COMPUTERIZED DAILY CONSTRUCTION SITE REPORTING SYSTEM (DSRS)

by

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ABSTRACT

The concept of daily site reporting is not new to the construction industry. For years, superintendents have been completing daily site reports by pencil and paper and then filing them away at the end of the day. In the event of a construction dispute, the company is faced with the tedious task of having to search through these reports for the pertinent information. Often, this task is further complicated by the fact that much of the data was entered without standard formats and descriptions.

Daily site reporting can benefit from standardization and computerization. The objective of this thesis was to develop a conceptual design of a micro-computer based Daily Construction Site Reporting System (DSRS) which would operate as an integral part of a construction project monitoring and control system. By tracking a project on a daily basis throughout its construction duration, the DSRS is able to provide immediate feedback to the Scheduling and Cost Control Systems. This is an important step towards real-time monitoring and control of a construction job. With this system in place, not only can claims preparation be facilitated, but status information on individual activities, frequency of occurrence of different problem types, and their impact on achieving productivity and scheduled targets may also be generated. Examples of such

analysis using project information are provided.

The DSRS consists of a Data Collection System and a Data Reporting System. The development of the former involved designing data collection forms and gradually improving them by field testing. The sample output reports presented in this thesis were prepared with the data collected on a local high-rise condominium project using these forms. A prototype Data Collection System has been programmed for a micro-computer using dBASE III PLUS. The current state of development of the Data Reporting System is limited to the design of a report generator and filter.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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1.0 INTRODUCTION

For centuries, constructors have been keeping track of their daily job progress. From Egyptian records of the builders of the pyramids, remarks such as "men were making their quota of bricks daily" and officials having neither "men nor straw for producing bricks" can be found. Other historic Egyptian documents reveal that workmen of the ancient tombs scribbled "daily work sheets" on potsherd (pottery fragments equivalent to modern day memo pads), detailing "days worked" and "days idle" [2:154],[reference#:page#]. Likewise, in today's construction industry, "both successful contractors and owners record daily job progress in some type of daily log."[41:178] In fact, the underlying purpose of these diaries has remained the same; and it is to provide a good job record which may be used to explain any deviations from the original construction plan.

1.1 THESIS OBJECTIVES

Today's leaders in the construction industry seem to have caught the wave of micro-computerization. In fact, a study has predicted that within the next five to ten years,

it is inevitable that almost every construction project will be supported to some degree by onsite micro-computers.[22:2]

The purpose of this thesis is to develop a conceptual design of a micro-computer based Daily Construction Site Reporting System (DSRS). The following is a list of the specific objectives of this study:

1) To identify and justify important construction information that can be reasonably collected on a daily basis (eg. information for future estimation, factors affecting productivity, information for project monitoring and control, etc.);

2) To design a set of short and concise forms for recording the daily site information;

3) To test the data collection forms in the field (which will include the documentation of resistance to implementation of such a system from site personnel);

4) To design a micro-computer based **Data Collection System** (accept and store data) that will facilitate automated updating of the Scheduling System and/or Cost Control System (hence enabling real time monitoring and control of the job); and

5) To outline what can be extracted from the data collected and to design a micro-computer based **Data Reporting System** for such outputs.

1.2 ASSUMPTIONS

Designing a computerized information management system is similar to writing a technical paper in that one must identify his or her audience first. The audience, or intended users in this case, are general contractors and

construction managers, namely people who run construction jobs on a day-to-day basis and will benefit from such a system.

Other assumptions made which underlie this thesis are:

1) The DSRS is designed for general contractors and construction managers who are already employing some form of daily site reporting. That is, the idea behind this thesis is not to convince these people that a daily site report is important because it would be beneficial in claims situations and would keep their superintendents on their toes, etc.. Instead, the intention of this thesis is to explore the potential uses of the information in a daily site report by representing and analyzing it in a computer environment;

2) The implementation of the DSRS will not require additional manpower at the site level. The superintendent will be responsible for completing the report as in the past. The stored information will be analyzed at the head office by project management; and

3) The DSRS can be operated with or independently from the other information sub-systems (eg. Scheduling System and Cost Control System) of the company's management information system.

1.3 RESEARCH APPROACH

Typically, a research project of this type (conceptualization of a software system) is initiated by reviewing the literature and commercially available software packages directly related to the subject. Unfortunately, literature on the topic of daily construction site reporting is scarce (with the exception of a handful of CE 520 class

projects from the University of British Columbia). Likewise, there are no commercial systems for the construction industry that deal solely with this issue. A system such as Expedition (by Primavera Systems, Inc.) does contain a very general daily report on construction activity, equipment, field-force, materials, and visitors. It allows the user to link together all of the information related to specific issues (eg. by date, by vendor, by item, etc.) for immediate review of problem areas. But this actually means that one can only focus in on a problem after it has surfaced. Instead, a daily reporting system should place emphasis on recording the problems encountered by the job and their negative effects (eg. estimated lost man-hours and lost time) in a standardized fashion so that forecasting of potential problems and variance analyses can be performed immediately and thereby prevent minor deviations from becoming serious problems.

The remedy for the lack of documented information on the subject of daily construction site reporting was to acquire a great deal of input from the field at the start of the research. Daily site reports from different construction companies were analyzed and specific information items were selected to form the basis of the data to be collected by the DSRS. Then, the following steps were taken to carry out the research:

1) Data collection forms were designed (for testing the

information to be collected and for gathering data for the exploration of potential outputs and analyses) with careful consideration of how the information should be grouped to facilitate easy information retrieval in the future. Only the most significant information items (eg. anything that caused problems to job progress and performance) were selected for the daily site report because the superintendent should not be bombarded with unnecessary paperwork;

2) The data collection forms were tested in the field with a local construction company on a pre-selected type of project (so that these forms could be tailored to the job for efficient data collection during testing) - J. C. Scott Construction Ltd. was recommended by Dr. Alan Russell, my supervisor, for field testing of the proposed daily site reporting system since the two parties had already been engaged in construction management research for several years. At the time of this study, J. C. Scott Construction was a medium-sized construction management and general contracting firm. It was an experienced non-union residential high-rise contractor in the local market. Under general contracting, it usually subcontracted out approximately 80% of its work by money. The project selected for this field testing was a general contracting high-rise condominium job at 2020 Highbury. This particular project was chosen for two reasons. Firstly, it was only ten minutes away from the University of British Columbia by car. This proximity was very significant because it was agreed with the company that the superintendent would not have to fill out the daily reports himself which meant that I had to conduct data collection on site everyday. Secondly, the commencement of this project coincided with the initiation of field testing for this research. And, it was thought to be more convenient to implement a new system at the start of a project instead of in the middle of it. Furthermore, since the rate of production at the front end of the project ("coming out of the ground") often varied greatly from job to job, some of the typical problem areas could be captured with the proposed daily site reports;

3) Updating was facilitated with a list of activities to serve as a checklist. This checklist was available since the project had already been scoped and scheduled;

4) Field data were obtained from the site

superintendent;

5) The data collection forms were improved continually (content and method of data collection) with feedback from the site superintendent;

6) Meanwhile in the office, databases were being structured on dBASE III Plus in accordance with the data collection forms. Then, the Data Collection System was designed to include some of the features as outlined in the CE 520 class reports and as conceived during the course of the research (eg. different system configurations such as: Turn-around Document Concept, Direct Computer Input with Hard Copies Output, etc. were considered). Since this system was designed for site implementation and to be operated by site personnel (who were not necessarily computer inclined), user-friendliness was one of the key considerations during the design of the system;

7) A preliminary implementation of the Data Collection System was programmed on dBASE III PLUS;

8) Ten weeks of field data were collected to ensure that there would be sufficient information for analysis purposes;

9) The data collection forms were carefully examined to see what information could be extracted from the database and what management functions they would serve. Literature review was carried out again for additional ideas;

10) Both text and graphical outputs were considered. Since graphical outputs were not available on dBASE III PLUS, an additional software package was needed. Lotus 1-2-3 was employed for this purpose. Only very crude programs were written to demonstrate these outputs (because the purpose of this thesis was system conceptualization and not software production). Nevertheless, two classes of reports were proposed: i) Direct Reports - straight data echoing; ii) Analyzed Reports - required data processing before data were presented; and

11) A complete picture of the DSRS was outlined to show how the Data Collection and Reporting Systems would work together.

1.4 THESIS STRUCTURE

Presented in this thesis is a detailed conceptualization of the micro-computer based DSRS which would operate as an integral part of a construction project monitoring and control system. By tracking a project on a daily basis throughout its construction duration, the DSRS is able to provide immediate feedback to the Scheduling and Cost Control Systems. In addition, the DSRS places special emphasis on claims and variance analyses.

The remainder of the thesis is structured as follows:

- Chapter 2 - outlines the information items that should be collected by the daily site report and organizes them in data collection forms that are suitable for field testing;
- Chapter 3 - conceptualizes the micro-computer based Data Collection System and presents a prototype implementation on dBASE III PLUS;
- Chapter 4 - provides sample outputs from the data collected during field testing of the data collection forms and conceptualizes the micro-computer based Data Reporting System;
- Chapter 5 - describes the process of implementing the data collection forms in the field and provides feedback on the sample outputs from the project management of J. C. Scott Construction; and
- Chapter 6 - summarizes the findings of the research and the shortcomings of the proposed system. As well, it provides recommendations for future research.

2.0 DEVELOPMENT OF THE DAILY SITE REPORT FOR FIELD TESTING

The purpose of this chapter is to identify and justify the important construction information that can be reasonably collected on a daily basis. To begin with, daily site reports presently used in the industry are examined to facilitate identification of such information items. Then this information is organized into data collection forms that are suitable for field implementation (justification of the information items and report format; and collect data for the production of sample outputs).

2.1 DAILY SITE REPORTS PRESENTLY USED IN THE INDUSTRY

Today, most construction companies have some form of a daily site log (see Appendix A). The information that these reports attempt to record seems to be common to all; this includes:

1) Identification Information such as: Job Number, Date, Weather, Temperature, Hours Worked, and Data Entered By;

2) Work Accomplished on that Date;

3) Manpower on site including Own Labour Forces and Subcontractors;

4) Equipment Usage;

5) Deliveries (eg. Materials, Drawings, etc.);

6) Visitors;

7) Verbal Discussions and/or Instructions (eg. Changes Originated that Date); and

8) Unusual Developments (eg. Problems, Shortages, Delays, Strikes, etc.) and Other Pertinent Information.

It is very easy then for someone faced with the task of designing a daily site log to make a summary checklist of the headings from these reports. However, this approach seems to overlook the issue of information justification. At this point, one might argue that in the event of a construction claim, every piece of collected information might be of value; therefore, management would prefer the longest and most complete checklist. Ideally, yes; but in reality, management has limited resources (time and money) that can be allocated to the task of daily site reporting. Furthermore, this data is often not analyzed; thus, valuable information is lost. Therefore, it is essential to establish some criteria for determining what information should be included in the daily site report and how they should be recorded such that it will facilitate data analysis.

2.2 PROPOSED DAILY SITE REPORT

It should be made clear that the daily site report presented in this section is not intended to be a working tool for the superintendent; but, it is merely an instrument for system development. The ultimate goal of the DSRS is to do away with written reports and work directly with the computer.

The criteria chosen for the design of the report are:

1) The total time that it takes to complete the report by pencil and paper should be less than 15 minutes;

2) The information requested by the forms should be as specific as possible instead of being unformatted [18:5];

3) Field responses should be as simple as possible and in a form that can be analyzed (for example, use standard responses such as: yes/no, poor/fair/good, etc.; but one should focus on quantitative responses where possible and minimize subjective responses);

4) The fields will be generously spaced to allow comments where necessary (because it is often very difficult to get someone to write more information than the space allows [18:5]);

5) Data collected should identify job factors resulting in lost time;

6) Unnecessary or non-applicable questions can be passed over by keyword responses;

7) Reporting makes use of existing resources only, that is, no new personnel are required for this task;

8) The fields should be categorized and structured in a logical fashion to facilitate data input; and

9) The information collected should be project specific (eg. since labour turnover is not very significant in non-repetitive construction, it could be excluded from the daily site report).

With the above guidelines and some recommendations from site superintendents [16 & 19], a daily site report consisting of the following three types of forms were designed:

1) Site / Environment Information;
2) Work Force Information; and
3) Activity Information.

2.2.1 SITE / ENVIRONMENT INFORMATION

This is the first form (see Figure 2.1) to be filled out in the daily site report. As suggested by the title, it covers general site and environment information. This form is broken down into 4 sections:

1) Report Identification;
2) Weather Information;
3) Site Conditions; and
4) Unusual Developments.

Report Identification

This section consists of basic job information for report identification, namely:

- **Project** - official project name as registered at head office;
- **Project No.** - project number as registered at head office;
- **Date** - the date of the report; and

SITE / ENVIRONMENT INFORMATION

Initials: _____

Project: _____

Project No.: _____

Date: _____

Superintendent: _____

Weather (AM): clear/cloudy/rainy/snowy; other _____
(PM): clear/cloudy/rainy/snowy; other _____

Temperature (Hi/Lo): _____ /_____ ^{o}C

Precipitation: _____ mm

Wind: _____ Kph

Site Conditions:

- Access to Site: poor/fair/good _____
- Storage on Site: poor/fair/good _____
- Ground Conditions: poor/fair/good _____

Unusual Developments: yes/no _____ Estimated Time Lost

- Strikes/Job Actions: yes/no _____ (____days)
- Potential Problems: yes/no _____ (____days)
- Delays: yes/no _____ (____days)
- Disputes: yes/no _____ (____days)
- Others _____ (____days)

Figure 2.1 - Site / Environment Information Form

- **Superintendent** - the name of the head superintendent who is also responsible for completing the report.

Weather Information

This section is job specific. For example, poor weather that would have an impact on high-rise construction might not affect tunneling. The items listed below apply to high-rise construction projects:

- **Weather** - due to the often unsettled climate in this region (west coast of Canada), both **AM** and **PM** weather information should be recorded. To minimize writing and to establish a standard language for the report, multiple choices have been pre-printed (**clear/cloudy/rainy/snowy**) on the form. If necessary, further description may be entered under **other.** These observations should be made by the superintendent on site;

- **Temperature** - both **Hi**'s and **Lo**'s are necessary because, for example, the former might affect productivity and the latter might influence concrete curing;

- **Precipitation** - the effects of rain on a construction site are obvious; its damages range from simple activity delays to creating impossible working conditions (especially when the project is "coming out of the ground"); and

- **Wind** - this data should be recorded for high-rise construction because under high winds, the tower crane may be inoperable for safety reasons, thereby shutting down work on many activities.

Temperature, **Precipitation**, and **Wind** data can be obtained from the local weather station, newspaper, or even directly on site via automatic weather recording stations.[13:21]

Site Conditions

Information regarding site conditions can often explain causes of job delays. However, they may not be readily quantifiable into time lost. The more practical approach is

to subjectively rate these site conditions (**poor/fair/good**) and allow comment spaces for describing the features of the site conditions and what activities they affect. The three most significant site conditions are:

- **Access to Site** - should consider public or private access roads to the site as well as actual access into the site (eg. dirt ramps);
- **Storage on Site** - should consider access to these areas, their organization as well as space sufficiency [44:32-36]; and
- **Ground Conditions** - this is often a major concern prior to the completion of the slab on grade. For example, churned up soil may be difficult to travel on for both machine and men.

Unusual Developments

This section concerns unusual developments at the project level. First of all, the superintendent decides whether or not there were unusual developments that day by circling **yes** or **no**. If the choice is **no**, this entire section is skipped over. But if it is **yes**, the superintendent must determine which one of the following categories the unusual development(s) belong to by circling **yes** after the appropriate item, followed by a description and an **Estimated Time Lost** if possible:

- **Strikes/Job Actions** - walkouts, lockouts, pickets, government stop work notices, etc.;
- **Potential Problems** - any issues or events that might escalate into real problems;
- **Delays** - any delays that affect the entire job;
- **Disputes** - unsettled matters which deserve further attention or investigation; and
- **Others** - any other unusual developments not covered

by the above categories.

Otherwise, **no** is circled after the item.

2.2.2 WORK FORCE INFORMATION

The next form to be completed in the daily site report is the **Work Force Information** (see Figure 2.2). This form collects information regarding one trade only. Hence, the number of times this form must be filled out depends on the number of trades on site that day. For each trade, the following information are requested:

1) Trade Identification and General Information;
2) Manpower Information;
3) Drawings Availability;
4) Delivery Information;
5) Equipment Usage; and
6) Accident Information.

Trade Identification and General Information

This section covers the following basic trade information:

- **Trade** - for identification. Indicate **own force** or **subtrade** then the official trade name as registered at head office;
- **Contract Awarded** - **yes**, **no**, or **hourly** response is requested to indicate the contractual status of the trade. If the status is **no**, this documentation may be used to substantiate backcharges or claims for work performed outside of the contract (the key word here is **substantiate**; actual backcharging data will

WORK FORCE INFORMATION

Initials: _____

Trade: own force/subtrade _____

Contract Awarded: yes/no/hourly _____

Work Available: yes/no _____

Total No. of Men: (foreman/other) _____ /_____

. Skill Level: poor/fair/good _____

. Sufficient to Meet Job Conditions: yes/no _____

. Turnover: yes/no _____

Ref. No.

Drawings Available: yes/no _____ (_____)

. Quality: poor/fair/good _____ (_____)

. Detailing: inadequate/adequate _____ (_____)

Deliveries: yes/no _____

Description	Supplier/ Invoice #	Quantity Delivered	On Time /Late	Quality (poor/fair/good)

Equipment Usage (for own force only):

Description	Owned/ Rental	No. of Items	Total Hrs. Used

Accidents: yes/no _____

Figure 2.2 - Work Force Information Form

be recorded in some of the items on the **Activity Information** form under **Why "unsatisfied" ?**). It may also explain why the trade is often not readily available. NOTE: General contractor's own crews are not usually under contracts but are paid **hourly**; and

. **Work Available - yes** or **no** response is desired. This may be used to account for lost man-hours and poor rates of production.

Manpower Information

Invariably, recording manpower level alone does little towards explaining lost time. Thus, the subsequent information should be reported instead:

. **Total No. of Men** - this should include the **foreman** and any one else (**other**) working under his supervision exclusive of the superintendent himself;

. **Skill Level** - a subjective rating (**poor/fair/good**) is requested, followed by comments if necessary. A trade with lower than **good** skill level may explain its lower than expected rate of production;

. **Sufficient to Meet Job Conditions** - if **no** is selected (from the **yes/no** multiple choice), then an explanation is needed for the cause of this deficiency; and

. **Turnover** - a **yes** or **no** response is expected. Turnover may have great impact on the rate of production of a trade, especially in repetitive construction (eg. high-rise). The learning curve effect may be encountered each time a new worker is hired.

Drawings Availability

Shop drawings control is the main concern of this section. The three relevant items are:

. **Drawings Available** - if **no** is selected (from the **yes/no** multiple choice), descriptions of the drawings needed and their **reference numbers** (if possible) are requested;

. **Quality** - a subjective rating (**poor/fair/good**) of the legibility and comprehensibility of the

currently available drawings. Drawings that are below standard (poor or poor to fair) should have their deficiencies described and **reference numbers** recorded; and

- **Detailing** - a subjective rating (**inadequate/adequate**) of the detailing adequacy of the currently available drawings. Drawings that are not adequately detailed should have their deficiencies described and **reference numbers** recorded.

Even though the last two items could be grouped into one entry, they have been deliberately separated into independent categories in this prototype daily site report for field testing purposes. An analysis of the data collected should indicate whether or not such a distinction is warranted.

Delivery Information

This section records material delivery information for a particular trade. If there were no deliveries that day, the superintendent would simply circle **no** (from the **yes/no** multiple choice) and skip to the next section on the form. Otherwise, each type of material delivered should be entered as a separate record under the following headings:

- **Description** - the material description as on the delivery invoice. It is important to have a standard description for a material for the entire job and that the description is consistent with that of the supplier. The main advantage is that it would facilitate tracking and monitoring when the report is computerized;

- **Supplier/Invoice #** - the official name of the supplier as registered at head office and the invoice number;

- **Quantity Delivered** - the amount of material delivered and the appropriate unit of measure;

- **On Time/Late** - indicate the timeliness of the delivery (**O** for **On Time** and **L** for **Late**). If the delivery was late, specify the amount of time lost; and

- **Quality (poor/fair/good)** - a subjective rating of the quality of the delivered material.

Equipment Usage

Generally, this section should be completed for the general contractor's own work force only because the superintendent rarely, if ever, monitors the equipment usage of the subtrades. Each type of equipment should be registered as a separate record under the following headings:

- **Description** - a standard description for a piece of equipment, preferably the same as that used by the supplier. This is necessary for the same reason as that mentioned for the description of material delivered. As well, such descriptions could give rise to a standardized menu of equipment items for the computerized system;

- **Owned/Rental** - equipment classification. Sometimes it is necessary to rent additional units of an equipment that the general contractor already owns (for example, during heavy rain storms, supplemental water pumps might be required). For control purposes, it is essential to distinguish the number of owned (**O**) units from the number of rental (**R**) units;

- **No. of Items** - the total number of units of an equipment belonging to a specific class (for example, an owned water pump should be recorded independently from two rental water pumps even though they are exactly the same); and

- **Total Hrs. Used** - the total number of hours used for an equipment of a specific class (for example, two rental water pumps used for the entire work day equals 16 hours).

Accident Information

In the event of an accident (circle **yes** from the **yes/no** multiple choice), it is vital to identify the member(s) involved as well as render a full description of the incident (where, how, when, and pertaining to which activity).

2.2.3 ACTIVITY INFORMATION

Activity Information (see Figure 2.3) is the last form of this proposed daily site report. This form collects information for one activity only. Consequently, the number of times this form must be filled out depends on the number of activities that were in progress that day. This form is categorized into four sections:

1) Activity Identification and General Information;
2) Activity Progress;
3) Activity Performance; and
4) Quality Control.

Activity Identification and General Information

This section covers the following basic activity information:

- **Activity Description** - this should be the same description as that already used in the scheduling program. The main advantages are that the superintendent is already familiar with the description and it also promotes the idea of standardization;

ACTIVITY INFORMATION

Initials: _____

Activity Description: _____ Code: _____

Activity Scope (quantity/unit/description): _____

_____

Construction Method: _____

Activity Status: started/in progress/idle/finished/started & finished

Work Performed Today: _____

Rate of Production: excellent/satisfactory/unsatisfactory
(quantify if possible) _____
Why "unsatisfied" ?

	Estimated Lost Time /Man-Hrs.
. Rework Due to:	
- Design Error: _____	(____days/____)
- Prefab. Error: _____	(____days/____)
- Field Error or Damage: _____	(____days/____)
. Change Orders/Extra Work:	
- Owner Initiated: _____	(____days/____)
- Mandatory: _____	(____days/____)
- Contractor Initiated: _____	(____days/____)
. Delays Due to Waiting for:	
- Materials: warehouse/vendor _____	(____days/____)
- Tools: _____	(____days/____)
- Construction Equipment: _____	(____days/____)
- Information/Decisions: _____	(____days/____)
- Other Crews: _____	(____days/____)
- Fellow Crew Members: _____	(____days/____)
. Equipment Breakdown (downtime): _____	(____days/____)
. Unexplained or Unnecessary Move: _____	(____days/____)
. Late Inspection: _____	(____days/____)
. Strike/Job Action: _____	(____days/____)
. Weather: _____	(____days/____)
. Others: _____	(____days/____)

Quality of Work: good/fair/poor _____
. Inspections: _____
. Tests: _____

Figure 2.3 - Activity Information Form

- **Code** - it follows that this code should be the same as that already used in the scheduling program for the same reasons as mentioned above;

- **Activity Scope (quantity/unit/description)** - this should be filled out only once at the start of the activity. Its major function is for estimating percent completion and time to complete; and

- **Construction Method** - this should also be filled out only once at the start of the activity. However, if the construction method is altered during the course of construction, it must be recorded again. This is useful information for comparing rates and costs of production for different construction methods.

