-floor with epoxy

Floor Tile Cutouts

- Obtain contractors specification for raised floor grid
- Line cutouts with protective trim
- Purchase extra floor panels from contractor
- Establish raised floor cutout requirements

Figure 2-4
FLOORING ACTIVITIES

air conditioning activities are listed in Figure 2-5 and are all discussed in Section 3.1.4 of Chapter 3. There are only three activities listed under the submodel, acoustics, and the explanation of these functions is given in Chapter 3, Section 3.1.5. The submodel is shown in Figure 2-6. The submodel, fire protection contains eight activities (see Figure 2-7). Three of these were considered self-explanatory. These are: a) assure all exits are easily reachable and clearly posted, b) verify that all equipment aisle ways are large enough to accommodate portable fire fighting equipment, and c) police area of trash during construction and installation. Safety is a submodel that cannot be discussed under a single installation section. Figure 2-8 breaks out the activities for safety under the major installation areas where they are discussed. This completes the submodels that are part of environmental preparation.

The next group of activities listed are grouped by submodel under the major category, electrical activities. The submodels include power requirements, cabling and grounding, equipment compatibilities and system configuration. The submodel, power requirements, is composed of eighteen activities and represents the largest submodel in the report. Figure 2-9 depicts the activities. Three of these activities all listed under miscellaneous are felt to be in no need of further explanation. Cable activities, the next submodel, is shown in Figure 2-10 with

Air Conditioning

- Decide if air conditioning is to be dedicated to the computer
- Establish drainage under the raised floor
- Determine optimum location for air conditioning system
- Avoid overhead air vents blowing directly into equipment

Air Flow Requirements

- Determine type of cooling system required
- Install separate humidity control
- Install temperature control device

Cooling System Requirements

- Determine temperature and humidity specification

Air Cleaning

- Determine air cleaning requirements

Computing Total Heat Load

- Compute total heat load

Static Electricity

- Evaluate methods for reducing static electricity

Testing

- Test air conditioning system
- Balance air distribution after hardware installation
- Monitor system after initial power up

Requirements

- Submit detailed cooling requirements to contractor

Figure 2-5
AIR CONDITIONING ACTIVITIES

Acoustics

- Review general guidelines for sound absorption
- Review general guidelines for sound isolation
- Estimate requirement for acoustical treatment

Figure 2-6 ACOUSTIC ACTIVITIES

Fire Protection

- Coordinate installation with fire inspector
- Assure all exits are easily reachable and clearly posted
- Verify that all equipment aisles are large enough to accommodate portable fire fighting equipment
- Clean area of trash during construction and installation

Electrical Systems

- Position electrical shut-down switches at all exits

General Storage

- Establish proper storage areas for supplies

Type of Fire Protection

- Install and test fire protection equipment
- Locate fire extinguishers in computer area

Figure 2-7 FIRE PROTECTION ACTIVITIES

Flooring

- Avoid exposed cabling on the floor

Fire Protection

- Post the number of fire department
- Post electrical shut down procedures
- Establish evacuation routes

Power Requirements

- Use only qualified electricians to wire power to equipment
- Install emergency lighting
- Locate emergency power off switches at all exits

Movement Techniques

- Cover all raised floor cutouts and open floor areas

Hardware Installation

- Verify that the equipment is grounded prior to power up
- Level all equipment prior to power up

Safety

- Restrict access to the construction area

Figure 2-8
SAFETY ACTIVITIES

Power Requirements

- Isolate power for computer from other power systems

AC Power Distribution

- Install separate power panels for main frame and peripheral equipment
- Locate power panels in same room with equipment
- Determine which equipment components are "hard-wired" or require receptacles

Protective Power Systems

- Evaluate requirement to install protective power systems

AC Convenience Outlets

- Locate convenience outlets in computer room

Lightning Protection

- Install lightning protection

Overhead Lighting

- Evaluate need for overhead lighting
- Coordinate location of overhead lights with equipment

Emergency Lighting

- Install emergency power off switches at all exits

Phase Balancing

- Phase balance electrical power

Figure 2-9
continued

Communications Support

- Determine electrical support required for communications equipment

Remote Terminals

- Install phone lines

Detail Power Requirements

- Determine electrical requirements for all equipment
- Provide contractor with equipment layout and electrical requirements

Miscellaneous

- Assure spare breakers are installed in all power panels
- Schedule electrician to connect power to equipment
- Verify line voltages prior to power up