Activity Progress

Extensive progress measurement for productivity analysis is not one of the major objectives of the daily site report; therefore, activity progress should be recorded in a relatively simple way:

- **Activity Status** - it can be one of the following: **started, in progress, idle, finished,** or **started & finished.** By including idle work days, more accurate activity durations can be derived after the job; and

- **Work Performed Today** - this is a description of the accomplishments associated with the activity for the day. It should include quantities installed and work locations as much as possible.

Activity Performance

The underlying functions of this section are for performance measurement and productivity improvement. The former is accomplished by recording, qualitatively, the **Rate of Production** and, quantitatively, the **Estimated Lost Man-Hrs.** and the **Estimated Lost Time** associated with the activity. The latter is achieved by identifying the causes of **unsatisfactory** rates of production (then necessary

corrective actions could be arranged). The specific items are:

- **Rate of Production** - this can be evaluated as being **excellent**, **satisfactory**, or **unsatisfactory.** A quantitative description is solicited (**quantify if possible**) to assist future estimation; and

- **Why "unsatisfied" ?** - this section is designed to identify the cause of an **unsatisfactory** rate of production; thus, it could be skipped if **excellent** or **satisfactory** was selected for the above item. The superintendent is asked to identify the cause of activity delay by providing a description of the incident (including the parties involved) after the appropriate heading on the **Activity Information** form. Moreover, an **Estimated Lost Time** for the activity and an **Estimated Lost Man-Hrs.** (number of work hours lost x number of men working on this activity only) are requested. The same procedure should be carried out for recording any additional causes of delay. The following list of possible causes of delay from the **Activity Information** form is derived from the Foreman-Delays Surveys as conceived by Tucker et al [46:580], with a few minor modifications:

    1) **Rework Due to Design Error;**
    2) **Rework Due to Prefab. Error;**
    3) **Rework Due to Field Error or Damage;**
    4) **Owner Initiated Change Orders/Extra Work;**
    5) **Mandatory Change Orders/Extra Work;**
    6) **Contractor Initiated Change Orders/Extra Work;**
    7) **Delays Due to Waiting for Materials: warehouse/vendor;**
    8) **Delays Due to Waiting for Tools;**
    9) **Delays Due to Waiting for Construction Equipment;**
    10) **Delays Due to Waiting for Information /Decisions;**
    11) **Delays Due to Waiting for Other Crews;**
    12) **Delays Due to Waiting for Fellow Crew Members;**
    13) **Equipment Breakdown (downtime);**
    14) **Unexplained or Unnecessary Move;**
    15) **Late Inspection;**
    16) **Strike/Job Action;**
    17) **Weather;** and
    18) **Others.**

Quality Control

Quality control should not be overlooked in daily site reporting because it can be easily carried out:

- **Quality of Work** - this requires a subjective rating (**poor/fair/good**) followed by comments if possible;
- **Inspections** - since site inspections are always documented as a memo or report by the inspector, this section should simply identify the inspector (the name of the company, agency or institution only) and followed by a short description of the inspection (eg. line 21 wall forms); and
- **Tests** - similarly, tests performed on site are always documented as a report. Thus, just identifying the tester (the name of the company, agency or institution only) and describing the tests performed (tests results are unnecessary, eg. concrete cylinder tests on 35 MPa concrete for slab on grade) would be adequate for this section.

Furthermore, **tracking of deficiencies** may be carried out if additional comments such as "insufficient tie rods" and "failed slump test" are also provided for the last two items respectively.

It should be noted that the information items presented in the above proposed daily site report were not intended to be complete. In fact, the subsequent field testing was intended to reveal necessary changes to this daily report.

3.0 DEVELOPMENT OF THE COMPUTERIZED DATA COLLECTION SYSTEM

3.1 GENERAL CRITERIA

The introduction of micro-computers for project control (eg. Scheduling System, DSRS, etc.) is often not well received at site level. This opposition mainly comes from the experienced site superintendent who has managed numerous jobs over the years without such aids; therefore, he or she is very set on how to run the job. Moreover, this person is most likely to be computer illiterate. Thus, some general criteria for the development of the Data Collection System must be established:

1) The system should be designed around the daily site reporting forms described in section 2.2 because implementation of the computerized system will be preceded by a discussion (based on the these forms) on the information to be collected. This way, even though the superintendent would have to cope with the operation of the computer, at least, the questions and responses will seem familiar;

2) The system must not overwhelm the superintendent with excessive data collection time or data volume.[37:435-436] The 15 minute time limit set for reporting by pencil and paper (section 2.2) should also apply here;

3) Anticipated responses should be presented on the computer screen so that data entry can be expedited. Otherwise, the responses can be readily revised or overwritten to reflect the actual occurrences of the day.[13:4] This technique is commonly known as **full**

screen editing. Two other input formats should also be incorporated: **selective** and **full screen text input.** Selective input requires the user to simply choose a response (usually by highlighting it or by entering the corresponding item number) from a list of possible responses. Whereas, full screen text input solicits the response with a blank field;

4) The system should be menu driven as much as possible. At most, it should only require **y** or **n** (yes or no) responses to get from screen to screen;

5) The system should have error checking capabilities such that only information of the correct format can be entered;

6) The system should be flexible. It should allow easy customization of input display screens and be capable of being interfaced with other popular application software such as Lotus 1-2-3, MS Word, etc.;

7) The system should have provision for brief text entries after **selective inputs** (recall definition from criterion 3) as this could be used to pick up additional information that would have otherwise be left unsaid;

8) As mentioned in section 2.2, keyword responses should be used to skip over unnecessary or non-applicable questions;

9) The system should have a security feature to prevent tampering of stored data (eg. a password for system entry); and

10) The system should have the option of being installed in a local area network (LAN) environment whereby site computers are directly linked to those at the head office. This would enable information retrieval in real time.

3.2 DEVELOPMENT TOOLS

Since complete development of the DSRS is not within the realm of this report, the development tools (software and hardware) should be selected on the basis of their ease

of operation, compatibility, accessibility, and capacity. The prototype DSRS described hereafter was developed on dBASE III PLUS using a MS DOS-based micro-computer.

Software Requirements

Selecting the data processing and management software package for the development of the prototype DSRS can be much more difficult than choosing the hardware simply because of the numerous choices available in todays market. The top of the line products include: Paradox, XDB, PowerBase, Open Access II, DataEase, dBASE III PLUS, and R:BASE System V. However, any one of these packages would be suitable for meeting the data processing and management demands of the prototype system (that is, choosing the best database for the development of the actual DSRS is not one of the objectives of this report).

dBASE III PLUS was chosen mainly for the following reasons:

1) The original dBASE II was one of the first proven commercial data processing and management software packages on the market. dBASE III PLUS is even more powerful and refined, and has become the industrial standard. NOTE: at the inception of this development, dBASE IV (which will meet or beat the capabilities of its main competitors) had not been released. However, Ashton-Tate claims that all databases, forms, reports, and applications developed in dBASE III will run without modification in dBASE IV [3:113];

2) It can display, change, find, rearrange, analyze, relate, and print any data that has been stored in a database;

3) It features a user-friendly menu driven Assistant that can be used to develop specific applications, for example, creating screen formatted data entry which greatly facilitate the data entry process. As well, it can be used to accomplish most of the day-to-day data management tasks;

4) It includes a programming language called **dBASE** that can be used to create customized applications for specific needs. Programming in **dBASE** is easier to learn than many other programming languages because dBASE III PLUS has many built-in features (these features will not be discussed in this report; for more information, refer to the dBASE III PLUS user manuals);

5) dBASE III PLUS can be installed in a LAN environment. On a network, users with a wide range of backgrounds and expertise can work with dBASE III PLUS. For example, at the site level, users will only enter data or operate ready-to-use programs and applications. Whereas, others will program in **dBASE**, creating database files and application programs at head office;

6) dBASE III PLUS files can be converted such that they can be imported and exported from and to other software applications. This is extremely important because dBASE III PLUS does not have graphics capabilities. For example, by exporting data to LOTUS 1-2-3, graphs and bar-charts can be readily plotted; and

7) It features a utility called **PROTECT** which can be used to create and maintain security on the system. This important feature is not widely available in today's application software. For example, Expedition, a total construction project document control package does not have a security system, but it is currently on the drawing board according to one of its sales representatives.[1]

Hardware Requirements

From a technical standpoint, a micro-computer that is capable of running dBASE III PLUS should be adequate for the DSRS. However, the time it takes to operate the system on site cannot be overlooked since the system will have to be

tested in the field eventually. Given the anticipated volume of information that the system will handle and the criterion of minimizing operating time, the computer should have at least an Intel 80286 CPU and a hard disk drive.

3.3 DATA ORGANIZATION

Data organization addresses the questions of how many databases are required to completely represent the information on the daily site report forms, what information should be contained in each database, and how these databases must be indexed in order to facilitate data retrieval.

The following criteria were considered in establishing the number of databases required and the information that should be stored in each:

1) Group information such that each database carries one or at most two related ideas. That is, there is no reason to include weather information in the same database as that containing drawings availability information;

2) Collect information that could be represented by the same database structure (same set of fields, where a **field** is an item of information within a **record** of a database) into one database. For example, data relating to the five types of unusual developments at the project level (strikes/job actions, potential problems, delays, disputes, and others) should be stored in one database because their data could be recorded in the same format; and

3) Consider data manipulation requirements. The time it takes to search and locate specific information within a database should be minimized. Searching

and locating specific information generally takes longer in a larger database (more records and/or more fields) than in a smaller one. However, it would be more cumbersome to have to assemble a number of databases (instead of having everything in one) in order to retrieve some specific category of information. Examples of these two different data storage schemes are outlined in Figure 3.1 along with their respective advantages and disadvantages.

Based on the above guidelines, twelve databases were needed to most effectively represent the information on the daily site report forms. Figure 3.2 shows the section(s) of the daily site report that are represented by each of the twelve databases. Each database will be illustrated by a customized screen display during the data entry process. These screen displays and their respective dBASE III PLUS field definitions are presented in Figures 3.3 to 3.13.

Notwithstanding the information on the daily site report forms, the subsequent databases of the Data Collection System contain additional field entries to further enhance the comprehensiveness of the proposed daily site report:

1) **dsr_head.dbf** (see Figure 3.3)

- **DATA ENTERED BY:** in some instances, the superintendent might have completed the daily site report by pencil and paper and computer data entry was performed by a clerk. Then, it is important to acknowledge the computer operator just in case a dispute arises from the report.

- **RAIN & SNOW:** the item, **Precipitation**, on the **SITE / ENVIRONMENT INFORMATION** form are separated into these two fields for further

Scheme A: Sample Data Stored in One Database File with Two Content Fields		Scheme B: The Same Data Stored in Two Database Files with One Content Field Each	
- Activity I + Delay Ia - Activity I + Delay Ib - Activity I + Delay Ic - Activity II - Activity III + Delay IIIa - Activity III + Delay IIIb		- Activity I - Activity II - Activity III	- Delay Ia - Delay Ib - Delay Ic - Delay IIIa - Delay IIIb
Total No. of Records	6	3	5
		8	
Advantages	Disadvantages	Advantages	Disadvantages
- Less Records			- More Records
	- Same Info. Stored More Than Once	- No Info. Stored More Than Once	
- Easier to Retrieve Both Types of Info. at the Same Time			- Must Relate the Two Files Before Both Types of Info can be Retrieved at the Same Time
	- Slower Because the File is Larger and has more Records	- Faster for Retrieving Only One Type of Info.	

Figure 3.1 - Two Different Data Storage Schemes

Information Item	Database File
Site / Environment Information	
- Report Identification & Weather Information	- DSR_HEAD.DBF & PROJNAME.DBF
- Site Conditions	- SITECOND.DBF
- Unusual Developments	- UNUSUAL.DBF
Work Force Information	
- Trade Identification and General Information, Manpower Information & Drawings Info.	- WKFCINFO.DBF
- Delivery Information	- DELIVERY.DBF
- Equipment Usage	- EQIPMENT.DBF
- Accident Information	- ACCIDENT.DBF
Activity Information	
- Activity Identification and General Information, Activity Progress, Activity Performance (Rate of Production) & Quality Control (Quality of Work)	- ACTYINFO.DBF
- Activity Performance (Cause of Activity Delay)	- ACTYDLAY.DBF
- Quality Control (Inspections)	- INSPECTS.DBF
- Quality Control (Tests)	- TESTS.DBF

Figure 3.2 - Data Storage Organization

Field definitions for Screen : C:HEAD.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	3	20	DSR_HEAD	PROJECT_NO	Character	7	
1	7	20	DSR_HEAD	REVIEWD_BY	Character	3	
1	7	73	DSR_HEAD	DATA_ENTRY	Character	3	
1	3	68	DSR_HEAD	DATE	Date	8	
1	11	8	DSR_HEAD	WEATHER_AM	Character	30	
1	13	20	DSR_HEAD	TEMP_HI	Numeric	3	0
1	13	71	DSR_HEAD	TEMP_LO	Numeric	3	0
1	15	10	DSR_HEAD	RAIN_MM	Numeric	4	1
1	15	41	DSR_HEAD	SNOW_MM	Numeric	4	1
1	17	29	DSR_HEAD	HRS_WRK_AM	Numeric	5	2
1	17	71	DSR_HEAD	HRS_WRK_PM	Numeric	5	2
1	15	69	DSR_HEAD	WIND	Numeric	3	0
1	5	18	PROJNAME	PROJECTNAM	Character	30	
1	19	23	DSR_HEAD	HRS_WRK_OT	Numeric	5	2
1	11	49	DSR_HEAD	WEATHER_PM	Character	30	

FUNCTION S27

Content of page : 1

BASIC DAILY JOB INFORMATION

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

PROJECT NAME: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

SUPERINTENDENT: XXX DATA ENTERED BY: XXX

WEATHER (if appropriate, enter: CLEAR, CLOUDY, RAINY, or SNOWY)

AM: XXXXXXXXXXXXXXXXXXXXXXXXXXXXX PM: XXXXXXXXXXXXXXXXXXXXXXXXXXX

TEMPERATURE HI: XXX C TEMPERATURE LO: XXX C

RAIN: XXXX mm SNOW: XXXX mm WIND: XXX kph

HOURS WORKED IN MORNING: XXXXX HOURS WORKED IN AFTERNOON: XXXXX

HOURS OF OVERTIME: XXXXX

Figure 3.3 - Field Definitions for dsr_head.dbf and projname.dbf

Field definitions for Screen : C:SITE.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	3	71	SITECOND	ACCESS	Character	2	
1	5	16	SITECOND	ACCESS_D	Character	61	
1	9	72	SITECOND	STORAGE	Character	2	
1	11	16	SITECOND	STORAGE_D	Character	61	
1	15	74	SITECOND	GRDCOND	Character	2	
1	17	16	SITECOND	GRDCOND_D	Character	61	
1	1	18	SITECOND	PROJECT_NO	Character	7	
1	1	70	SITECOND	DATE	Date	8	
1	7	12	SITECOND	ACCESS_R	Memo	10	
1	13	12	SITECOND	STORAGE_R	Memo	10	
1	19	12	SITECOND	GRDCOND_R	Memo	10	

Content of page : 1

SITE CONDITIONS

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

ACCESS TO SITE (PP=POOR/PF=POOR-FAIR/FF=FAIR/FG=FAIR-GOOD/GG=GOOD): XX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

STORAGE ON SITE (PP=POOR/PF=POOR-FAIR/FF=FAIR/FG=FAIR-GOOD/GG=GOOD): XX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

GROUND CONDITIONS (PP=POOR/PF=POOR-FAIR/FF=FAIR/FG=FAIR-GOOD/GG=GOOD): XX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.4 - Field Definitions for sitecond.dbf

Field definitions for Screen : C:UNSL.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	7	9	UNUSUAL	TYPE	Character	26	
1	9	16	UNUSUAL	DESCRPTION	Character	61	
1	13	12	UNUSUAL	REMARKS	Memo	10	
1	11	39	UNUSUAL	TIMELOST	Numeric	5	2
1	4	18	UNUSUAL	PROJECT_NO	Character	7	
1	4	70	UNUSUAL	DATE	Date	8	

Content of page : 1

UNUSUAL DEVELOPMENTS

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

TYPE: XXXXXXXXXXXXXXXXXXXXXXXXX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

ESTIMATED TIME LOST TO OVERALL JOB: XXXXX Days

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.5 - Field Definitions for unusual.dbf

Field definitions for Screen : C:WKFC.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	6	45	WKFCINFO	CREWTYPE	Character	1	
1	8	15	WKFCINFO	CREWDSCRTN	Character	62	
1	10	43	WKFCINFO	CONTRACT	Character	1	
1	12	11	WKFCINFO	CONTRACT_N	Character	66	
1	14	32	WKFCINFO	WK_AVAILBE	Logical	1	
1	16	11	WKFCINFO	WK_AVAIL_N	Character	66	
1	4	18	WKFCINFO	PROJECT_NO	Character	7	
1	4	70	WKFCINFO	DATE	Date	8	
2	1	40	WKFCINFO	FOREMEN	Numeric	2	0
2	1	45	WKFCINFO	OTHER	Numeric	2	0
2	3	75	WKFCINFO	SKILL	Character	2	
2	4	18	WKFCINFO	SKILL_N	Character	59	
2	6	58	WKFCINFO	SUFFICIENT	Logical	1	
2	7	18	WKFCINFO	SUFFICNT_N	Character	59	
2	9	33	WKFCINFO	TURNOVER	Logical	1	
2	10	18	WKFCINFO	TURNOVER_N	Character	59	
2	12	36	WKFCINFO	DWGS_AVAIL	Logical	1	
2	13	11	WKFCINFO	DWGS_AVL_N	Character	66	
2	15	71	WKFCINFO	QUALITY	Character	2	
2	16	18	WKFCINFO	QUALITY_N	Character	59	
2	18	47	WKFCINFO	DETAILING	Character	1	
2	19	18	WKFCINFO	DETAIL_N	Character	59	

Content of page : 1

WORK FORCE INFORMATION

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

WORK FORCE TYPE (O=OWN FORCE/S=SUBTRADE): X

DESCRIPTON: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

CONTRACT AWARDED (Y=YES/N=NO/H=HOURLY): X

REMARK: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

WORK AVAILABLE (Y=YES/N=NO): X

REMARK: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Content of page : 2

TOTAL NUMBER OF MEN (FOREMEN/OTHER): XX / XX

. SKILL LEVEL (PP=POOR/PF=POOR-FAIR/FF=FAIR/FG=FAIR-GOOD/GG=GOOD): XX
REMARK: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

. SUFFICIENT TO MEET JOB CONDITIONS (Y=YES/N=NO): X
REMARK: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

. TURNOVER (Y=YES/N=NO): X
REMARK: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DRAWINGS AVAILABLE (Y=YES/N=NO): X
REMARK: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

. QUALITY (PP=POOR/PF=POOR-FAIR/FF=FAIR/FG=FAIR-GOOD/GG=GOOD): XX
REMARK: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

. DETAILING (I=INADEQUATE/A=ADEQUATE): X
REMARK: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Figure 3.6 - Field Definitions for wkfcinfo.dbf

Field definitions for Screen : C:DELI.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	7	16	DELIVERY	DESCRPTION	Character	61	
1	9	13	DELIVERY	SUPPLIER	Character	64	
1	12	23	DELIVERY	QUANTITY	Numeric	8	2
1	12	41	DELIVERY	UNITS	Character	4	
1	14	25	DELIVERY	ONTIME	Logical	1	
1	16	64	DELIVERY	QUALITY	Character	2	
1	18	12	DELIVERY	REMARKS	Memo	10	
1	3	18	DELIVERY	PROJECT_NO	Character	7	
1	3	70	DELIVERY	DATE	Date	8	
1	5	9	DELIVERY	CREWDSCRTN	Character	62	

Content of page : 1

DELIVERY INFORMATION

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

TRADE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

SUPPLIER: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

QUANTITY DELIVERED: XXXXXXXX UNITS: XXXX

ON TIME (Y=YES/N=NO): X

QUALITY (PP=POOR/PF=POOR-FAIR/FF=FAIR/FG=FAIR-GOOD/GG=GOOD): XX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.7 - Field Definitions for delivery.dbf

Field definitions for Screen : C:EQIP.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	8	16	EQIPMENT	DESCRPTION	Character	61	
1	10	24	EQIPMENT	OWN_RENT	Character	1	
1	12	20	EQIPMENT	NO_OF_ITEM	Numeric	2	0
1	14	31	EQIPMENT	TOTAL_HRS	Numeric	5	2
1	16	12	EQIPMENT	REMARKS	Memo	10	
1	4	18	EQIPMENT	PROJECT_NO	Character	7	
1	4	70	EQIPMENT	DATE	Date	8	
1	6	9	EQIPMENT	CREWDSCRTN	Character	62	

Content of page : 1

EQUIPMENT USAGE

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

TRADE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

O=OWNED OR R=RENTAL: X

NUMBER OF ITEMS: XX

TOTAL NUMBER OF HOURS USED: XXXXX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.8 - Field Definitions for eqipment.dbf

Field definitions for Screen : C:ACCI.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	9	16	ACCIDENT	DESCRPTION	Character	61	
1	4	18	ACCIDENT	PROJECT_NO	Character	7	
1	4	70	ACCIDENT	DATE	Date	8	
1	14	12	ACCIDENT	REMARKS	Memo	10	
1	6	9	ACCIDENT	CREWDSCRTN	Character	62	

Content of page : 1

ACCIDENT INFORMATION

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

TRADE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DESCIRPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.9 - Field Definitions for accident.dbf

Field definitions for Screen : C:ACTI.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	5	16	ACTYINFO	DESCRPTION	Character	61	
1	6	9	ACTYINFO	CODE	Character	9	
1	7	15	ACTYINFO	WORK_TODAY	Character	62	
1	11	68	ACTYINFO	STATUS	Character	2	
1	14	69	ACTYINFO	PRODUCTION	Character	1	
1	15	38	ACTYINFO	PRODCTIVTY	Character	39	
1	18	72	ACTYINFO	QUALITY	Character	2	
1	19	12	ACTYINFO	REMARKS	Memo	10	
1	2	18	ACTYINFO	PROJECT_NO	Character	7	
1	2	70	ACTYINFO	DATE	Date	8	
1	3	9	ACTYINFO	CREWDSCRTN	Character	62	

Content of page : 1

ACTIVITY INFORMATION

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

TRADE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

CODE: XXXXXXXXX

WORK TODAY: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

ACTIVITY STATUS (SD=STARTED/IP=IN PROGRESS/ID=IDLE/FD=FINISHED
/SF=STARTED AND FINISHED ON THE SAME DAY): XX

RATE OF PRODUCTION (E=EXCELLENT/S=SATISFACTORY/U=UNSATISFACTORY): X

QUANTIFY PRODUCTIVITY IF POSSIBLE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

QUALITY OF WORK (PP=POOR/PF=POOR-FAIR/FF=FAIR/FG=FAIR-GOOD/GG=GOOD): XX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.10 - Field Definitions for actyinfo.dbf

Field definitions for Screen : C:ACTD.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	10	9	ACTYDLAY	TYPE	Character	68	
1	12	16	ACTYDLAY	DESCRPTION	Character	61	
1	15	29	ACTYDLAY	TIMELOST	Numeric	5	2
1	18	12	ACTYDLAY	REMARKS	Memo	10	
1	2	18	ACTYDLAY	PROJECT_NO	Character	7	
1	2	70	ACTYDLAY	DATE	Date	8	
1	7	17	ACTYDLAY	ACTIVITY	Character	61	
1	4	9	ACTYDLAY	CREWDSCRTN	Character	62	
1	8	17	ACTYDLAY	CODE	Character	9	
1	15	71	ACTYDLAY	MANHR_LOST	Numeric	5	2
FUNCTION S00							
1	15	72	ACTYDLAY	MANHR_LOST	Numeric	5	2

Content of page : 1

DELAY / REWORK INFORMATION

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

TRADE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

ACTIVITY
DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CODE: XXXXXXXXX

TYPE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

ESTIMATED ACTIVITY DELAY: XXXXX Hrs. ESTIMATED MAN-HOURS LOST: XXXXX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.11 - Field Definitions for actydlay.dbf

Field definitions for Screen : C:INSPECT.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	13	16	INSPECTS	DESCRPTION	Character	61	
1	18	12	INSPECTS	REMARKS	Memo	10	
1	3	18	INSPECTS	PROJECT_NO	Character	7	
1	3	70	INSPECTS	DATE	Date	8	
1	9	10	INSPECTS	CODE	Character	9	
1	5	9	INSPECTS	CREWDSCRTN	Character	62	
1	8	17	INSPECTS	ACTYDSCRTN	Character	61	

Content of page : 1

INSPECTION LOG

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

TRADE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

ACTIVITY
DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CODE: XXXXXXXXX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.12 - Field Definitions for inspects.dbf

Field definitions for Screen : C:TEST.scr

Page	Row	Col	Data Base	Field	Type	Width	Dec
1	13	16	TESTS	DESCRPTION	Character	61	
1	18	12	TESTS	REMARKS	Memo	10	
1	9	10	TESTS	CODE	Character	9	
1	3	18	TESTS	PROJECT_NO	Character	7	
1	3	70	TESTS	DATE	Date	8	
1	5	9	TESTS	CREWDSCRTN	Character	62	
1	8	17	TESTS	ACTYDSCRTN	Character	61	

Content of page : 1

TESTING LOG

PROJECT NUMBER: XXXXXXX DATE: XXXXXXXX

TRADE: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

ACTIVITY
DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CODE: XXXXXXXXX

DESCRIPTION: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

REMARKS: XXXX Press CONTROL-PGDN to enter a remark; CONTROL-PGUP to return.

Figure 3.13 - Field Definitions for tests.dbf

distinction in order to facilitate data retrieval.

- **HOURS WORKED IN MORNING, HOURS WORKED IN AFTERNOON & HOURS OF OVERTIME:** making these entries directly would eliminate having to deduce these information, if so desired, from daily timesheets (NOTE: it is necessary to distinguish morning work hours from afternoon work hours because it is not unusual for some local construction sites to begin the day earlier in the summer months in order to provide extra after work daylight hours for their workers and their families). For projects which employ shift work, the time and duration of each shift should be recorded.

2) **sitecond.dbf** (see Figure 3.4), **unusual.dbf** (see Figure 3.5), **delivery.dbf** (see Figure 3.7), **eqipment.dbf** (see Figure 3.8), **accident.dbf** (see Figure 3.9), **actyinfo.dbf** (see Figure 3.10), **actydlay.dbf** (see Figure 3.11), **inspects.dbf** (see Figure 3.12), **tests.dbf** (see Figure 3.13)

   - **REMARKS:** this special dBASE field, **memo**, has been added to all of the aforementioned databases. It only takes up 4 characters on the computer screen, but it allows an entry containing text of up to 5,000 characters. This field could be used to pick up additional information that would have otherwise be left unsaid because of the limited width that can be displayed on the computer screen for description fields. In particular, for **inspects.dbf** and **tests.dbf**, this field should be used for describing deficiencies.

Furthermore, since the Data Collection System consists of twelve databases, certain fields must be stored in more than one databases in order to keep track of related information in different databases. Table 3.1 shows the databases that are affected and the corresponding information that must be carried over. However, not all of the five types of relational fields listed in Table 3.1 are

Database File (.DBF)	Relational Fields				
	Project Number	Date	Trade	Activity Description	Activity Code
SITECOND	X	X			
UNUSUAL	X	X			
WKFCINFO	X	X			
DELIVERY	X	X	X		
EQIPMENT	X	X	X		
ACCIDENT	X	X	X		
ACTYINFO	X	X	X		
ACTYDLAY	X	X	X	X	X
INSPECTS	X	X	X	X	X
TESTS	X	X	X	X	X

Table 3.1 - Relational Fields Required for Proper Data Relation

absolutely essential for proper data relation. **PROJECT NUMBER** is required only if the system is to be operated in a LAN environment. In this environment, daily site reports from all of the company's projects will be stored in the same twelve databases; thus, it is necessary to distinguish the reports. **ACTIVITY DESCRIPTION** is included mainly for convenience. If the data entry process is interrupted while entering information regarding activity delays (**actydlay.dbf**), activity inspections (**inspects.dbf**), or activity tests (**tests.dbf**), the operator may forget which activity he or she was concerned with even though the **ACTIVITY CODE** is displayed (carried over from **actyinfo.dbf**) on the screen because this code is not usually memorized. Therefore, it is extremely helpful to have the full description of the activity displayed on the screen.

In dBASE III PLUS, one can **index** a database file so that all records containing the desired string are grouped together in ascending order, alphabetically, chronologically, or numerically. Then, once dBASE III PLUS finds the first matching record, the search proceeds very rapidly. If the DSRS is to be operated in a LAN environment, all of the databases (with the exception of **projname.dbf**) should be indexed by **PROJECT NUMBER** and **DATE.** The former facilitates retrieval of information pertaining to one specific job; and the latter assists retrieval of information from all of the jobs on a specific date.

Whereas if the system is operated on a stand alone basis for each project, indexing by **DATE** only is adequate. In chapter 4.0, some special indexing will be discussed for the retrieval of specific information.

3.4 AN OVERVIEW OF THE PROTOTYPE DATA COLLECTION SYSTEM

3.4.1 METHOD OF DATA INPUT

The method of **Direct Computer Input** was selected for the Data Collection System of the prototype DSRS. As the name implies, this method requires the superintendent to directly input the daily site information into the computer without having to complete the report by pencil and paper first (the report would appear right on the screen as a series of windows). Then, the computer would generate a hard copy of the report for the superintendent to verify. Consequently, it requires less manpower and paper work. However, the following methods of data entry were also considered, but they were determined to be inappropriate for this application:

1) **The Basic 2-Stage System** - this is a desirable method for the superintendent who dislikes having anything to do with a computer. The superintendent's task is restricted to only filling out the daily site report on paper (first stage). Then the task of computer data entry may be carried out by someone else such as a clerk (second stage). The major drawbacks of this method are that it

involves more paper work, requires more manpower than **Direct Computer Input**, and can result in errors during computer data entry.

2) **The Turnaround Document** [13:3] - this is a modified version of **The Basic 2-Stage System.** The only difference is that the daily site report is a computer generated daily menu that is to be edited and re-submitted at the end of the day as the actual construction record. This menu contains the planned outcome of that day's activities (based on the assumption that much of the daily recorded information does not change significantly from day-to-day on a typical high-rise construction site). Nevertheless, it still suffers from the same problems of excessive paper work and additional manpower requirement.

3) **The Computer Readable Form** - this method requires designing special forms that can be read by the computer to speed up the updating process. This means the superintendent must still fill out the daily site report first, but computer data entry is relegated to a scanner. In the past, these forms had to be in a multiple choice format due to the limited capacity of the scanner. Therefore, this system was suited to large institutions with very specific information needs. For example, the City of Vancouver's Engineering Department used to employ a similar system for their annual infrastructure inspections. But as their information needs grew, this department found that the forms were not detailed enough, and some information items can be better expressed with supplemental comments.[23] Hence, they are now using a system called the **Information Retrieval System** (see Appendix B) that is similar to **The Turnaround Document.** Today, pattern recognition scanners with Optical Character Recognition (OCR) technology can identify written characters and thereby allowing additional comments after multiple choice entries [PC Magazine, November 29, 1988]. Unfortunately, at their present stage of development, the pattern recognition ability of these scanners is still rather weak; therefore, the writer often has to be trained to write in a certain way. However, due to the relatively low set up cost of these systems (approximately $ 2,000 for the scanner, $ 1,000 for the translator, and $ 200 for the customized database interface), they should be further investigated.

4) **The Voice Entry System** - voice entry capabilities exist and are being used by the U.S. Corps of Engineers for an inspection system.[6:11] Such a

system may be appropriate for some parts of the DSRS, for example, narrative reports on discussions, delays and inspections. Unfortunately, this system requires the forefront of computer hardware which is not yet readily accessible commercially. Moreover, implementation of such a system is likely to be very expensive.

3.4.2 THE DATA ENTRY PROCESS

The prototype Data Collection System described hereafter adheres to, as much as possible, the general criteria outlined in section 3.1. The idea is that the superintendent works directly with the system and not with an intermediate hard copy format. Invariably, shortcomings exist because this is the first prototype system of its kind. For example, error checking has not been programmed into the system due to time constraints. This and other deficiencies will be discussed within the following step-by-step description of the data entry process of the prototype system. A flowchart outlining the entire data entry process is presented in Figure 3.14.

Entering the Data Collection System

This system can be entered from any directory or sub-directory of the hard disk drive by typing **"dsrsin <return>"**. The batch file, **dsrsin.bat**, has been written for accessing dBASE III PLUS and the **dBASE** program, **mainin.prg**, in order to commence the data entry process. The first display screen is the dBASE III PLUS License Agreement which

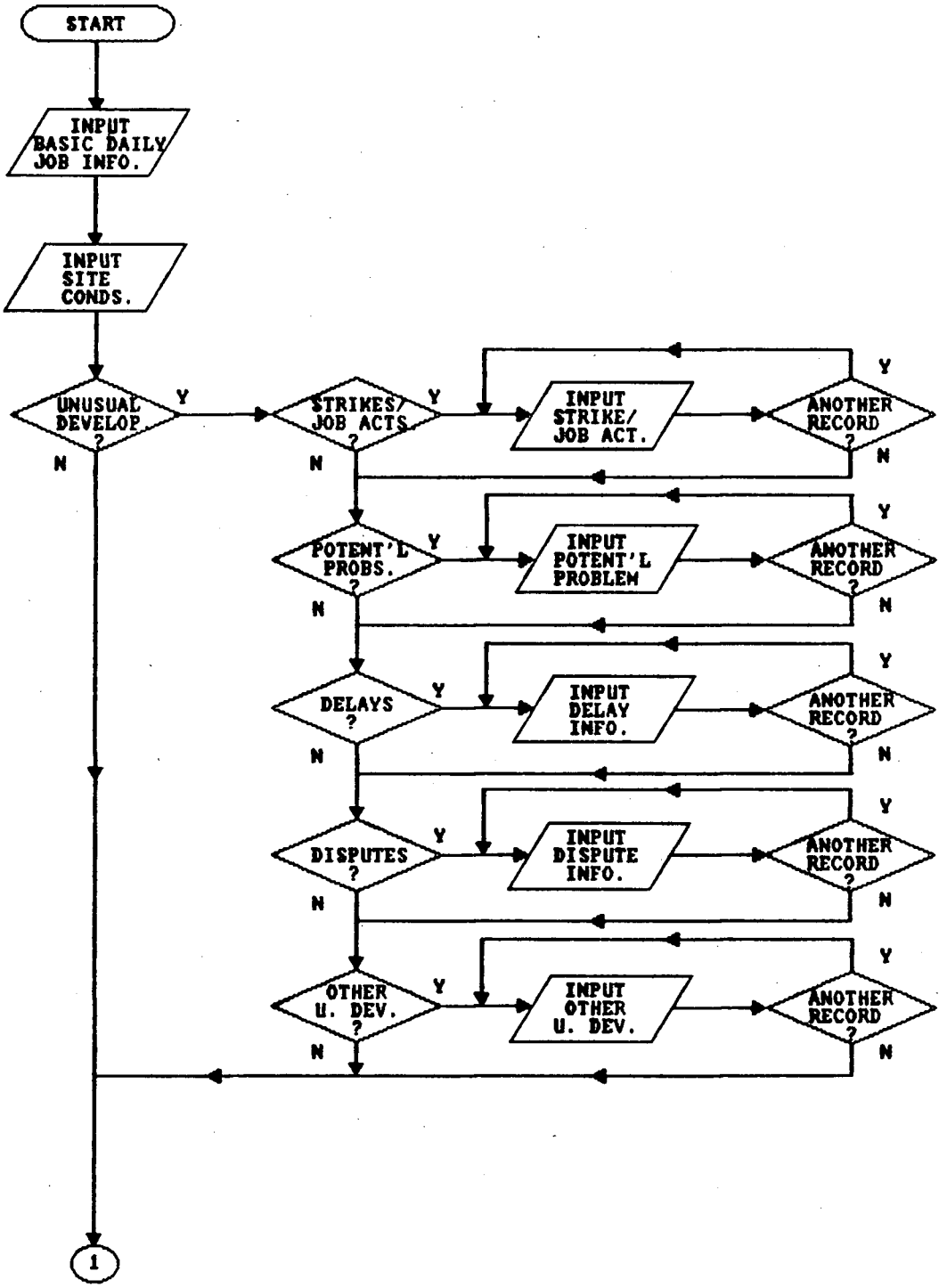

Figure 3.14 - Flowchart of the Data Entry Process (Screen-By-Screen)

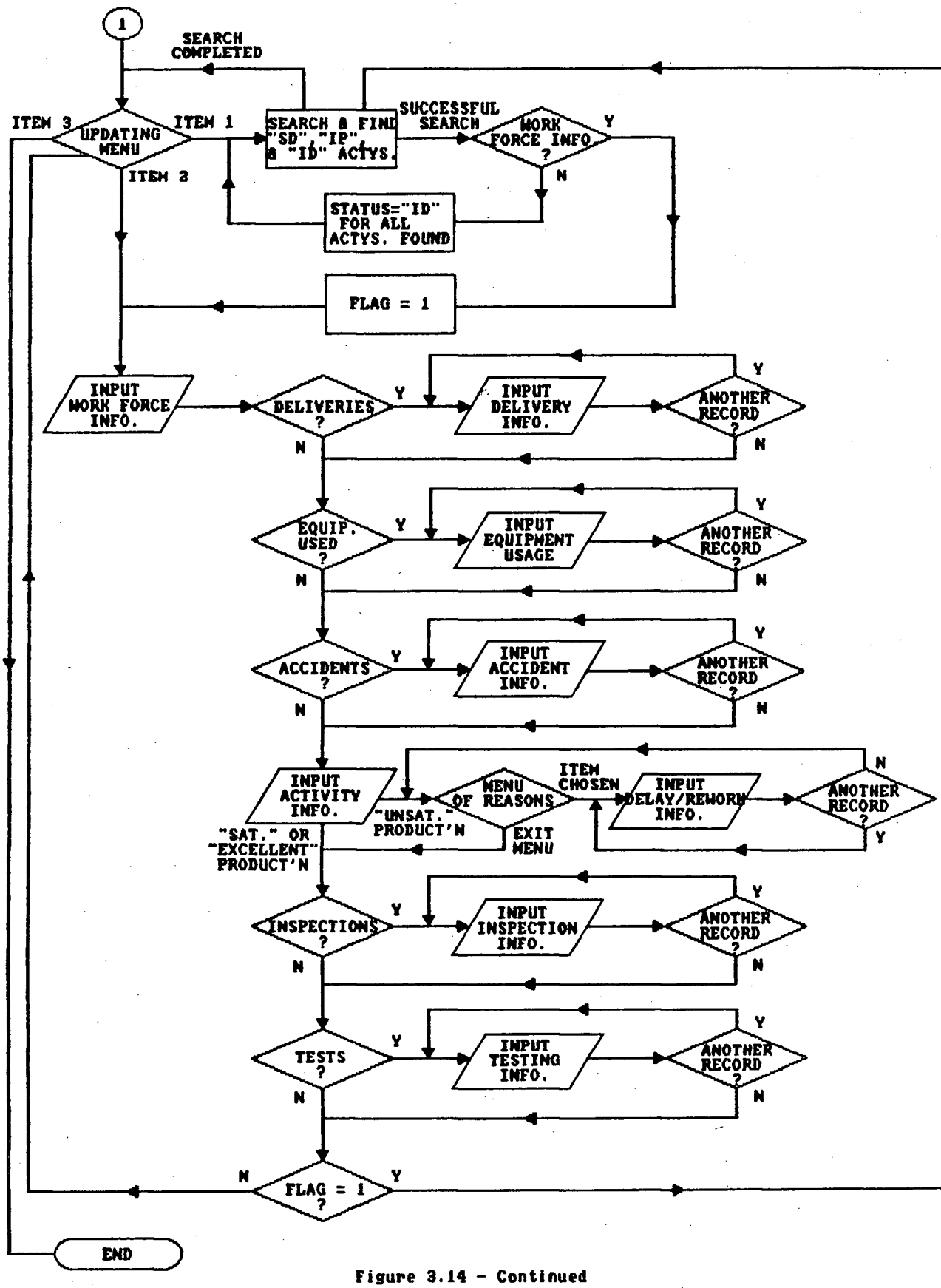

Figure 3.14 - Continued

is not part of the system (simply hit **<return>** to skip to the first data entry screen).

Basic Daily Job Information Screen

This is the first data entry screen (see Figure 3.15), and all of the highlighted entry fields must be completed. The field, **PROJECT NAME**, is not highlighted because it is automatically entered by the computer. From the **PROJECT NUMBER** entered, the computer will find the corresponding project name from the database **projname.dbf**. However, the **AM** and **PM WEATHER** fields can be improved. At present, the operator must type in the appropriate weather description. If a menu of weather characteristics is provided, the operator would just select the appropriate response (either with a highlight or with an item number) and the entry would be made. Moreover, an anticipated response could be presented wherever the entry is not likely to change from day-to-day. For this screen, they may be used for these fields: **SUPERINTENDENT**, **DATA ENTERED BY**, **HOURS WORKED IN MORNING**, **HOURS WORKED IN AFTERNOON**, and **HOURS OF OVERTIME**. But they must be changeable in order to facilitate possible editing. Finally, it is very important to have error checking for the last field on every screen. Since the next data entry screen would appear as soon as the last field had been entered, no corrections could be made (at least until after the entire data entry process is over) to this or any other previous entries if so desired.

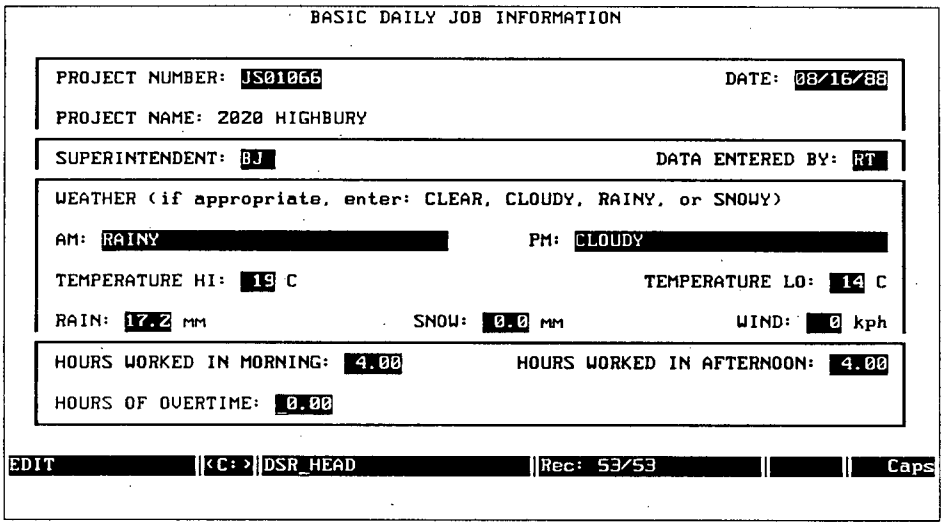

Figure 3.15 - Basic Daily Job Information Screen

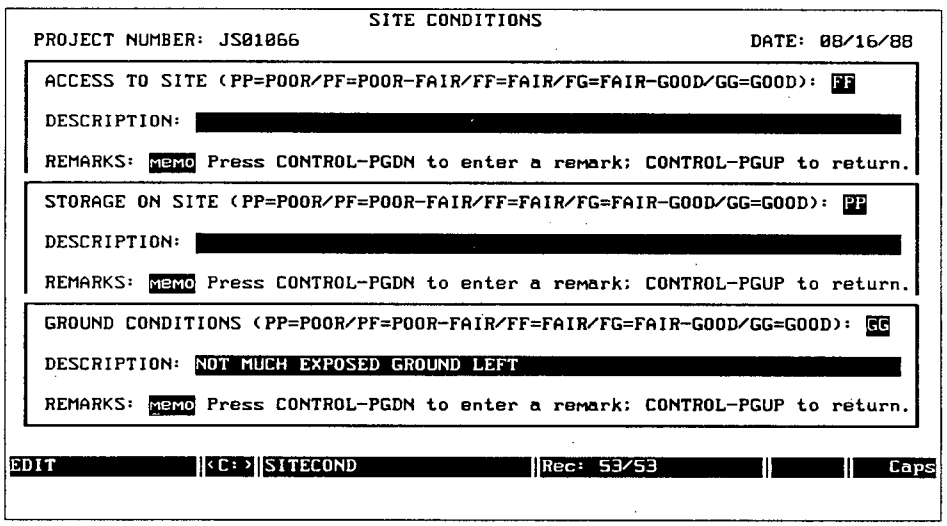

Figure 3.16 - Site Conditions Screen

Site Conditions Screen

For this screen (see Figure 3.16) and all subsequent data input screens, **PROJECT NUMBER** and **DATE** are automatically carried over from the first screen. And they are not highlighted so that they cannot be accidently edited. Anticipated responses for **ACCESS TO SITE**, **STORAGE ON SITE**, and **GROUND CONDITIONS**, if implemented, should be those from the previous work day. If the **DESCRIPTION** fields do not provide sufficient room for data entry, **REMARKS** fields could be opened up (refer to the instructions on the screen) for additional space.

Unusual Development Prompt

The purpose of this screen is to find out whether or not any unusual developments were encountered that day (see Figure 3.17). If not, the operator would answer "No", by typing "**N <return>**", to the question at the bottom of the screen, and the system would proceed to the Updating Menu. On the other hand, if the operator wishes to record any of the five types of unusual developments listed on the screen, he or she would respond "Yes" to the question either by typing "**Y <return>**" or simply hitting the **<return>** key (that is, if an input prompt is in the format, "... [Y/N]? [Y]:", then the anticipated response is "Yes").