Figure 2-9
POWER ACTIVITIES

Cabling

- Determine type and length of data cable
- Order data cable after final hardware layout has been approved
- Tag cable showing length and equipment destination
- Develop overlay depicting the major cable routes between equipment
- Locate and identify any under floor obstructions

Cable Installation

- Install data cable prior to equipment installation

Cable Connection

- Schedule maintenance personnel to connect data cable

Figure 2-10
CABLE ACTIVITIES

seven activities. All of the activities are discussed in Chapter 3 in Section 3.2.2. The grounding submodel contains four activities which provide a general concept for grounding a computer system. It should be noted that grounding schemes vary from vendor to vendor and specific vendor specifications must be accomplished by the manager. These are noted as vendor dependent. The submodel contains activities of a general nature (see Figure 2-11). The last submodel under the major category, electrical construction, is equipment compatibilities and system configuration. This submodel contains eight activities (see Figure 2-12). All of these are elaborated in Chapter 3, Section 3.2.4.

The next major category is physical installation with three submodels: movement planning, hardware installation and special considerations. All the movement planning activities listed are nearly self-explanatory; therefore, there is only a short discussion of this submodel in Chapter 3, Section 3.3.1. Figure 2-13 lists these activities. Movement technique is a submodel that requires considerable explanation because of the innovative ideas advocated by the author. All activities in Figure 2-14 are discussed in Chapter 3, Section 3.3.2. The submodel, hardware installation, represents the final phase of the model. The activities listed are all discussed in Chapter 3, Section 3.3.3 (see Figure 2-15).

The final category is called special considerations. The reason for its inclusion in the model is that this model

Earth Connections

- Install and test earth ground

Green Wire or Green Yellow Safety Ground

- Hook up green wire ground as per equipment specification

Signal Ground

- Install equipment ground braids for signal ground if required by equipment specification
- Determine vendor dependent grounding requirements

Figure 2-11
GROUNDING ACTIVITIES

Logical Configuration

- Develop logical configuration to support software requirements

Physical Configuration

- Determine minimum distance allowable between equipment for maintenance and operator access
- Determine the maximum cable length allowed between equipment
- Develop hardware configuration to support operational requirements
- Consider ease of operator access, control and visual observation of peripheral equipment
- Consider efficient work flow pattern supported by equipment layout
- Establish space between equipment to allow ease of tape changing, printer paper loading and removal, access for service, etc.

Site Layout

- Develop site layout to document final hardware layout

Figure 2-12
EQUIPMENT COMPATIBILITIES AND SYSTEM
CONFIGURATION ACTIVITIES

- Verify size and weight capacity before using an elevator
- Check size of all doorways leading into the site
- Arrange for temporary storage of equipment if required
- Verify that hallways and turns permit passage of the largest component of equipment
- Check unloading area for limitations on vehicle size
- Establish projected delivery date for equipment
- Arrange for carrier
- Survey of equipment by moving contractor
- Estimate time required to load and deliver hardware
- Reserve area for truck unloading
- Clear route from carrier parking area to computer room
- Arrange for equipment packaging and crating removal
- Schedule personnel to bolt main frame together and level equipment
- Determine if there will be a single or phased equipment delivery

Figure 2-13
MOVEMENT PLANNING ACTIVITIES

- Arrange for temporary protection of floor along route
- Tag all major components of equipment
- Post equipment layouts at room entry points
- Provide personnel to direct movers in the placement of equipment
- Cover all floor cutouts
- Mark hardware layout on floor with tape, verify accuracy of layout

Figure 2-14
MOVEMENT TECHNIQUE ACTIVITIES

- Level all equipment
- Connect mainframe
- Install copper straps for signal ground
- Monitor equipment as it is powered up
- Schedule maintenance personnel to connect data cable
- Turn the system over to systems analysts

Incremental Installation

- Determine the timetable for hardware installation

Figure 2-15
HARDWARE INSTALLATION ACTIVITIES

has been developed to aid a manager in the installation of hardware without consideration given as to whether:

1. this is an initial installation, or
2. the hardware is to be interfaced to an already existing system, or
3. the hardware is to be installed as an additional stand alone system.

If the first case applies, the general model will satisfy management requirements. If either of the later two cases apply to an installation, additional activities will have to be considered and more precise planning and coordination may be required. These additional activities are provided in a separate list (see Figure 2-16).