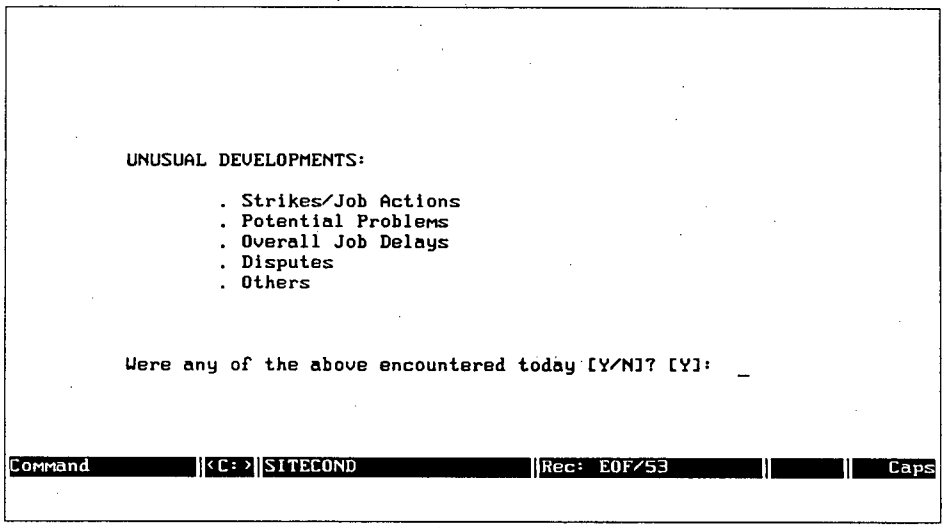

Figure 3.17 - Unusual Development Prompt

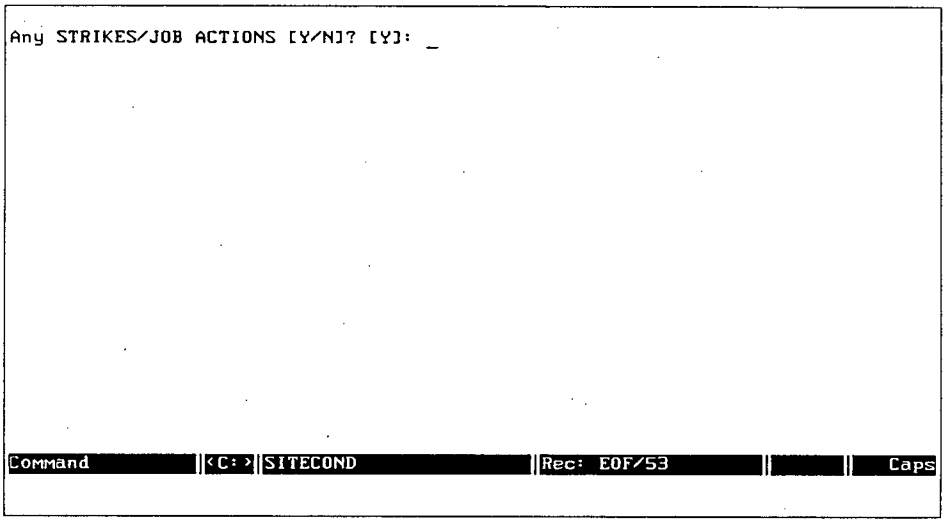

Figure 3.18 - Strikes/Job Actions Prompt

Unusual Developments Screen

Instead of having a menu consisting of the five types of unusual developments to choose from, the system utilizes a more robust scheme. Upon responding "Yes" to the Unusual Development Prompt, the system would solicit input to each of the five types of unusual developments one at a time (see Figures 3.18 to 3.22). A "Yes" reply to any of the five questions would bring up the Unusual Developments Screen (see Figure 3.23) with the corresponding type of unusual development already stored in the **TYPE** field (note that it is also not highlighted, thus not editable). After each unusual development entry, the system has provision for additional entries of the same type (see Figure 3.24).

Updating Menu

As indicated by its title, this menu (see Figure 3.25) facilitates updating Work Force Information and Activity Information.

Unless it is the first day of system implementation, "Begin Updating", should be the first item selected each day. It aids the user by recalling any activity (and hence the trade responsible) that was in progress, idle, or started on the last working day. This means that **TRADE DESCRIPTION**, **ACTIVITY DESCRIPTION**, and **ACTIVITY CODE** would not have to be re-entered for these activities.

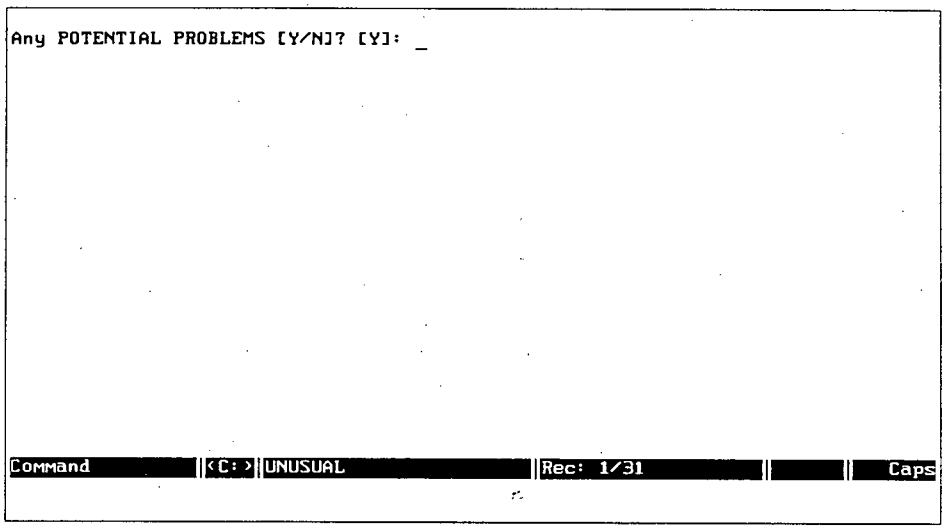

Figure 3.19 - Potential Problems Prompt

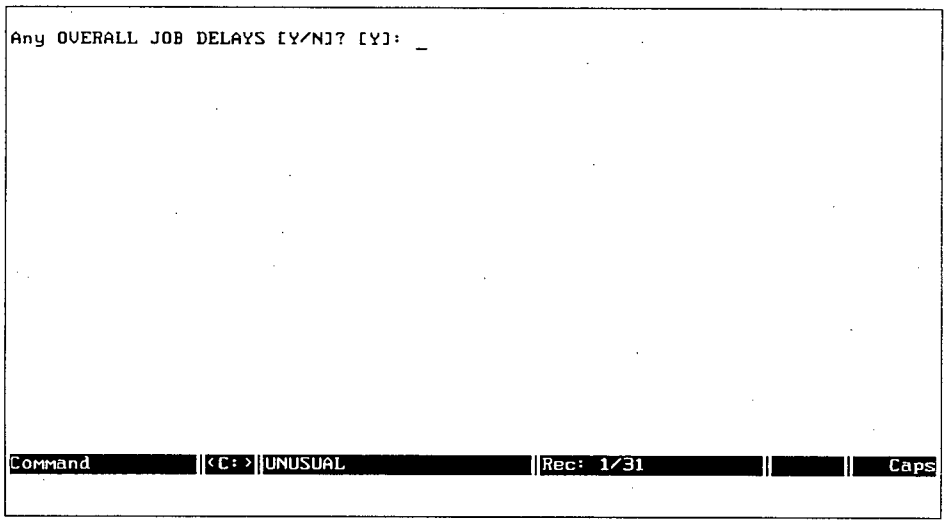

Figure 3.20 - Overall Job Delays Prompt

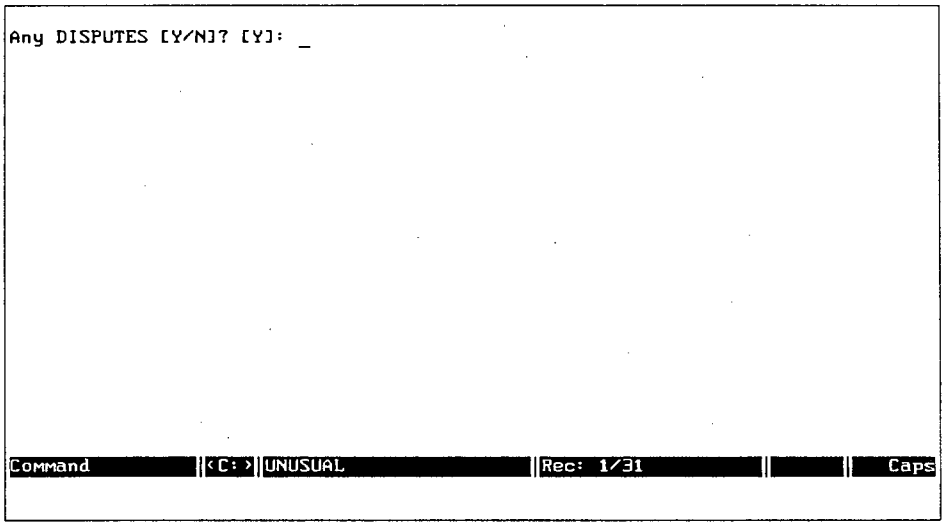

Figure 3.21 - Disputes Prompt

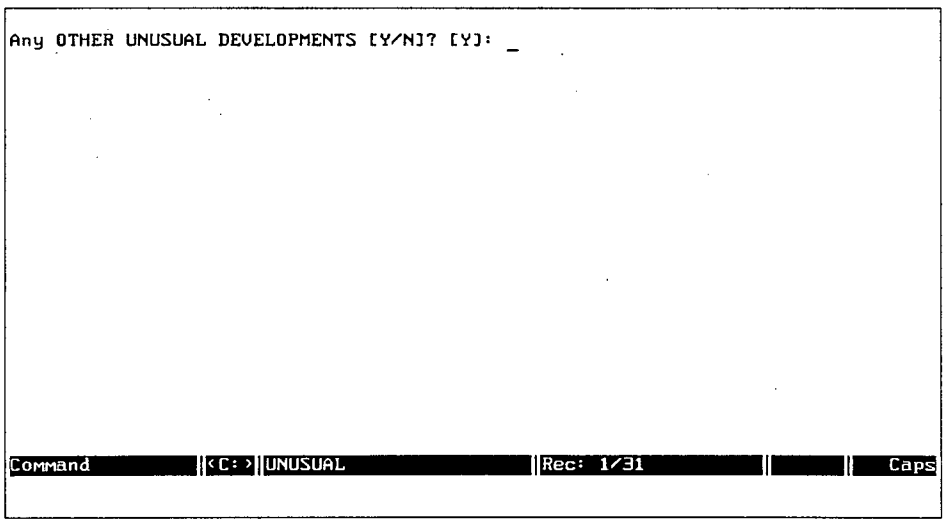

Figure 3.22 - Other Unusual Developments Prompt

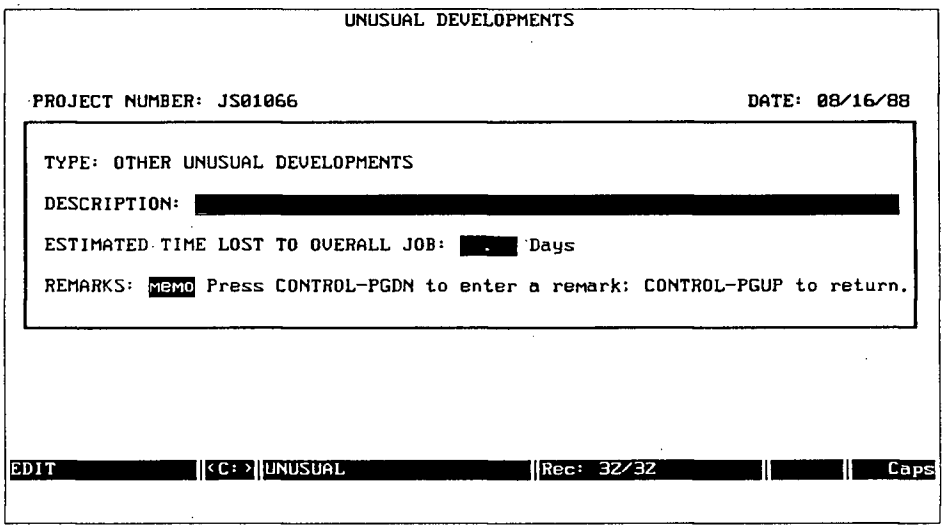

Figure 3.23 - Unusual Developments Screen

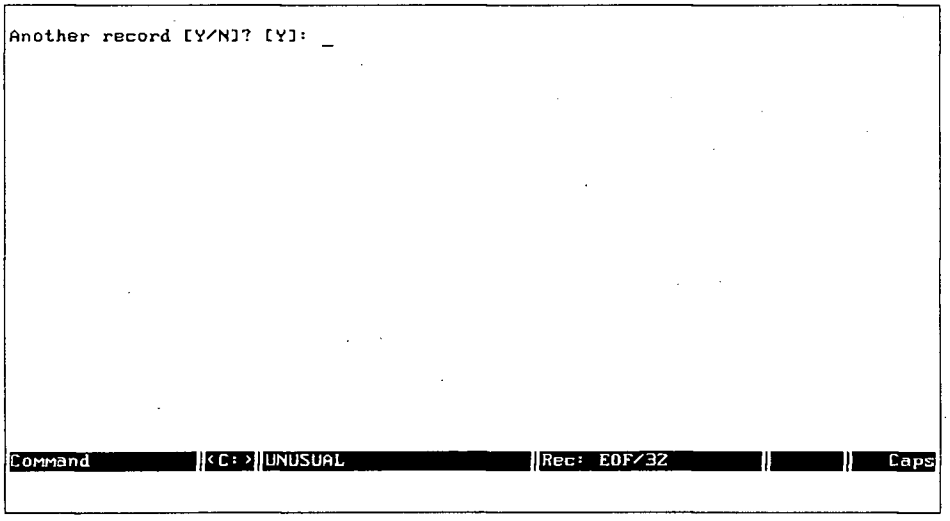

Figure 3.24 - Additional Entry Prompt

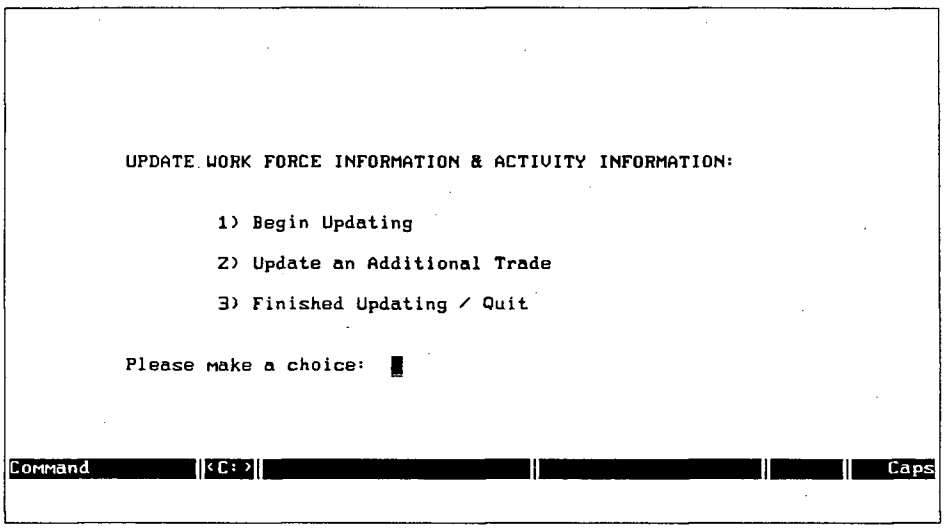

Figure 3.25 - Updating Menu

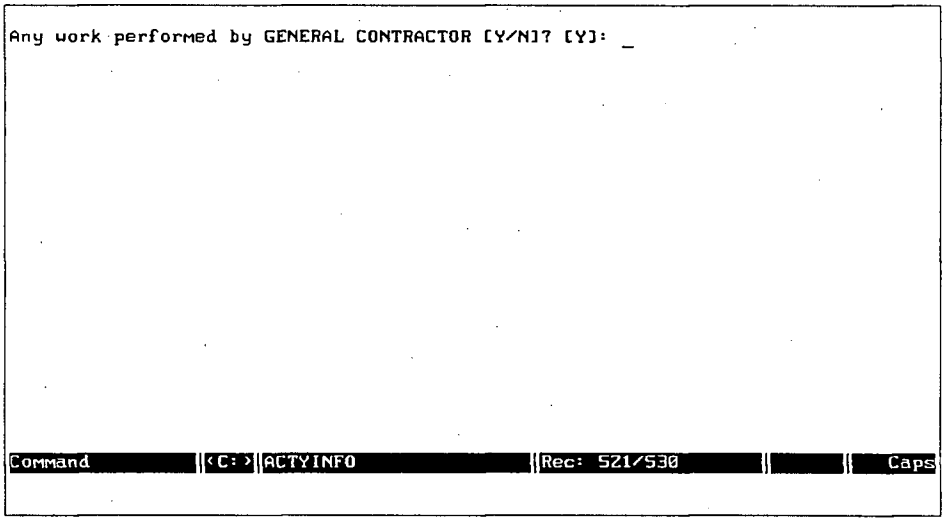

Figure 3.26 - Work Force Information Prompt

Item 2, "Update an Additional Trade", should be used for updating any new or returning trades starting new activities. Since there is no previous information regarding these activities, **TRADE DESCRIPTION**, **ACTIVITY DESCRIPTION**, and **ACTIVITY CODE** must be entered manually. However, if the DSRS is linked to the Scheduling System (it is not at the time of this report), a menu of forthcoming activities (say ones that are scheduled to start within the next 2 weeks) could be called up on the screen to facilitate data entry. This option could be included as an additional item on the Updating Menu. Then, item 2 would only be used for entering activities that are not already in the scheduling program. And the DSRS could, in turn, insert these new activities back into the scheduling program given a mechanism is added for inserting such information as activity logic and durations. This is known as **Real Time Job Monitoring and Control.**

Finally, item 3, "Finished Updating / Quit", is executed to exit the Data Collection System.

Work Force Information Prompt

Upon selecting item 1, "Begin Updating", from the Updating Menu, the system begins its search through the activity database (**actyinfo.dbf**) for activities that were in progress, idle, or started on the last working day. The name of the trade responsible for the first activity found

is used in the Work Force Information Prompt (see Figure 3.26). If the operator answers "No" to this question, the system would automatically issue an **ACTIVITY STATUS** of **"ID"** (for idle) for each activity found in the search belonging to this trade. Then the search process continues (until the last activity fulfilling the above condition has been found) with another Work Force Information Prompt using a different trade name. If this trade was on site that day, the operator would respond "Yes" and the first Work Force Information Screen appears.

Work Force Information Screens

If the operator reaches the Work Force Information Screens (see Figures 3.27a and 3.27b) via a Work Force Information Prompt, the **WORK FORCE TYPE** and **DESCRIPTION** would be already entered. Otherwise, they must be recorded manually along with all of the other items on the two screens. A pull-down menu showing all of the trades involved in this job would expedite data entry here. Furthermore, anticipated responses could be programmed for all of the items requiring selective input because these data do not tend to change very much from day to day. However, if the data entry process is interrupted on a screen full of anticipated responses, the operator might forget to check each entry item when he or she returns, thereby increasing the risk of recording false information. Thus, anticipated responses should be incorporated with due

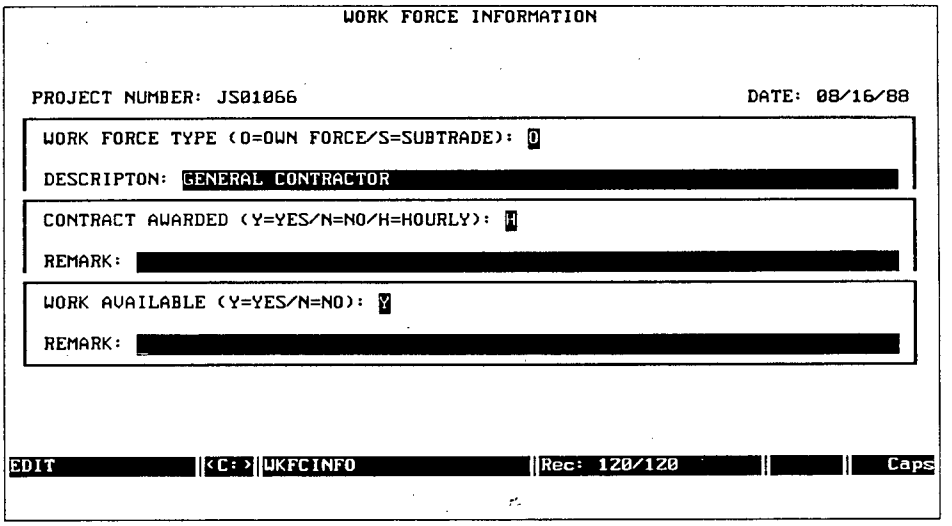

Figure 3.27a - Work Force Information Screen 1

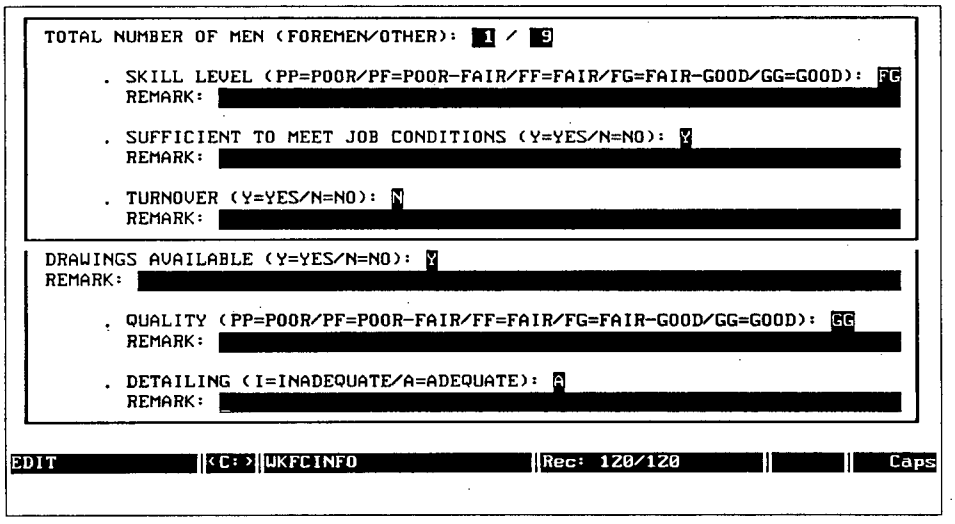

Figure 3.27b - Work Force Information Screen 2

consideration. NOTE: the information items on these two screens only have to be completed once per day for each active trade.

Delivery Information Prompt / Delivery Information Screen

Each time after Work Force Information had been entered, the Delivery Information Prompt (see Figure 3.28) appears. If the operator's response is "Yes", the Delivery Information Screen emerges with the **TRADE** field already filled out (see Figure 3.29). Upon the completion of one record, the system asks whether or not another delivery was made (see Figure 3.24). A reply of "No" would take the user to the Equipment Usage Prompt (otherwise, a new Delivery Information Screen is brought back to allow further input).

Equipment Usage Prompt / Equipment Usage Screen

Equipment Usage entries are solicited in exactly the same fashion as for Delivery Information, that is by a prompt (see Figure 3.30) followed by an input screen (see Figure 3.31). A pull-down standardized menu of equipment items here would expedite data entry as well as eliminate inconsistent descriptions. And the system uses the same prompt in Figure 3.24 to accept additional entries.

Accident Information Prompt / Accident Information Screen

The system requests Accident Information next. This information is also captured in the same way. First, the

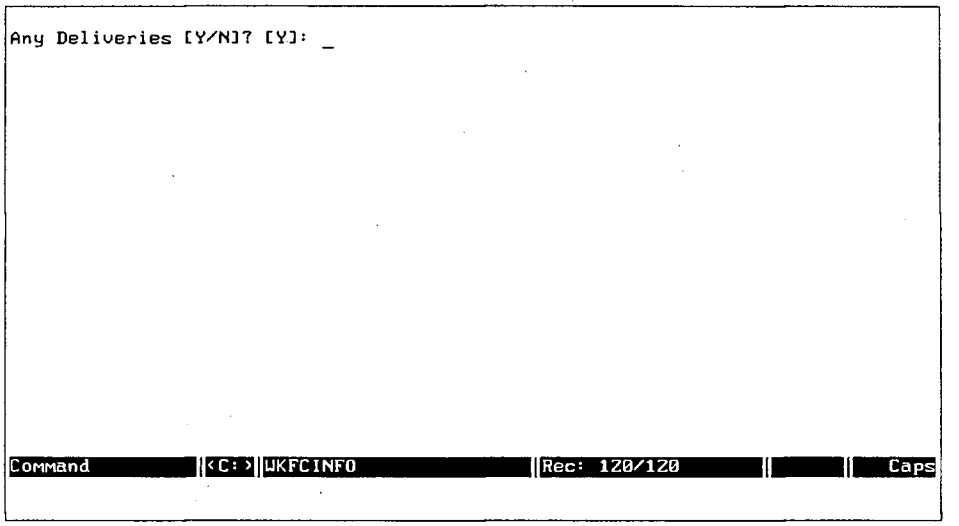

Figure 3.28 - Delivery Information Prompt

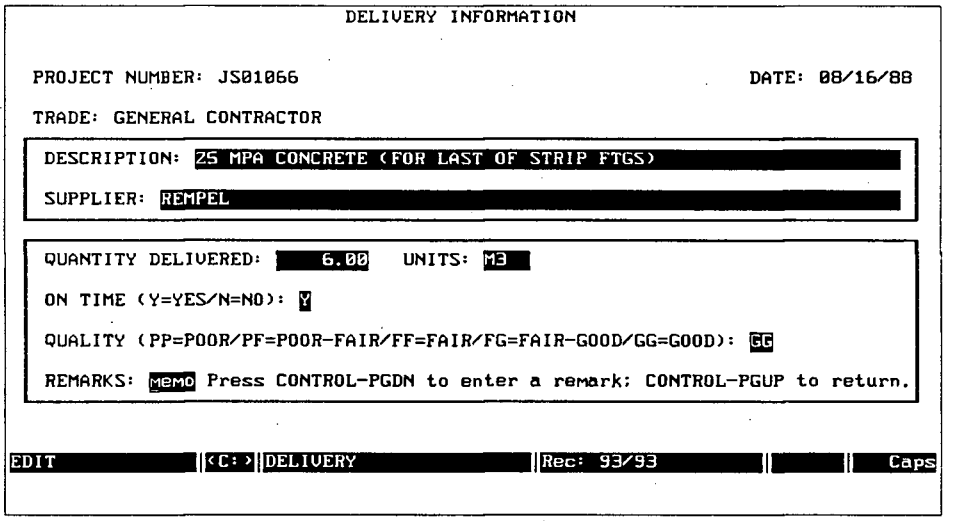

Figure 3.29 - Delivery Information Screen

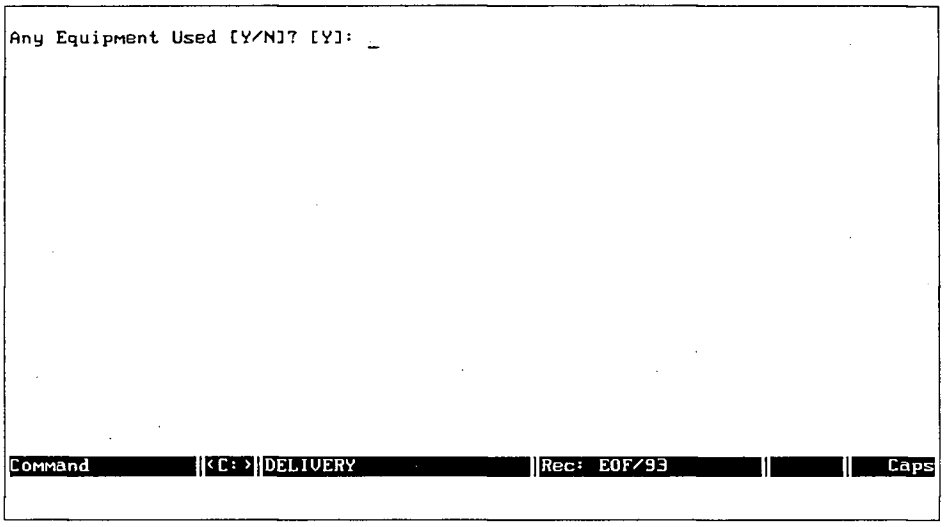

Figure 3.30 - Equipment Usage Prompt

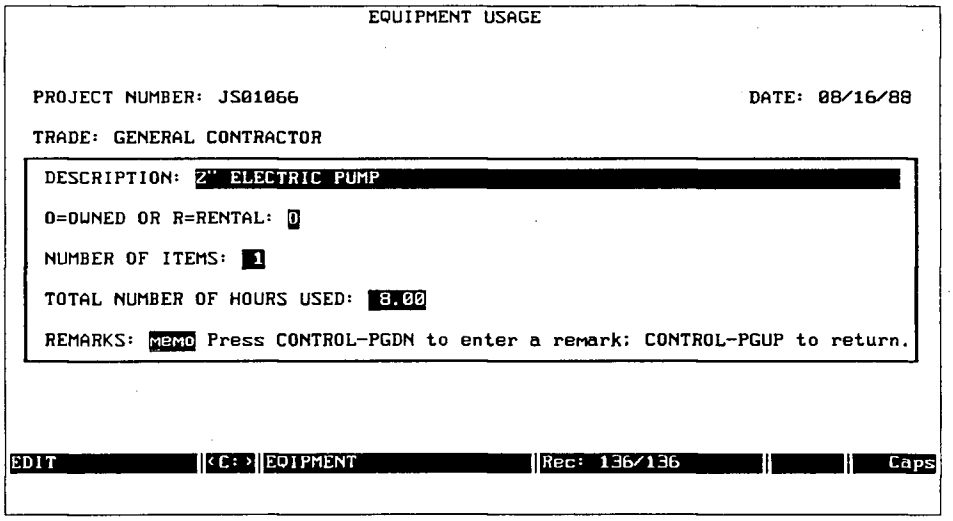

Figure 3.31 - Equipment Usage Screen

Accident Information prompt appears (see Figure 3.32). It is followed by the Accident Information input screen (see Figure 3.33), if so required. Finally, the process is completed with the prompt in Figure 3.24.

Activity Information Screen

If the operator arrives at the Activity Information Screen (see Figure 3.34) through a Work Force Information Prompt, the **TRADE**, (ACTIVITY) **DESCRIPTION**, and (ACTIVITY) **CODE** would be already filled out because the search and find function (item 1 of Updating Menu) is still activated. Otherwise, only the **TRADE** field would be carried over from the first Work Force Information Screen.

Reasons for Unsatisfactory Rate of Production Menu

If unsatisfactory **RATE OF PRODUCTION**, "U", is recorded on an Activity Information Screen, the Reasons for Unsatisfactory Rate of Production Menu (see Figure 3.35) would be the next display screen. This menu is used to identify a cause of unsatisfactory rate of production which would be inserted into the **TYPE** field of the Delay / Rework Information Screen.

Delay / Rework Information Screen

The **TRADE**, **ACTIVITY DESCRIPTION**, **ACTIVITY CODE**, and **TYPE** fields would be already filled out when this screen first appears on the monitor (see Figure 3.36). After the

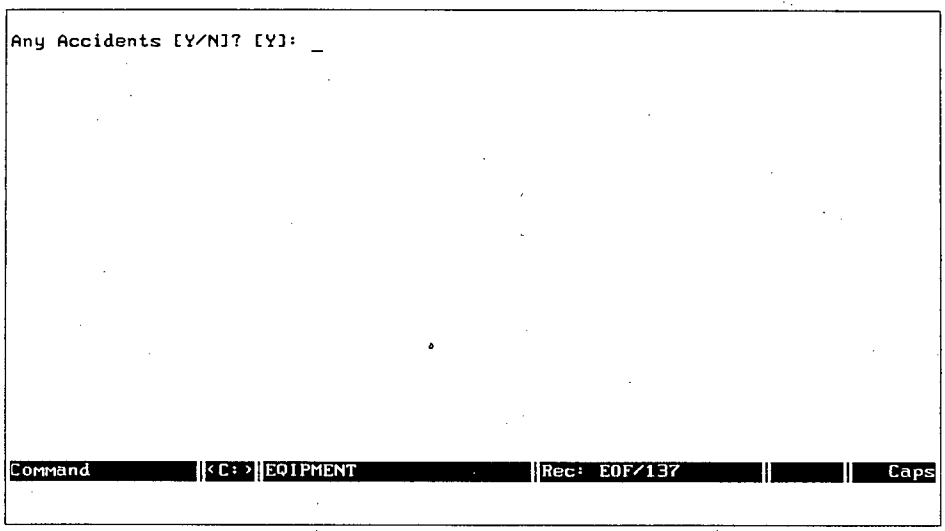

Figure 3.32 - Accident Information Prompt

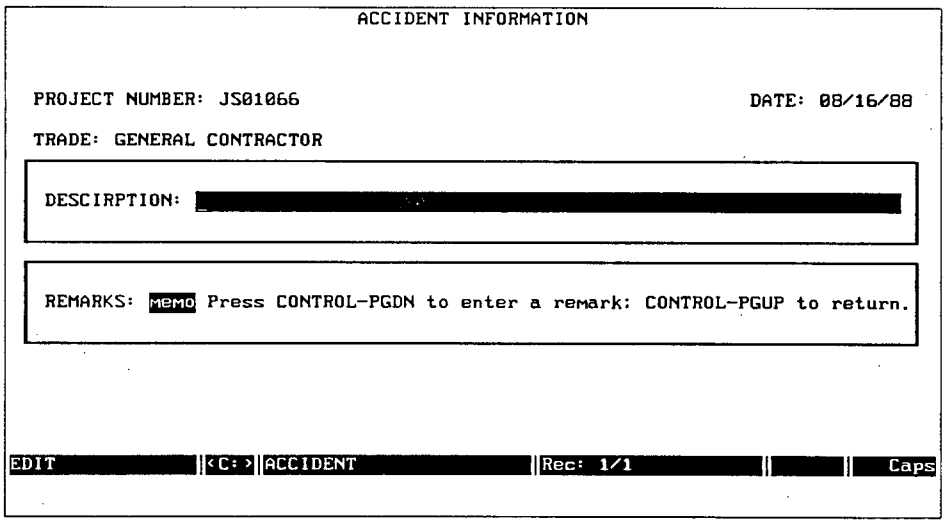

Figure 3.33 - Accident Information Screen

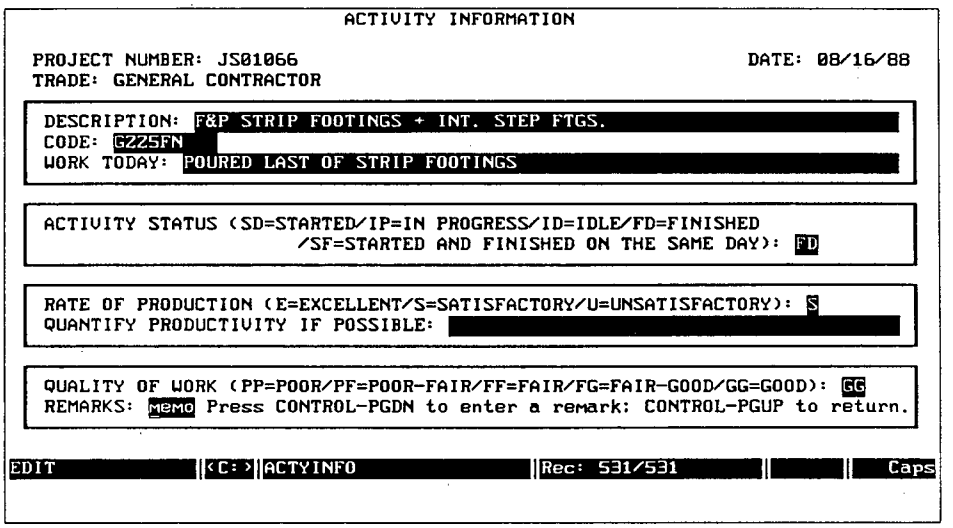

Figure 3.34 - Activity Information Screen

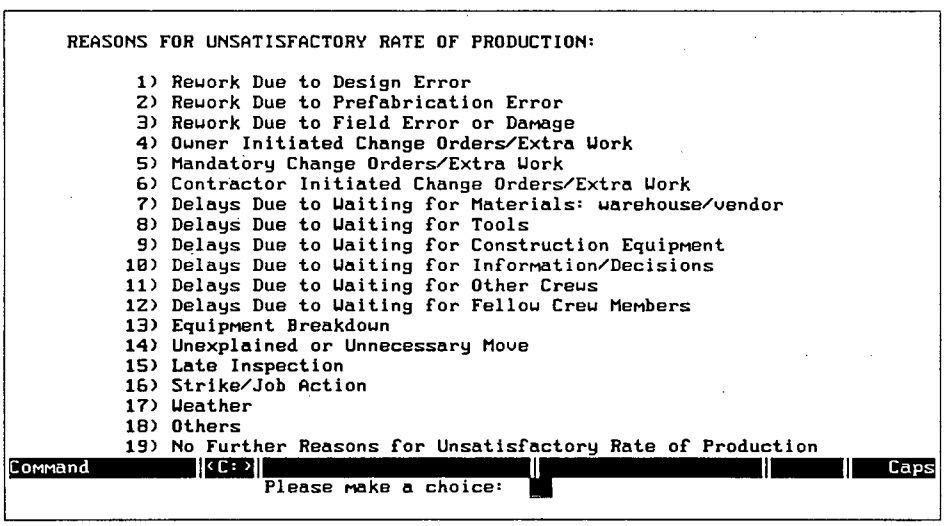

Figure 3.35 - Reasons for Unsatisfactory Rate of Production Menu

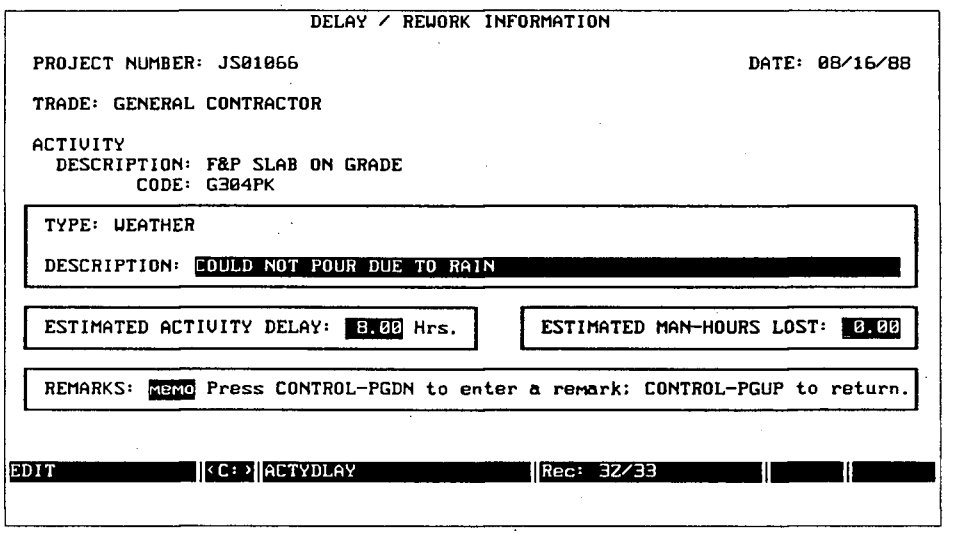

Figure 3.36 - Delay / Rework Information Screen

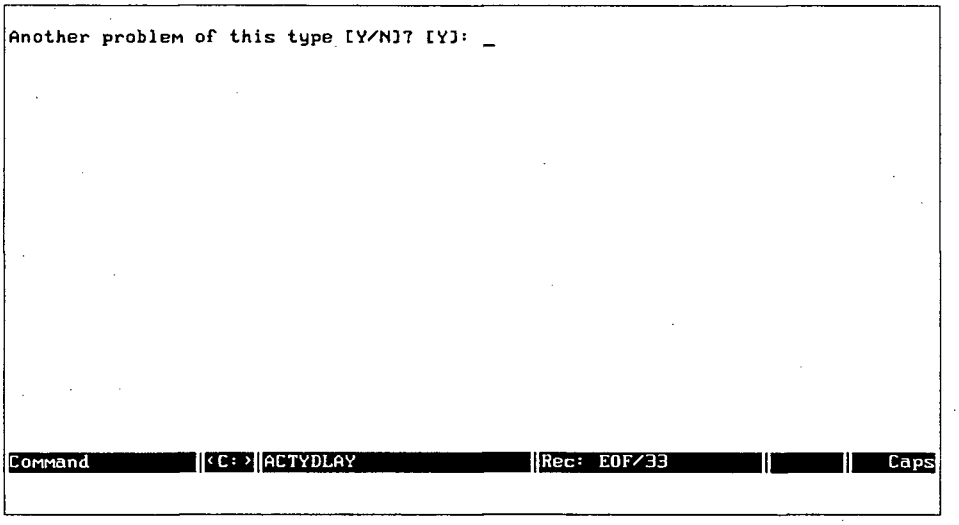

Figure 3.37 - Additional Entry Prompt

last item on the screen is entered, the system prompts for additional input (see Figure 3.37). A reply of "No" would take the operator back to the Reasons for Unsatisfactory Rate of Production Menu (where the user can identify another problem or exit the menu). Whereas, a reply of "Yes" would bring up a new Delay / Rework Information Screen, with the same **TYPE** of problem already registered, for data entry.

Inspection Log Prompt / Inspection Log Screen

The Inspection Log Prompt (see Figure 3.38) follows an exit from the Reasons for Unsatisfactory Rate of Production Menu or an Activity Information Screen. If the user responds with "Yes", the system would bring up the Inspection Log Screen (see Figure 3.39) with its **TRADE**, **ACTIVITY DESCRIPTION**, **ACTIVITY CODE**, and **TYPE** fields already filled out. And the system also utilizes the prompt in Figure 3.24 to solicit additional inspections. However, if the response to the Inspection Log Prompt is "No", the next display would be the Testing Log Prompt.

Testing Log Prompt / Testing Log Screen

The system acquires Testing Information in exactly the same fashion as for Inspection Information, that is by a prompt (see Figure 3.40) followed by an input screen (see Figure 3.41). And once again, it uses the prompt in Figure 3.24 to accept additional tests. Since this is the last information item to be completed for an activity, the next

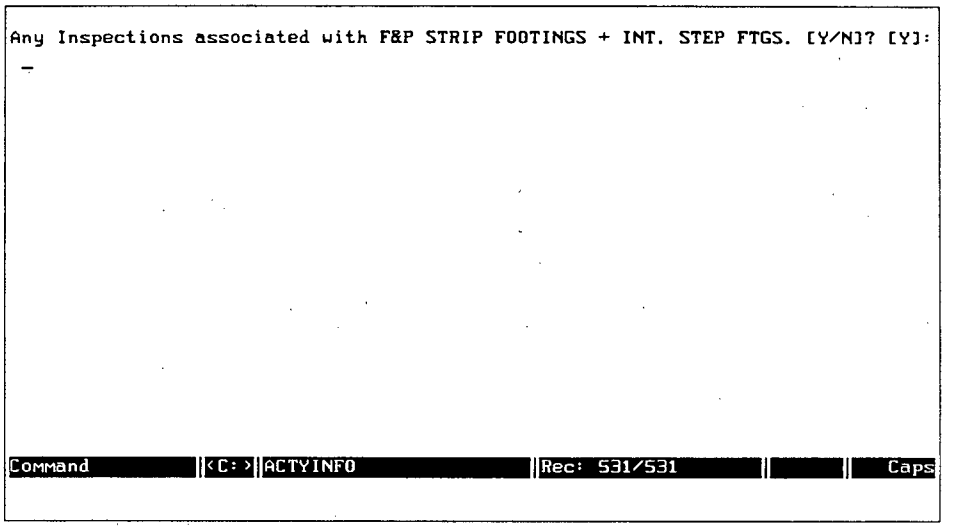

Figure 3.38 - Inspection Log Prompt

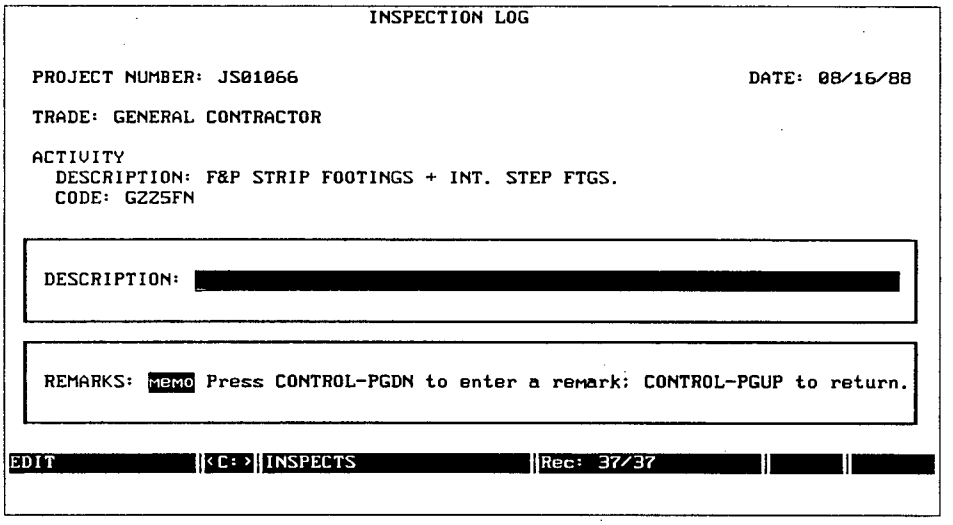

Figure 3.39 - Inspection Log Screen

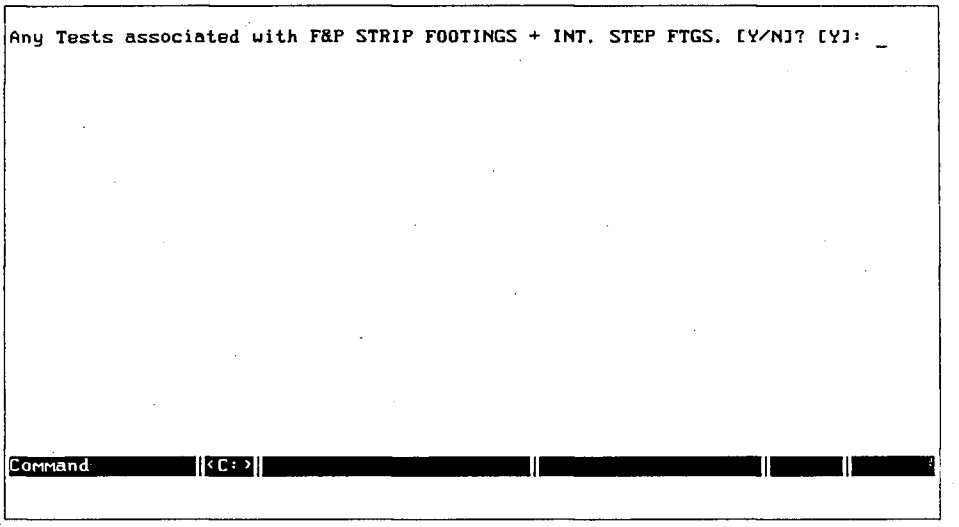

Figure 3.40 - Testing Log Prompt

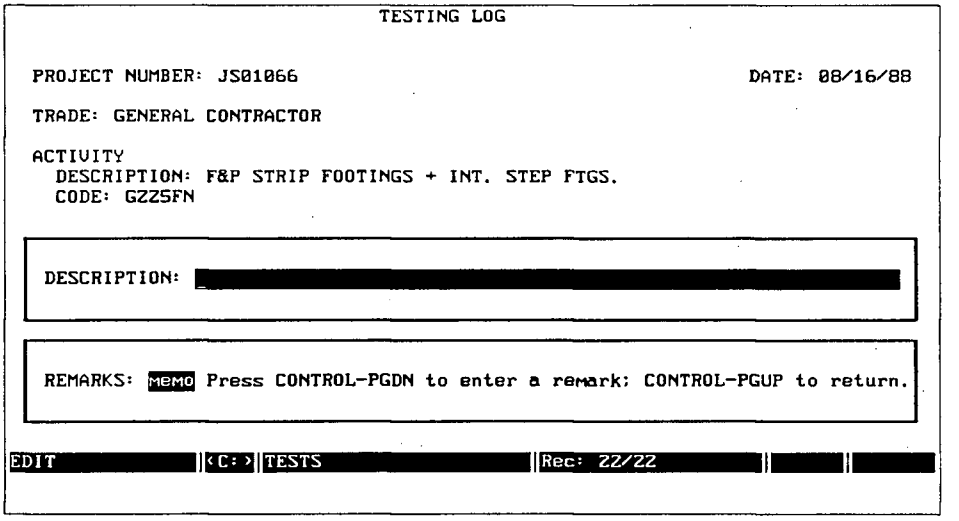

Figure 3.41 - Testing Log Screen

screen can either be the Updating Menu, Work Force Information Prompt, Activity Information Screen or the prompt for another activity for the same trade (see Figure 3.42).