2.4 Dependencies

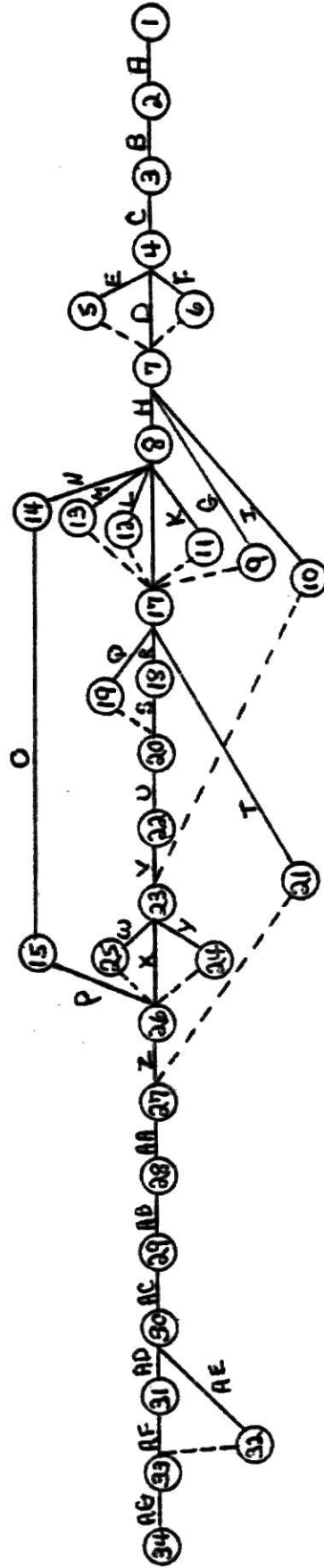
The events listed in Section 2.2 have been consolidated into thirty-four key installation activities and the dependencies between these major activities depicted in a PERT network system (see Figure 2-17, 2-18). The PERT network serves as a management and planning tool providing a graphic picture of the goals to be achieved and their interrelationships. A further discussion of PERT and its application is given in Chapters 4 and 5.

- Coordinate installation schedule with computer operations
- Schedule computer down time for electrical work
- Determine requirements to change logical configuration to support installation of additional hardware
- Isolate existing system from new construction area
- Schedule computer down time during nonpeak workload periods
- Schedule integration testing of new and existing system
- Determine requirement to revise physical configuration of existing system to accommodate new system
- Verify that existing air conditioning can accommodate additional heat load
- Plan to power new system from separate power panels to minimize interruptions to existing system
- Determine maximum drive distances before interfacing systems

Figure 2-16
SPECIAL CONSIDERATION ACTIVITIES

Task ID	Event Description
A	Points of contact with vendor and contractor
B	Determine logical configuration
C	Establish initial hardware layout and square foot requirements
D	Site selection process
E	Estimate of construction completion date
F	Estimate construction requirements
G	Miscellaneous construction requirements
H	Final hardware layout
I	Initial movement plan
J	Electrical requirements
K	Air conditioning requirements
L	Raised floor requirements
M	Acoustical requirements
N	Cable requirements
O	Order and receive cable
P	Mark cable
Q	Develop floor cutout requirements from floor specification
R	Consolidate construction requirements
S	Review contractor construction specifications
T	Tag hardware
U	Start construction
V	Complete construction
W	Test air conditioning
X	Final movement plan
Y	Mark floor layout
Z	Install data cable
AA	Install hardware
BB	Electrical connection and grounding
AC	Power-up equipment
AD	Connect data cable
AE	Balance air
AF	Test hardware
AG	Acceptance of system by systems analysts

Figure 2-17
EVENT DEPENDENCY LIST



LEGEND:

- represents the beginning or conclusion of an activity
- = activity
- = activity
- = activity

LETTERS = represent the activities listed in Figure 2-17

Figure 2-18
MASTER NETWORK

CHAPTER 3 ACTIVITY DESCRIPTION AND RECOMMENDED PROCEDURE

3.0 Introduction

This chapter is designed to supplement the activities list and activity dependencies by providing sufficient information to accomplish the activity. The model is presented under the three major submodels--environmental preparation (Section 3.1), electrical construction (Section 3.2), and physical installation (Section 3.3).

3.1 Environmental Preparation

As soon as a computer has been contracted for or it is known that one is being considered for acquisition, contact the vendor representative. Determine from the vendor how much support will be provided in the installation of the hardware. Subsequently, obtain the equipment specifications. Contact will also have to be established with a construction contractor if any room or building modifications are anticipated. These initial activities will have to be completed prior to beginning environmental preparation. Subactivities of environmental preparation are discussed in the following paragraphs.

3.1.1 Site Selection Activities

The major factors that must be satisfied when selecting a site are construction support, space, power, clearance, floor loading, and ceiling clearance. These topics are