The **dBASE** source code for the Data Collection System described above can be found in Appendix C.

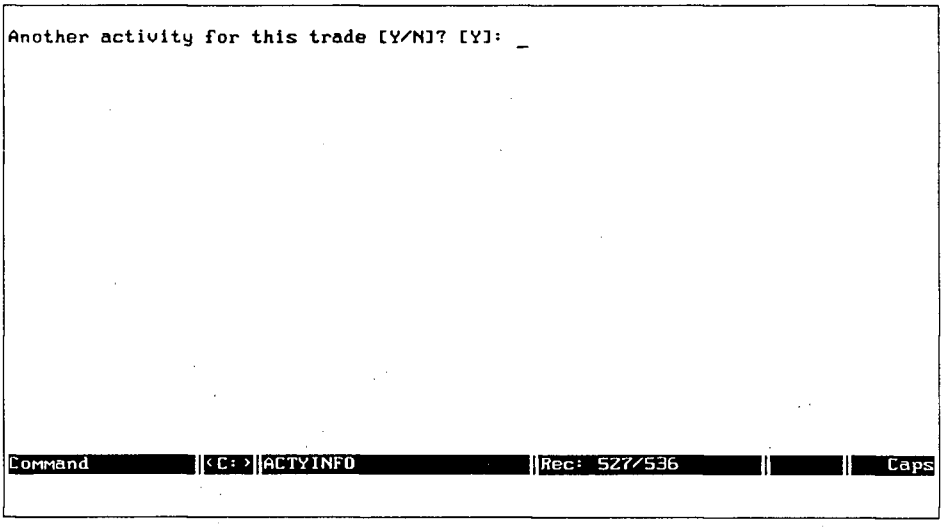

Figure 3.42 - Additional Activity Prompt

4.0 DEVELOPMENT OF THE COMPUTERIZED DATA REPORTING SYSTEM

4.1 GENERAL CRITERIA

The Data Reporting System should be catered to a larger audience than the Data Collection System since the former will not be solely operated by the superintendent. For example, the project manager needs to know labour availability and productivity; whereas, the superintendent requires quality control information and change order reports. Nevertheless, many of the general development criteria of the Data Collection System are also applicable to this system. The following is a list of general criteria for the development of the Data Reporting System:

1) The system should be menu driven. Pre-defined reports could then be accessed upon the specification of time span, activity, trade, etc;

2) The system should be flexible. It should allow tailoring of output for different audiences (eg. broader time span summary information for the project manager and more detailed shorter duration information for the superintendent);

3) The system should be capable of exporting/importing output data sets to/from other popular application software (eg. Lotus 1-2-3, MS Word) and processing them as required;

4) The system should include graphical outputs as well as text reports. Displays that incorporate pictures, graphs, colours, etc. are always easier to

comprehend; and

5) The system should have a security feature to prohibit illegal accessing of stored information.

4.2 DEVELOPMENT SOFTWARE

Recall the objective of this investigation has been limited to system conceptualization only and not software development. Therefore, development software were once again selected on the basis of their ease of operation, compatibility, accessibility, and capacity. The outputs presented hereafter were prepared with dBASE III PLUS and Lotus 1-2-3.

dBASE III PLUS

In addition to the features described in section 3.2, dBASE III PLUS also has reporting capabilities. Its user-friendly menu driven Assistant can be used to produce quick reports and to calculate totals for numeric fields. In fact, all of the reports in Sections 4.3.1 to 4.3.4 were created and generated with the Assistant. If more elaborate printed output is desired, dBASE III PLUS has other special commands and functions for printing that can make the programming tasks easier (these features are discussed in the dBASE III PLUS user manuals).

dBASE III PLUS also has built-in **dBASE** commands for

writing its database files directly to Lotus 1-2-3 format. This makes data transfer for graphing an extremely easy task.

Lotus 1-2-3

Lotus 1-2-3 was chosen mainly for its graphical capabilities and compatibility with dBASE III PLUS.

4.3 DATA USES

For most construction companies, daily site reports are simply filed away at the end of the day without any processing. Then, for example, in the event of a construction claim, the contractor is faced with the tedious and expensive task of having to search through each of these reports for the pertinent information. Thus, the next step is to find out what can be gained from analyzing these reports on a regular basis.

At the construction company level, these reports serve at least 3 fundamental functions [38:4.15]:

1) to maintain currency of the schedule through daily monitoring of job progress;

2) to provide a basis for variance analysis by recording problems encountered on site each day; and

3) to provide knowledge for use on future projects such as performance information about subcontractors, suppliers, designers, clients, etc..

At the project level, such reports would support the following management functions [38:4.18]:

- Time Control;
- Cost Control;
- Quality Control;
- Subcontractor Control;
- Variance Analysis;
- Claims Preparation;
- Assessment of Site Management Effectiveness; and
- Change Order Control.

In order to substantiate the above claims, output reports have been prepared from two and a half months of daily performance data collected for an eleven story condominium project currently under construction (the actual method of data collection employed for this exercise will be discussed in section 5.0). These output reports come in three different formats:

1) **Daily Format** - only information for a specific day is presented;
2) **Time Series Format** - information for a specific time span is presented chronologically; and
3) **Frequency of Occurrence Format** - information of the same type (eg. **POTENTIAL PROBLEMS) is grouped together and presented chronologically.**

Moreover, both text and graphical outputs have been incorporated. In some instances, both types of outputs are used for reporting a single item of information.

4.3.1 GENERAL PROJECT INFORMATION

This category of information can be reported directly in the **Time Series Format** without data analyzing. The associated reports are important in explaining reasons for productivity levels measured. Thus, they can be used for variance analysis and seeking project duration extensions, etc.. These reports are summarized in Figures 4.1a through 4.4.

Figures 4.1a and 4.1b present weather information, namely, Precipitation and Temperature Profiles. Unusually high amount of precipitation and extreme temperatures may explain lost time (eg. too wet for pouring slab on grade) and higher costs (eg. had to rent an extra water pump). A Wind Profile has not been included here because no such data was collected. However, since high winds may inhibit the operation of the tower crane, it could be used to justify lower than usual production rates. Threshold lines could be added to the above profiles to emphasize the extent of these extreme weather conditions (eg. abnormal precipitation, temperature above which concrete placing becomes a problem, and winds that create tower crane shutdown).

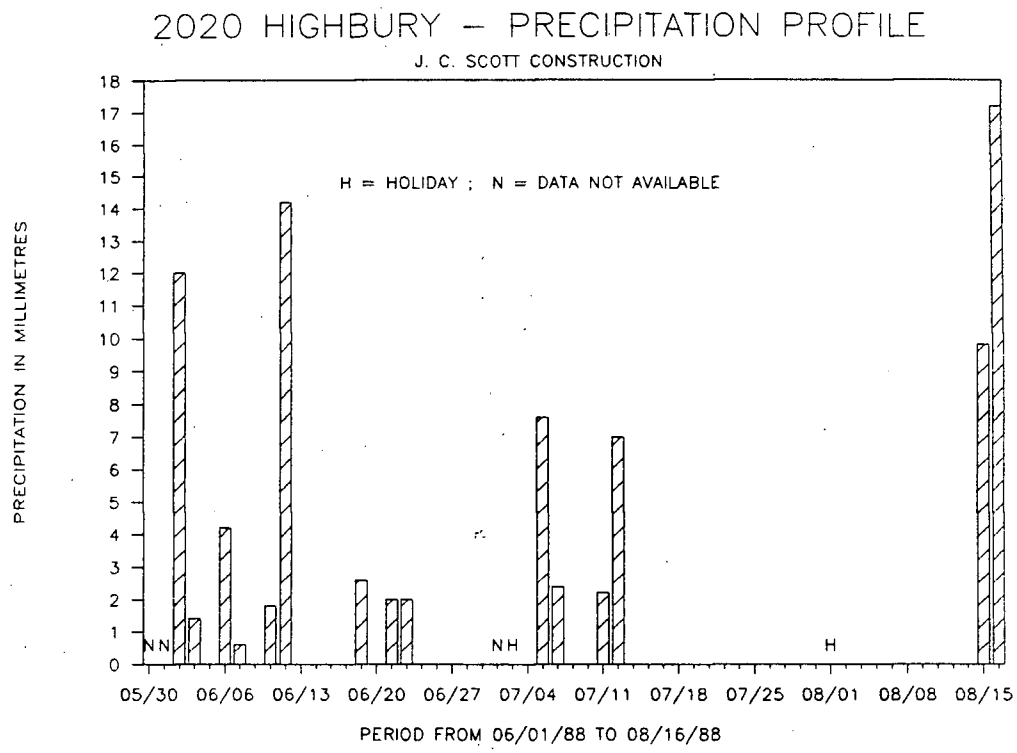

Figure 4.1a - Precipitation vs. Time

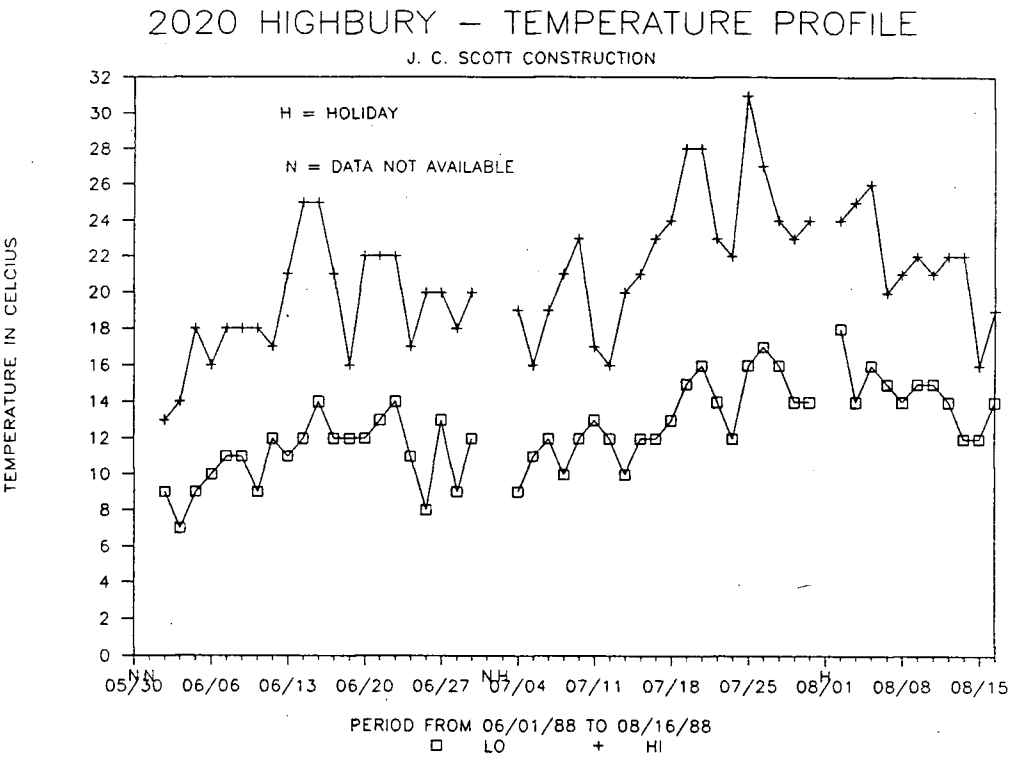

Figure 4.1b - Temperature vs. Time

Figures 4.2a to 4.2c report such site conditions as Access to Site, Storage on Site, and Ground Conditions. Generally, poor site conditions could explain lost time and hence, higher costs. In particular, poor site access could account for long waiting time costs associated with material deliveries. Less than adequate space for site storage could rationalize the great deal of double handling of material and equipment required. And slow rates of production associated with substructure level activities could be due to poor ground conditions. Figure 4.2d is a text supplement to the three site conditions profile. Due to the subjective nature of these outputs, it is very difficult to deduce the impact of unfavourable site conditions on the progress of the job. A more quantitative way of measuring these conditions should be conceived.

Figures 4.3a to 4.3c portray trade manpower information. The general contractor has been chosen for these examples. Manpower sufficiency, turnovers, and worker skill levels are all relevant to rates of production recorded. The Manpower Usage Profile in Figure 4.3a is particularly useful in that it shows whether the size of a crew had been kept at a constant level. For most construction jobs, it is desirable to keep a crew at a constant size because it would imply job security and minimize worker turnovers. Moreover, recurring manpower

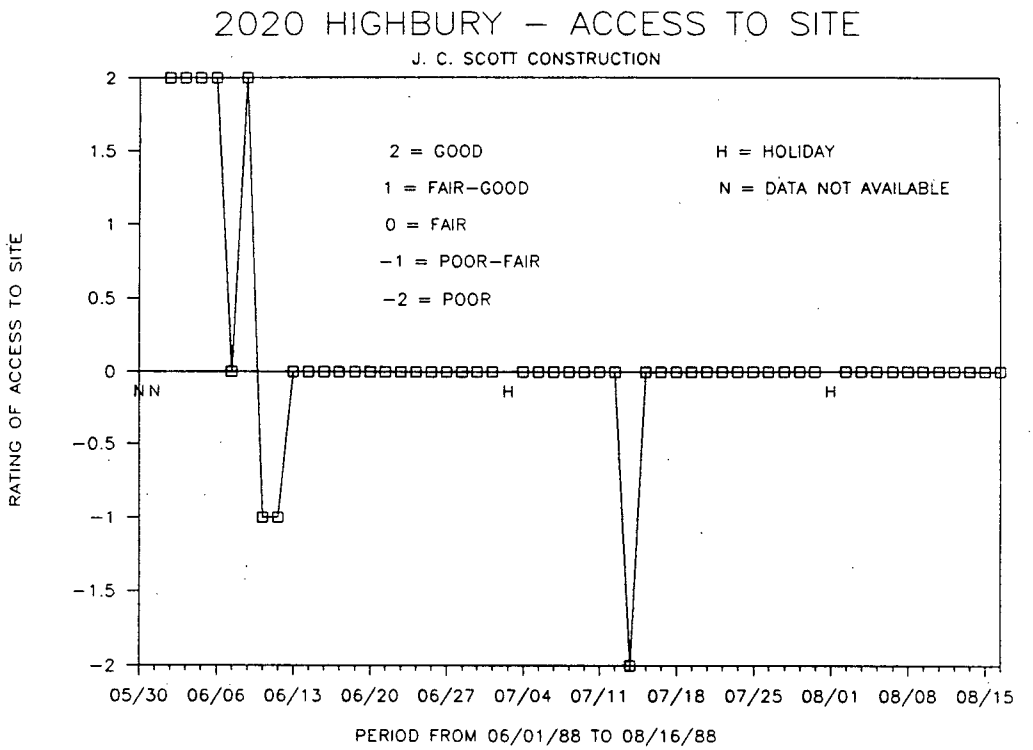

Figure 4.2a - Site Access vs. Time

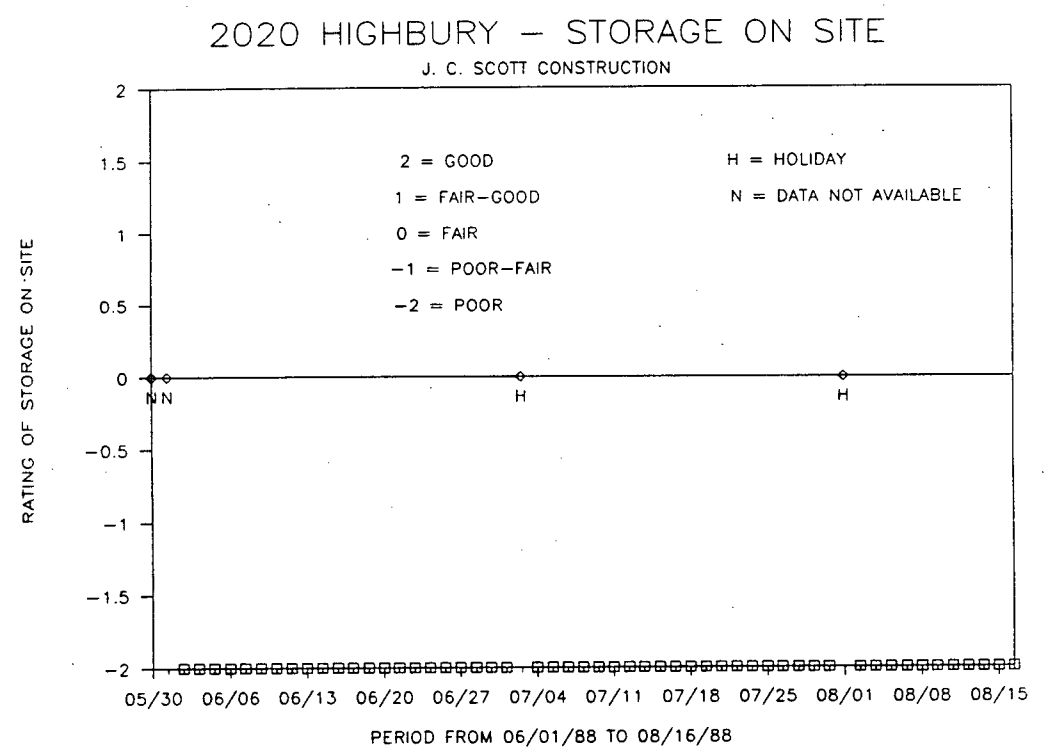

Figure 4.2b - Site Storage Condition vs. Time

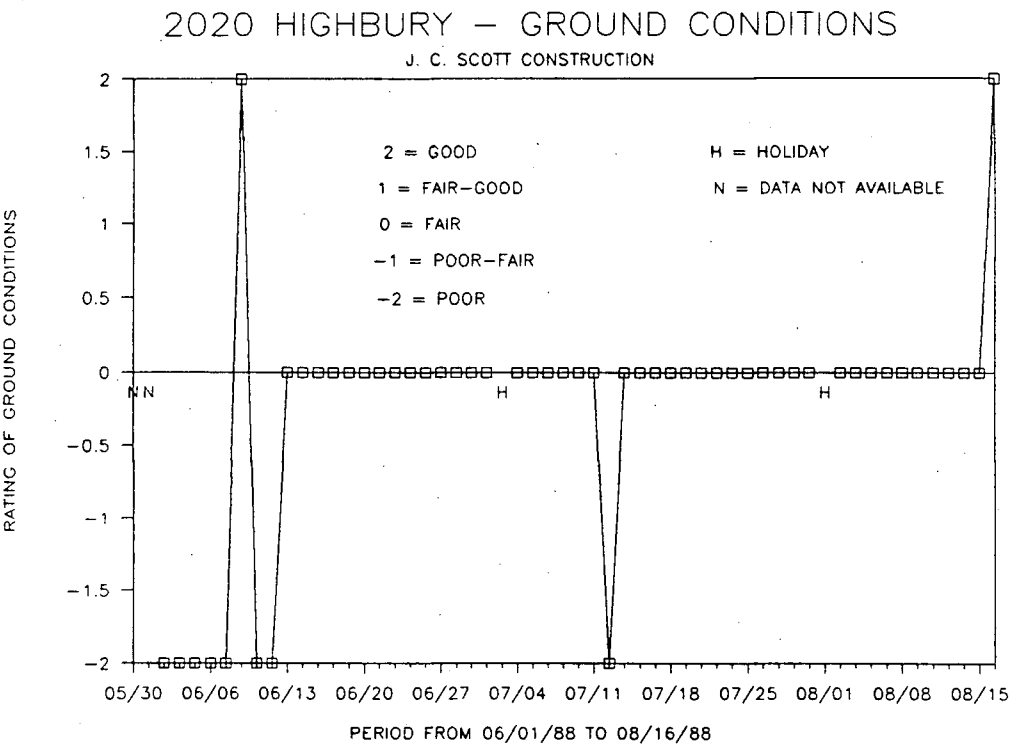

Figure 4.2c - Ground Conditions vs. Time

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - SITE CONDITIONS (SUPPLEMENT)

Date	Access To Site	Access Remarks	Storage On Site	Storage Remarks	Ground Conditions	Ground Conditions Remarks
06/01/88			DUE TO NATURE OF JOB (FOR 6-8 WKS UNTIL SLAB POURED)		DUE TO RAIN AND CLAY	
06/02/88						
06/03/88						
06/06/88					DUE TO POOR WEATHER STILL	
06/07/88						
06/08/88						
06/09/88	LOTS OF TRUCKS FROM BOTH SITES ON 5TH & ON HIGHBURY				CLAY IS GETTING CHURNED UP ALONG SOUTH WALL	
06/10/88						
06/13/88						
06/14/88						
06/15/88						
06/16/88						
06/17/88						
06/20/88						
06/21/88						
06/22/88						
06/23/88						
06/24/88						
06/27/88						
06/28/88						
06/29/88						
06/30/88						
07/04/88						
07/05/88						
07/06/88						
07/07/88						
07/08/88						
07/11/88						
07/12/88					BECAUSE OF RAIN	
07/13/88	RAMP IS BEING TAKEN OUT, TRUCKS CANNOT GET DOWN					
07/14/88	BILL REGARDS THE REMOVAL OF THE RAMP LESS THAN JIM DOES					
07/15/88						
07/18/88						
07/19/88						
07/20/88						
07/21/88	EVEN THOUGH RAMP BEING REMOVED, STILL CAN BE USED				IMPROVING BECAUSE FOUNDATION MOSTLY BACKFILLED	

Figure 4.2d - Site Conditions Text Supplement

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - SITE CONDITIONS (SUPPLEMENT)

Date	Access To Site	Access Remarks	Storage On Site	Storage Remarks	Ground Conditions	Ground Conditions Remarks
07/22/88	IN GENERAL, SITE COND. IMPROVING DUE TO PROGRESSIVE BACKFILL					
07/25/88	STILL IMPROVING					
07/26/88	STILL IMPROVING					
07/27/88						
07/28/88						
07/29/88						
08/02/88						
08/03/88						
08/04/88						
08/05/88						
08/08/88						
08/09/88						
08/10/88						
08/11/88						
08/12/88						
08/15/88						
08/16/88					NOT MUCH EXPOSED GROUND LEFT	

Figure 4.2d - Continued

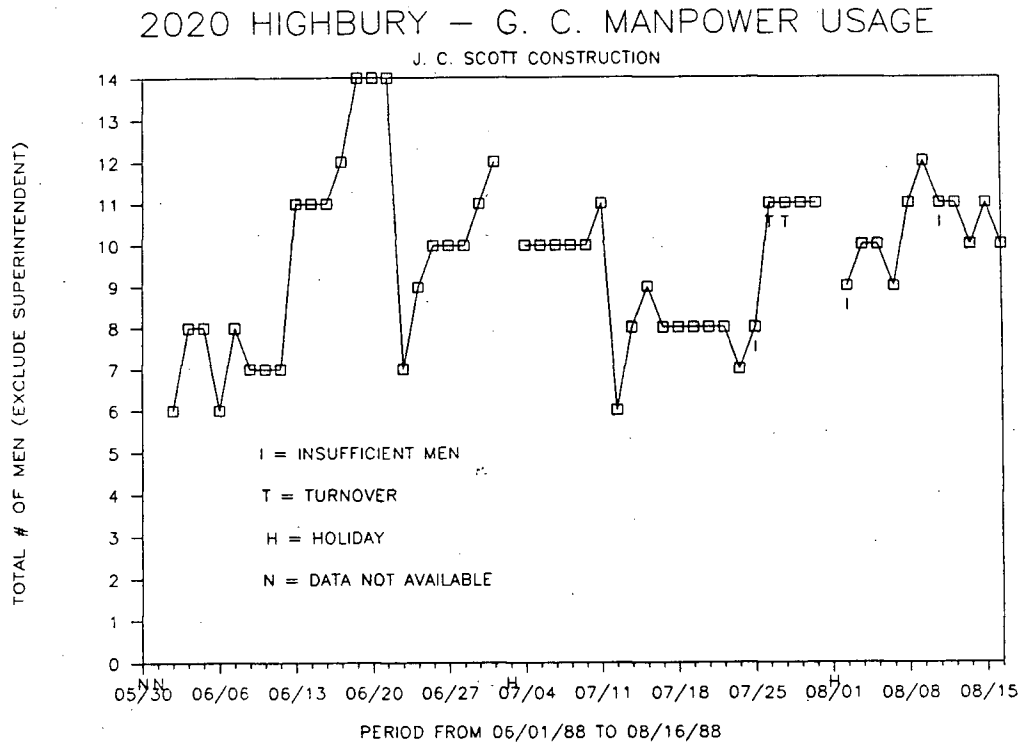

Figure 4.3a - Manpower Usage vs. Time

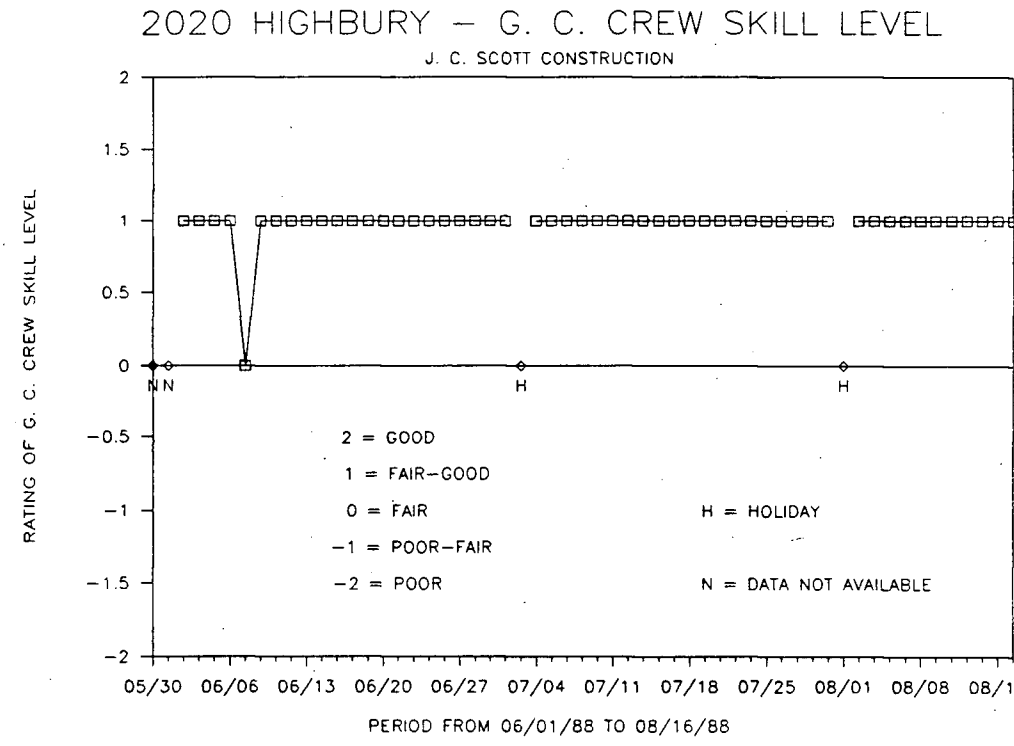

Figure 4.3b - Crew Skill Level vs. Time

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - G. C. MANPOWER INFORMATION (SUPPLEMENT)

Date	Work Available? (.T.= Yes, .F.= No)	Work Availability Remarks	Crew Skill Level Remarks	Sufficient Men To Meet Job Conditions Remarks	Turnover Remarks
06/01/88	.T.		3 GOOD & 3 NOT SO GOOD TRYING TO WEED OUT		
06/02/88	.T.		STILL HAVE SOME GOOD, SOME NOT SO GOOD		
06/03/88	.T.				
06/06/88	.T.			ONE GUY HAD A HEARTATTACK OVER THE WEEKEND	
06/07/88	.T.				
06/08/88	.T.				
06/09/88	.T.				
06/10/88	.T.				
06/13/88	.T.				
06/14/88	.T.				
06/15/88	.T.				
06/16/88	.T.				
06/17/88	.T.				
06/20/88	.T.				
06/21/88	.T.				
06/22/88	.T.			LAID OFF 4 CARPENTERS & 3 LABOURERS YESTERDAY	
06/23/88	.T.				
06/24/88	.T.				
06/27/88	.T.				
06/28/88	.T.				
06/29/88	.T.				
06/30/88	.T.				
07/04/88	.T.				
07/05/88	.T.				
07/06/88	.T.				
07/07/88	.T.				
07/08/88	.T.				
07/11/88	.T.				
07/12/88	.T.				
07/13/88	.T.				
07/14/88	.T.				
07/15/88	.T.				
07/18/88	.T.				
07/19/88	.T.				
07/20/88	.T.				
07/21/88	.T.				
07/22/88	.T.				
07/25/88	.T.			EXPECTED 2 CARPS FROM 2ND&YEW BUT NO SHOW, DEFINITE PROBLEM	
07/26/88	.T.			"JUST RIGHT" FOR WHAT BILL NEEDS	2 NEW CARPS FROM 2ND & YEW

Figure 4.3c - Manpower Information Text Supplement

Page No. 2
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - G. C. MANPOWER INFORMATION (SUPPLEMENT)

Date	Work Available? (.T.= Yes, .F.= No)	Work Availability Remarks	Crew Skill Level Remarks	Sufficient Men To Meet Job Conditions Remarks	Turnover Remarks
07/27/88	.T.		SOME OF THE YOUNG LABS HAVE TO BE TOLD EVERYTHING SAYS BILL		
07/28/88	.T.				
07/29/88	.T.				
08/02/88	.T.			2 DIDN'T SHOW (1 WAS IN CAR ACCIDENT LAST WEEK)	
08/03/88	.T.				
08/04/88	.T.				
08/05/88	.T.				
08/08/88	.T.				
08/09/88	.T.				
08/10/88	.T.			COULD HAVE USED ANOTHER LABOURER	
08/11/88	.T.				
08/12/88	.T.				
08/15/88	.T.				
08/16/88	.T.				

Figure 4.3c - Continued

insufficiency should indicate to management that a problem exists. Figure 4.3c is a text supplement to the two manpower information profiles. It also includes Work Availability information which may be used to explain lost man-hours and poor rates of production.

The usage of any one type of equipment can be plotted over a period of time (see Figure 4.4). Such a plot could be used to verify the rental cost of a particular type of equipment for the purpose of cost control. If the rental cost is found to be higher than indicated by the usage plot, then either the equipment had been wastefully left idle on site or an accounting error had been made.

4.3.2 STATUS INFORMATION ON INDIVIDUAL ACTIVITIES

Both **Daily Format** and **Time Series Format** reports have been designed to represent this category of information. These reports are mostly used for schedule updating, determination of actual activity durations, and determination of the extent that an activity is interrupted. These reports are summarized in Figures 4.5a to 4.7.

Figure 4.5a is a Daily Activity Status Report. Its main function is to keep management abreast of job progress on a daily basis. It can also be used for manual schedule updating if the DSRS is not integrated with the Scheduling

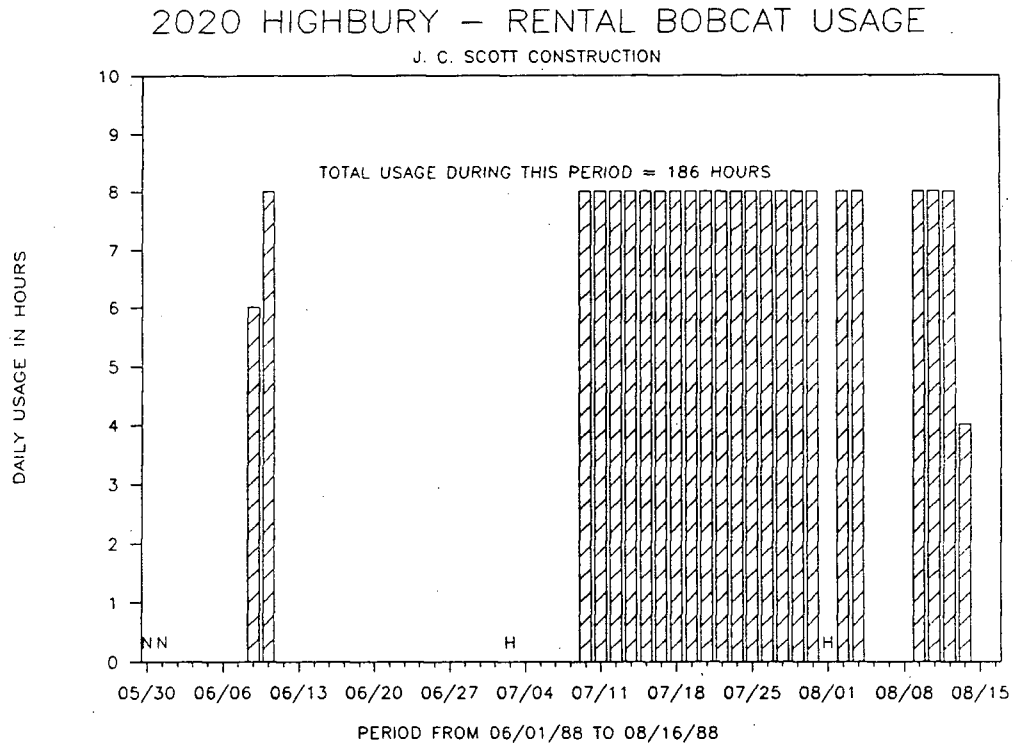

Figure 4.4 - Equipment Usage vs. Time

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
DAILY SITE REPORT

2020 HIGHBURY - ACTIVITY STATUS

KEY: 1) "Status": SD - Started, IP - In Progress, ID - Idle, FD - Finished, SF - Started & Finished
2) "Rate Of Production": E - Excellent, S - Satisfactory, U - Unsatisfactory

Code	Description	Status	Work Performed Today	Rate Of Production	Production Remarks
** Date: 06/01/88					
* Trade: GENERAL CONTRACTOR					
G205FN	F&P PERIMETER PILECAPS	ID		U	
G210FN	F&P COLUMN FTGS/PILECAPS	IP		S	
G215FN	F&P CRANE FOOTING	IP		S	
G220FN	F&P CORE FOOTING	SD	LAYOUT	S	
* Trade: UNITED REINFORCING					
0321FN	REINFORCE PERIMETER PILECAPS	IP	ONLY MADE 19/40 CAGES OF REBAR FOR PILES THEN LEFT	U	
0322FN	REINFORCE COLUMN FTGS/PILECAPS	SD		U	
* Trade: CAMPBELL CARTAGE					
0126FN	EXCAVATE STRIP FOOTINGS	ID			
0122FN	EXCAVATE COL FTGS/PILECAPS	ID			
0124FN	EXCAVATE CORE FOOTING	SD		E	FASTER THAN EXPECTED
* Trade: NIGHTINGALE ELECTRICIAN					
163100	TEMPORARY POWER	SF	TEMP POWER FOR 2 JC SCOTT TRAILERS & HOOKED UP GANG BOX (100')	S	

Figure 4.5a - Daily Activity Status Report

System. An activity which has an "Unsatisfactory" Rate of Production should prompt the reader to seek an explanation from the corresponding Daily Activity Problems Report (see Figure 4.6a). Here, estimates of delay time and man-hours lost are subtotalled by trade. Such information is important for backcharges. If multiple-day Activity Status and Activity Problems reports are preferred, they can also be generated (see Figure 4.5b and 4.6b respectively).

Figure 4.7 shows the pattern of work on an activity in terms of continuity. Reasons for significant levels of interruption should be deduced quickly. "It is possible that interruptions exist because an activity is acting as a buffer for maintaining work continuity for a crew. However, it often means that production rates of activities have not been well balanced or design information, materials or equipment are not available, signalling possible management problems."[38:4.18] Thus, for greater insights into activity interruptions, such profiles should be examined concurrently with an Activity Problems Summary Report.

4.3.3 FREQUENCY OF OCCURRENCE OF DIFFERENT PROBLEM TYPES

As indicated by the above heading, this category of information is presented in the **Frequency of Occurrence Format.** Grouping problems by type facilitates the identification of recurring problems (NOTE: this requires

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - ACTIVITY STATUS

KEY: 1) "Status": SD = Started, IP = In Progress, ID = Idle, FD = Finished, SF = Started & Finished
2) "Rate Of Production": E = Excellent, S = Satisfactory, U = Unsatisfactory

Code	Description	Status	Work Performed Today	Rate Of Production	Production Remarks
** Date: 06/02/88					
* Trade: GENERAL CONTRACTOR					
G20SFN	F&P PERIMETER PILECAPS	IP		S	
G210FN	F&P COLUMN FTGS/PILECAPS	IP	ALSO LAYOUT	S	
G215FN	F&P CRANE FOOTING	IP		S	
G220FN	F&P CORE FOOTING	IP	LAYOUT ONLY	S	
* Trade: UNITED REINFORCING					
0321FN	REINFORCE PERIMETER PILECAPS	IP		S	
0322FN	REINFORCE COLUMN FTGS/PILECAPS	IP		S	
0323FN	REINFORCE CRANE FTG/ANCH BOLTS	SD		S	
* Trade: CAMPBELL CARTAGE					
0126FN	EXCAVATE STRIP FOOTINGS	ID			
0122FN	EXCAVATE COL FTGS/PILECAPS	ID			
0124FN	EXCAVATE CORE FOOTING	IP		S	HITTING ROCKS, SLOWER THAN YESTERDAY
** Date: 06/03/88					
* Trade: GENERAL CONTRACTOR					
G20SFN	F&P PERIMETER PILECAPS	FD		S	
G210FN	F&P COLUMN FTGS/PILECAPS	IP	TEMPLATES FOR COLUMNS	S	
G215FN	F&P CRANE FOOTING	FD	POURED CRANE BASE FOOTING	U	
G220FN	F&P CORE FOOTING	IP	LAYOUT	S	
* Trade: UNITED REINFORCING					
0321FN	REINFORCE PERIMETER PILECAPS	FD		U	
0322FN	REINFORCE COLUMN FTGS/PILECAPS	IP		U	
0323FN	REINFORCE CRANE FTG/ANCH BOLTS	FD		U	
* Trade: CAMPBELL CARTAGE					
0126FN	EXCAVATE STRIP FOOTINGS	ID			
0122FN	EXCAVATE COL FTGS/PILECAPS	ID			
0124FN	EXCAVATE CORE FOOTING	IP		U	
** Date: 06/06/88					
* Trade: GENERAL CONTRACTOR					
G210FN	F&P COLUMN FTGS/PILECAPS	IP	LAYOUT	S	
G220FN	F&P CORE FOOTING	IP	LAYOUT	S	
G225FN	F&P STRIP FOOTINGS	SD	EAST WALL STRIP FOOTINGS	S	

Figure 4.5b - Summary Activity Status Report

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
DAILY SITE REPORT

2020 HIGHBURY - ACTIVITY PROBLEMS

Activity Code	Activity Description	Problem Type	Problem Description	Estimated Delay To Act.(Hrs.)	Estimated Man-Hrs. Lost
** Date: 06/03/88					
* Trade: GENERAL CONTRACTOR					
G215FN	F&P CRANE FOOTING	DELAYS DUE TO WAITING FOR MATERIALS: WAREHOUSE/VENDOR	SLIGHTLY LATE ARRIVAL OF CONCRETE BUT SCHEDULE NOT THROWN OFF	0.00	0.00
G215FN	F&P CRANE FOOTING	DELAYS DUE TO WAITING FOR OTHER CREWS	REBAR CREW LATE NEED PUMP FOR WHOLE DAY INSTEAD OF HALF DAY	4.00	0.00
* Subsubtotal *				4.00	0.00
* Trade: UNITED REINFORCING					
0321FN	REINFORCE PERIMETER PILECAPS	DELAYS DUE TO WAITING FOR FELLOW CREW MEMBERS	NOT ENOUGH MEN TO HAVE FTGS READY FOR POUR IN THE MORNING	4.00	0.00
0322FN	REINFORCE COLUMN FTGS/PILECAPS	DELAYS DUE TO WAITING FOR MATERIALS: WAREHOUSE/VENDOR	NO STEEL	4.00	0.00
0323FN	REINFORCE CRANE FTG/ANCH BOLTS	DELAYS DUE TO WAITING FOR FELLOW CREW MEMBERS	NOT ENOUGH MEN TO HAVE FTG READY FOR POUR IN THE MORNING	0.00	0.00
* Subsubtotal *				8.00	0.00
* Trade: CAMPBELL CARTAGE					
0124FN	EXCAVATE CORE FOOTING	MANDATORY CHANGE ORDERS/EXTRA WORK	ENCOUNTERED ROCK CALLED IN BLASTER (1 MAN)	8.00	0.00
* Subsubtotal *				8.00	0.00
** Subtotal **				20.00	0.00
*** Total ***				20.00	0.00

Figure 4.6a - Daily Activity Problems Report

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - ACTIVITY PROBLEMS

Activity Code	Activity Description	Problem Type	Problem Description	Estimated Delay To Act.(Hrs.)	Estimated Man-Hrs. Lost
** Date: 06/01/88					
* Trade: GENERAL CONTRACTOR					
G205FN	F&P PERIMETER PILECAPS	REWORK DUE TO FIELD ERROR OR DAMAGE	MUST REDESIGN 2 FTGS DUE TO GERHARD'S ERROR DURING PILING	0.00	0.00
* Subsubtotal *				0.00	0.00
* Trade: UNITED REINFORCING					
0321FN	REINFORCE PERIMETER PILECAPS	UNEXPLAINED OR UNNECESSARY MOVE	CREW TOOK OFF @ 10:00AM W/O INFORMING SUPERINTENDENT	0.00	0.00
0322FN	REINFORCE COLUMN FTGS/PILECAPS	UNEXPLAINED OR UNNECESSARY MOVE	CREW TOOK OFF @ 10:00AM W/O INFORMING SUPERINTENDENT	0.00	0.00
* Subsubtotal *				0.00	0.00
** Subtotal **				0.00	0.00
** Date: 06/03/88					
* Trade: GENERAL CONTRACTOR					
G215FN	F&P CRANE FOOTING	DELAYS DUE TO WAITING FOR MATERIALS: WAREHOUSE/VENDOR	SLIGHTLY LATE ARRIVAL OF CONCRETE BUT SCHEDULE NOT THROWN OFF	0.00	0.00
G215FN	F&P CRANE FOOTING	DELAYS DUE TO WAITING FOR OTHER CREWS	REBAR CREW LATE NEED PUMP FOR WHOLE DAY INSTEAD OF HALF DAY	4.00	0.00
* Subsubtotal *				4.00	0.00
* Trade: UNITED REINFORCING					
0321FN	REINFORCE PERIMETER PILECAPS	DELAYS DUE TO WAITING FOR FELLOW CREW MEMBERS	NOT ENOUGH MEN TO HAVE FTGS READY FOR POUR IN THE MORNING	4.00	0.00
0322FN	REINFORCE COLUMN FTGS/PILECAPS	DELAYS DUE TO WAITING FOR MATERIALS: WAREHOUSE/VENDOR	NO STEEL	4.00	0.00
0323FN	REINFORCE CRANE FTG/ANCH BOLTS	DELAYS DUE TO WAITING FOR FELLOW CREW MEMBERS	NOT ENOUGH MEN TO HAVE FTG READY FOR POUR IN THE MORNING	0.00	0.00
* Subsubtotal *				8.00	0.00
* Trade: CAMPBELL CARTAGE					
0124FN	EXCAVATE CORE FOOTING	MANDATORY CHANGE ORDERS/EXTRA WORK	ENCOUNTERED ROCK CALLED IN BLASTER (1 MAN)	8.00	0.00

Figure 4.6b - Summary Activity Problems Report

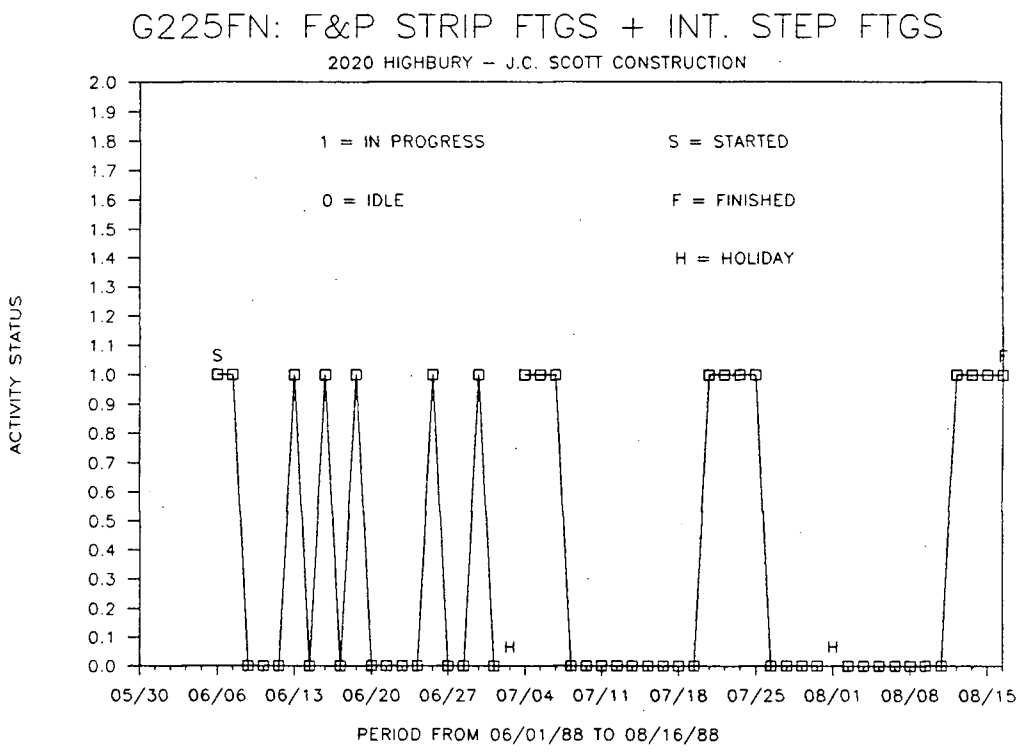

Figure 4.7 - Activity Work Pattern

the database file to be indexed by **TYPE** as well). Consequently, management can focus resources on controllable problems, seek compensation for problems created by others, and devise strategies to work around uncontrollable problems. Figures 4.8 and 4.9 are summary reports of unusual developments at the project level and activity problems respectively.

In Figure 4.8, estimates of overall project time lost are subtotalled for each type of unusual development. Clearly, unusual developments with great frequency of occurrence and large subtotal time lost deserve immediate management attention. Estimates of delay time and man-hours lost are subtotalled by activity problem type in Figure 4.9. Likewise, these values can act as warning flags to project managers.

4.3.4 ADDITIONAL INFORMATION

If recurring problems are suspected with such things as drawings, material deliveries, and quality control, additional reports can be generated in the **Time Series Format** (see Figures 4.10 to 4.12b). NOTE: to answer the question raised in Section 2.2.2 regarding drawing **Quality** and **Detailing**, clearly, there are not enough related **Remarks** in Figure 4.10 to determine whether these two items should be grouped into one entry.

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY-UNUSUAL DEVELOPMENTS: FREQUENCY OF OCCURRENCE

Date	Problem Description	Problem Remarks	Estimated Time Lost (Days)
** Problem Type: DISPUTES			
06/03/88	REBAR GUYS CLAIM BRACING NOT IN PLACE THUS CANNOT PLACE STEEL	BUT GERHARD SAYS THEY CAN STILL PLACE W/O THE BRACING.	0.00
06/03/88	HARDY WOULD NOT GIVE OFFICIAL APPROVAL OF "ROCK"	HARDY SAYS 225 EXCAVATOR BEING USED IS TOO SMALL BACAUSE IN ORDER TO GET "ROCK" CLASSIFICATION, NEED NO PROGRESS WITH A 235 EXCAVATOR. NOTE: THE RIPPER WAS BROKEN ONCE YESTERDAY.	0.00
06/08/88	PILING TRADE CHARGING MOB & TRAILER WAITING FOR 2 EXTRA PILES	GERHARD HAD TOLD THE TRADE THAT THE PILES WILL BE DRIVEN FOR SURE & THEIR POSITIONS WOULD BE KNOWN VERY SOON (SUCH THAT THERE IS NO NEED TO DEMOB & COME BACK). THE POSITIONS WERE AVAILABLE BEFORE DEMOB. WAS COMPLETED.	0.00
06/10/88	NO VERIFICATION OF ROCK & SOIL STRENGTH FROM HARDY IN CORE	NO RESULTS FROM SOIL INSPECTION IN CORE (NEED 20 KIPS FOR SOIL STRENGTH); BUT WILL POUR CORE FOOTING TOMORROW (SATURDAY) WITH OR W/O HARDY'S REPORT.	0.00
06/15/88	REMPEL WOULDN'T DELAY CONCRETE DELIVERY AS REQUESTED YESTRDAY	CONCRETE WAS SCHEDULED TO ARRIVE @8:00AM BUT WANTED IT TO BE DELAYED 'TIL 9:00AM BECAUSE THE LINE PUMP IS SCHEDULED TO ARRIVE THEN.	0.00
** Subtotal **			0.00
** Problem Type: OTHER UNUSUAL DEVELOPMENTS			
06/15/88	VAN MAREN FLOODED JUST POURED STRIP FTG WITH DISCHARGE PIPE	BUT IT SHOULD BE OK.	0.00
06/20/88	JOHN SCOTT HAS APPROACHED S. NEIGHBOUR ABOUT TRIMMING TREE	THE PROPOSAL IS TO TRIM 20' OFF THE TREE, BUT NO WORD YET. THE TREE COULD BE ON CITY PROPERTY.	0.00
06/27/88	RENTAL WATER PUMP WAS STOLEN BECAUSE WAS LEFT OUT OVER WKEND		0.00

Figure 4.8 - Frequency of Occurrence Report for Unusual Developments at the Site Level

Page No. 2
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY-UNUSUAL DEVELOPMENTS: FREQUENCY OF OCCURRENCE

Date	Problem Description	Problem Remarks	Estimated Time Lost (Days)
06/28/88	AT THIS STAGE, CRANE OPERATOR ONLY REQ'D FOR 4 HRS. A DAY		0.00
07/22/88	MOVED SANITARY SUMP IN MECH ROOM TO GARBAGE ROOM	BECAUSE CORE SHEAR WALL FTG IS HIGH - WAS BUILT ON ROCK, OTHERWISE HAD TO BLAST ROCK WHICH WOULD HAVE COST MORE - APPROVED BY "ED" OF STERLING COOPER.	0.00
08/08/88	BILL SAID DIFFICULT TO GET HIS MEN MOTIVATED TODAY		0.00
08/10/88	CALLED S.COOPER FOR DRAIN TILE INSPECT YESTERDAY, BUT NO SHOW		0.00
** Subtotal **			0.00
** Problem Type: OVERALL JOB DELAYS			
06/01/88	CHASING AFTER NEW DRAWINGS FOR COMMON WALL		0.00
06/03/88	DUE TO REBAR GUYS, CONCRETE POURING HELD UP		0.00
06/03/88	ENCOUNTERED ROCK DURING EXCAVATION OF CORE BLASTING REQUIRED		0.00
06/07/88	COMMON WALL ELEVATIONS FROM ARCH./STRUC. NOT AVAILABLE	COULD HAVE POURED TODAY: REBAR IN & CONCRETE ON SITE.	0.00
06/28/88	RE: LATE COMMON WALL ELEVATIONS		5.00
07/05/88	WET WEATHER DELAYING WATERPROOFING OF CORE	IF DONE, COULD BACKFILL TOMORROW.	0.00
07/12/88	IN GENERAL, DUE TO RAIN, 15 - 20% OF WORK DAY LOST		0.20
08/02/88	WATERMAIN TEST FAILED	ACCORDING TO SALES REP. WHO WAS ON SITE TODAY, PRIMER & GLUE USED NOT COMPATIBLE! COULD HAVE POURED INT. RAMP FROM 1065 TO 1045 THIS FRIDAY (08/05/88).	1.00
08/03/88	CANWEST LATE WITH DELIVERY OF MESH FOR S.O.G.	UNITED WILL STAY LATE UNTIL READY FOR 8:00AM POUR TOMORROW. BUT NOT ALL STEEL IS HERE, THUS WILL PLACE REMAINING TOMORROW MORNING OR LATER TONIGHT.	0.75

Figure 4.8 - Continued

Page No. 3
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY-UNUSUAL DEVELOPMENTS: FREQUENCY OF OCCURRENCE

Date	Problem Description	Problem Remarks	Estimated Time Lost (Days)
** Subtotal **			6.95
** Problem Type: POTENTIAL PROBLEMS			
06/02/88	ONLY IF KEEPS RAINING		0.00
06/03/88	CAN'T GET THE REBAR GUYS WHEN NEED THEM	GERHARD FORESEES PROBLEM TO ESCALATE AS JOB PROGRESSES: "THEY ARE TOO BUSY"	0.00
06/06/88	NO CONTRACT FOR RELOCATED PUMP SUMP IN ELEVATOR MACHINE ROOM	BUT WANT TO POUR FRIDAY. IF HAVE SIZE, CAN BE FORMED; THEN NO PROBLEM.	0.00
06/07/88	CRANE NOT GOING TO BE READY FOR JUNE 13, SCHEDULED ERECTION		0.00
06/13/88	ELEVATOR BOLTS: N-S DIRECTION OK, E-W OUT BY 1"	E-W DIRECTION, 8" INSTEAD OF 9". BUT SHOULD BE OK BECAUSE CAUGHT IN EARLY STAGE; HAVE INFORMED THE SUBTRADE (DOUG STOKES).	0.00
06/17/88	CRANE HITS SOUTH NEIGHBOUR'S TREE		0.00
06/21/88	LIMITED TURNING RADIUS FOR CRANE		0.00
06/21/88	NEW TEST BLOCKS REQUIRED FOR CRANE		0.00
07/05/88	WAITING FOR STEEL FOR LINE 15 LOWER FOOTING	IF STEEL NOT PLACED BY TOMORROW AT 10:00AM, WILL HAVE PROBLEMS.	0.00
08/12/88	LEFT OUT SOME DOWELS IN COLS WHERE SLAB THICKENING GOES	NO ANSWERS FROM GLOTMAN YET.	0.00
** Subtotal **			0.00
*** Total ***			6.95

Figure 4.8 - Continued

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - ACTIVITY PROBLEMS: FREQUENCY OF OCCURRENCE

Date	Trade	Activity Code	Activity Description	Problem Description	Est'd Delay To Activity (Hrs.)	Estimated Man-Hrs. Lost
** Problem Type: DELAYS DUE TO WAITING FOR FELLOW CREW MEMBERS						
06/03/88	UNITED REINFORCING	0321FN	REINFORCE PERIMETER PILECAPS	NOT ENOUGH MEN TO HAVE FTGS READY FOR POUR IN THE MORNING	4.00	0.00
06/03/88	UNITED REINFORCING	0323FN	REINFORCE CRANE FTG/ANCH BOLTS	NOT ENOUGH MEN TO HAVE FTG READY FOR POUR IN THE MORNING	0.00	0.00
07/07/88	THRORY WATERPROOFING	1921PK	WATERPROOFING CORE	NOT ENOUGH MEN, BUT NOT HOLDING UP ANYTHING AT THIS STAGE	0.00	0.00
08/02/88	UNITED REINFORCING		REINFORCE CORE WALLS + WING WALLS: PKDE	NOT ENOUGH MEN: COULD'VE POURED CORE & WING WALLS THIS FRIDAY	16.00	0.00
** Subtotal **					20.00	0.00
** Problem Type: DELAYS DUE TO WAITING FOR INFORMATION/DECISIONS						
06/07/88	GENERAL CONTRACTOR	G225FN	F&P STRIP FOOTINGS	COMMON WALL ELEVATIONS NOT AVAILABLE FROM STRUCTURAL	8.00	0.00
06/29/88	GENERAL CONTRACTOR	G302PK	F&P EXT WALLS/COLS: PARKADE	NO INFO FOR STEEL CHANGES TO LOWER ELEVATION OF LINE 15 WALL	16.00	0.00
08/04/88	GENERAL CONTRACTOR	G225FN	F&P STRIP FOOTINGS + INT. STEP FTGS.	ACTIVITY IDLE BECAUSE WAITING FOR SOILS REPORT	0.00	0.00
** Subtotal **					24.00	0.00
** Problem Type: DELAYS DUE TO WAITING FOR MATERIALS: WAREHOUSE/VENDOR						
06/03/88	GENERAL CONTRACTOR	G215FN	F&P CRANE FOOTING	SLIGHTLY LATE ARRIVAL OF CONCRETE BUT SCHEDULE NOT THROWN OFF	0.00	0.00
06/03/88	UNITED REINFORCING	0322FN	REINFORCE COLUMN FTGS/PILECAPS	NO STEEL	4.00	0.00
07/26/88	GENERAL CONTRACTOR	G302PK	F&P EXT WALLS/COLS: PARKADE + INT. WALLS	REMPEL LATE WITH CONCRETE DELIVERY	1.75	0.00
08/03/88	UNITED REINFORCING		REINFORCE SLAB ON GRADE	CANWEST LATE WITH MESH DELIVERY FOR S.O.G.	6.00	0.00
08/11/88	GENERAL CONTRACTOR		F&P CORE WALLS + WING WALLS: PKDE	REMPEL LATE WITH CONCRETE DELIVERY	1.50	0.00
** Subtotal **					13.25	0.00
** Problem Type: DELAYS DUE TO WAITING FOR OTHER CREWS						
06/03/88	GENERAL CONTRACTOR	G215FN	F&P CRANE FOOTING	REBAR CREW LATE NEED PUMP FOR WHOLE DAY INSTEAD OF HALF DAY	4.00	0.00

Figure 4.9 - Frequency of Occurrence Report for Activity Delay Problems

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - ACTIVITY PROBLEMS: FREQUENCY OF OCCURRENCE

Date	Trade	Activity Code	Activity Description	Problem Description	Est'd Delay To Activity (Hrs.)	Estimated Man-Hrs. Lost
** Subtotal **					4.00	0.00
** Problem Type: EQUIPMENT BREAKDOWN						
06/09/88	GENERAL CONTRACTOR	G303PK	BACKFILL/GRADING	BOBCAT GOT STUCK IN CLAY	2.00	0.00
06/15/88	GENERAL CONTRACTOR	G302PK	F&P EXT WALLS/COLS: PARKADE	LINE PUMP KEPT GETTING CLOGGED BY LARGE AGG. ALL DAY LONG	0.00	0.00
** Subtotal **					2.00	0.00
** Problem Type: MANDATORY CHANGE ORDERS/EXTRA WORK						
06/03/88	CAMPBELL CARTAGE	0124FN	EXCAVATE CORE FOOTING	ENCOUNTERED ROCK CALLED IN BLASTER (1 MAN)	8.00	0.00
08/04/88	UNITED REINFORCING		REINFORCE CORE WALLS + WING WALLS: PKDE	PROBLEM WITH DESIGN OF REBAR HOOKS, DIFFICULT TO PLACE STEEL	4.00	0.00
** Subtotal **					12.00	0.00
** Problem Type: OTHERS						
06/23/88	GENERAL CONTRACTOR	G302PK	F&P EXT WALLS/COLS: PARKADE	MUST USE CRANE & BUCKETS FOR CONCRETE POURING (TAKES LONGER)	0.00	0.00
07/04/88	THRORY WATERPROOFING	1921PK	WATERPROOFING CORE	WATER WEEPAGE ON TOP OF FTGS HAVE TO BE DRIED OUT FIRST	2.00	0.00
07/15/88	GENERAL CONTRACTOR	G303PK	BACKFILL/GRADING	SOIL A LITTLE TOO WET & COMPACTORS NOT ADEQUATE	0.00	0.00
08/10/88	GENERAL CONTRACTOR		F&P CORE WALLS + WING WALLS: PKDE	SHOULD HAVE HAD MORE LABOUR MONEY IN IT, BUT TIGHT IN SPACE	0.00	0.00
08/16/88	GENERAL CONTRACTOR	G304PK	F&P SLAB ON GRADE	DIFFICULT DETAILS FOR BULKHEADS	0.00	0.00
** Subtotal **					2.00	0.00
** Problem Type: REWORK DUE TO FIELD ERROR OR DAMAGE						
06/01/88	GENERAL CONTRACTOR	G205FN	F&P PERIMETER PILECAPS	MUST REDESIGN 2 FTGS DUE TO GERHARD'S ERROR DURING PILING	0.00	0.00
07/14/88	GENERAL CONTRACTOR	G309FN	DRAIN TILE, U/G PLUMBING	RELAY MECH DRAINAGE BETWEEN MAIN CATCH BASIN & PUMP SUMP	0.00	0.00
08/02/88	GENERAL CONTRACTOR	G202FN	EXCAV. DRAIN TILES, U/G PLUMB.	REDUG UP CLAIRMONT'S WATERMAIN DUE TO FAILED TEST - BACKCHARG	1.00	0.00
** Subtotal **						

Figure 4.9 - Continued

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - ACTIVITY PROBLEMS: FREQUENCY OF OCCURRENCE

Date	Trade	Activity Code	Activity Description	Problem Description	Est'd Delay To Activity (Hrs.)	Estimated Man-Hrs. Lost
** Problem Type: UNEXPLAINED OR UNNECESSARY MOVE						
06/01/88	UNITED REINFORCING	0321FN	REINFORCE PERIMETER PILECAPS	CREW TOOK OFF @ 10:00AM W/O INFORMING SUPERINTENDENT	0.00	0.00
06/01/88	UNITED REINFORCING	0322FN	REINFORCE COLUMN FTGS/PILECAPS	CREW TOOK OFF @ 10:00AM W/O INFORMING SUPERINTENDENT	0.00	0.00
** Subtotal **					0.00	0.00
** Problem Type: WEATHER						
07/06/88	IHRORY WATERPROOFING	1921PK	WATERPROOFING CORE	RAINY WEATHER PERSISTING (1/2 DAY TODAY & 1 DAY YESTERDAY)	12.00	0.00
07/08/88	GENERAL CONTRACTOR	G302PK	F&P EXT WALLS/COLS: PARKADE	TOO WARM (NO WIND IN THE HOLE: COMMON WALL)	1.20	0.00
07/12/88	GENERAL CONTRACTOR	G302PK	F&P EXT WALLS/COLS: PARKADE	RAIN	1.60	0.00
07/12/88	GENERAL CONTRACTOR	G309FN	DRAIN TILE, U/G PLUMBING	RAIN	1.60	0.00
07/12/88	GENERAL CONTRACTOR	G202FN	EXCAV. DRAIN TILES, U/G PLUMB.	RAIN	1.60	0.00
08/16/88	GENERAL CONTRACTOR	G304PK	F&P SLAB ON GRADE	COULD NOT POUR DUE TO RAIN	8.00	0.00
** Subtotal **					26.00	0.00
*** Total ***					104.25	0.00

Figure 4.9 - Continued

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020. HIGHBURY - G. C. DRAWINGS AVAILABILITY

KEY: 1) "Available?": .T. = Yes, .F. = No
2) "Quality": PP = Poor, PF = Poor-Fair, FF = Fair, FG = Fair-Good, GG = Good
3) "Detailing": A = Adequate, I = Inadequate

Date	Available?	Availability Remarks	Quality	Quality Remarks	Detailing	Detailing Remarks
06/01/88	.F.	CHASING AFTER NEW DRAWINGS FOR COMMON WALL	GG		A	
06/02/88	.T.		GG		A	
06/03/88	.T.		GG		A	
06/06/88	.T.		GG		A	
06/07/88	.F.	FOR COMMON WALL (AS NOTED ON 06/01/88)	GG		A	
06/08/88	.F.	COMMON WALL ELEVATIONS STILL NOT AVAILABLE	GG		A	
06/09/88	.F.	STRUCTURAL ENG. PROMISED TO HAVE COMMON WALL INFO. BY TOMORROW	GG		A	
06/10/88	.T.	FINALLY GOT THE ELEVATIONS FOR THE COMMON WALL	GG		A	
06/13/88	.T.		GG		A	
06/14/88	.T.		PP	ELEVATION DRAWINGS (REFER TO DETAILING)	I	ELEVATIONS: NEED TO KNOW FOR POUR OF LINE 1 WALL TOMORROW
06/15/88	.T.		GG		A	
06/16/88	.T.		GG		A	
06/17/88	.T.		GG		A	
06/20/88	.T.		FG		A	
06/21/88	.T.		GG		A	
06/22/88	.T.		GG		A	
06/23/88	.T.		GG		A	
06/24/88	.T.		GG		A	
06/27/88	.T.		GG		A	
06/28/88	.T.		GG		A	
06/29/88	.F.	GLOTMAN LATE WITH STEEL CHANGES TO LOWER ELEVATION OF LINE 15 WALL	GG		A	
06/30/88	.T.	RECEIVED STEEL CHANGES	GG		A	
07/04/88	.T.		GG		A	
07/05/88	.T.		GG		A	
07/06/88	.T.		GG		A	
07/07/88	.T.		GG		A	
07/08/88	.T.		GG		A	
07/11/88	.T.		GG		A	
07/12/88	.T.		GG		A	
07/13/88	.T.		GG		A	
07/14/88	.T.		GG		A	
07/15/88	.T.		GG		A	
07/18/88	.T.		GG		A	
07/19/88	.T.		GG		A	
07/20/88	.T.		GG		A	

Figure 4.10 - Drawings Availability Report
(for a Particular Trade)

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - G. C. DRAWINGS AVAILABILITY

KEY: 1) "Available?": .T. = Yes, .F. = No
2) "Quality": PP = Poor, PF = Poor-Fair, FF = Fair, FG = Fair-Good, GG = Good
3) "Detailing": A = Adequate
I = Inadequate

Date	Available?	Availability Remarks	Quality	Quality Remarks	Detailing	Detailing Remarks
07/21/88	.T.		GG		A	
07/22/88	.T.		GG		A	
07/25/88	.T.		GG		A	
07/26/88	.T.		GG		A	
07/27/88	.T.		GG		A	
07/28/88	.T.		GG		A	
07/29/88	.T.		GG		A	
08/02/88	.T.		GG		A	
08/03/88	.T.		GG		A	
08/04/88	.T.		GG		A	
08/05/88	.T.		GG		A	
08/08/88	.T.		GG		A	
08/09/88	.T.		GG		A	
08/10/88	.T.		GG		A	
08/11/88	.T.		GG		A	
08/12/88	.T.		GG		A	
08/15/88	.T.		GG		A	
08/16/88	.T.		GG		A	

Figure 4.10 - Continued

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - CONCRETE DELIVERY

KEY: 1) "On Time?": .T. = On Time, .F. = Late
2) "Quality" : PP = Poor, PF = Poor-Fair, FF = Fair, FG = Fair-Good, GG = Good

Date	Material	Supplier	On Time?	Quality	Remarks	Quantity Delivered (m3)
06/03/88	CONCRETE	REMPEL	.T.	GG		60.00
06/07/88	CONCRETE	REMPEL	.T.	GG		15.00
06/15/88	35 MPA CONCRETE	REMPEL	.F.	FF	CONCRETE WAS DELIVERED TOO EARLY. AND AGGREGATE SHOULD BE =< 3/4", BUT LARGE AGGREGATES FOUND (APPROX. 4 1/2") WHICH WERE CLOGGING THE LINE OF THE LINE PUMP.	10.00
06/15/88	25 MPA CONCRETE	REMPEL	.T.	FF		14.00
06/23/88	25 MPA CONCRETE	REMPEL	.T.	GG		42.00
06/24/88	20 MPA CONCRETE	REMPEL	.T.	GG		2.00
06/27/88	25 MPA CONCRETE	REMPEL	.T.	GG		30.50
06/29/88	20 MPA CONCRETE (FOR 12 COL. FTGS)	REMPEL	.T.	GG		22.70
06/30/88	25 MPA CONCRETE (FOR PERIMETER WALL)	REMPEL	.T.	GG		20.00
07/04/88	35 MPA CONCRETE (FOR 8 COLUMNS)	LAFARGE	.T.	GG		6.00
07/05/88	35 MPA CONCRETE	REMPEL	.T.	GG		7.60
07/06/88	25 MPA CONCRETE	REMPEL	.T.	GG		9.60
07/06/88	35 MPA CONCRETE	REMPEL	.T.	GG		3.40
07/13/88	35 MPA CONCRETE (FOR 2 COLS)	REMPEL	.T.	GG		1.25
07/13/88	25 MPA CONCRETE (FOR WALLS)	REMPEL	.T.	GG		10.40
07/20/88	25 MPA CONCRETE	REMPEL	.T.	GG		19.40
07/22/88	25 MPA CONCRETE	REMPEL	.T.	GG		5.00
07/25/88	35 MPA CONCRETE (FOR 6 COLS & ELEVATOR MACH RM SLAB)	REMPEL	.T.	GG		6.00
07/26/88	35 MPA CONCRETE (FOR INT. WALL)	REMPEL	.F.	GG	DELIVERY WAS LATE BY 1'45".	13.20
07/27/88	35 MPA CONCRETE	REMPEL	.T.	GG		1.80
08/02/88	25 MPA CONCRETE (FOR CROSSING GRATE)	REMPEL	.T.	GG		2.60
08/04/88	25 MPA "SPECIAL" CONCRETE (FOR S.D.G.)	REMPEL	.T.	GG		77.50
08/04/88	35 MPA CONCRETE (FOR STAIRS)	REMPEL	.T.	GG		2.00
08/05/88	35 MPA CONCRETE (FOR SHEAR WALLS + COLS)	REMPEL	.T.	GG		16.80
08/09/88	35 MPA CONCRETE (FOR INT. WALL JUST SOUTH OF CORE)	REMPEL	.T.	GG		3.60
08/11/88	35 MPA CONCRETE (FOR CORE WALLS)	REMPEL	.T.	GG		36.50
08/16/88	25 MPA CONCRETE (FOR LAST OF STRIP FTGS)	REMPEL	.T.	GG		6.00

Figure 4.11 - Material Delivery Report

Page No. 2
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - CONCRETE DELIVERY

KEY: 1) "On Time?": .T. = On Time, .F. = Late
2) "Quality" : PP = Poor, PF = Poor-Fair, FF = Fair, FG = Fair-Good, GG = Good

Date	Material	Supplier	On Time?	Quality	Remarks	Quantity Delivered (m3)
*** Total ***						444.85

Figure 4.11 - Continued

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - INSPECTION REPORT

Date	Inspection	Inspection Remarks
** Trade: UNITED REINFORCING		
* Activity: REINFORCE EXT WALLS/COLS:PKDE + INT. WALLS		
06/14/88	INSPECTION OF EXT WALL/COLS BY SUPER. WITH ENG'S PERMISSION	
06/15/88	INSPECTION OF COLS & WEST PERIMETER WALL BY GLOTMAN	
06/21/88	INSPECTION OF WALL REINFORCEMENT BY GLOTMAN	
06/30/88	INSPECTION OF COLUMN REINFORCEMENT BY GLOTMAN	
07/05/88	INSPECTION OF COLUMNS REINFORCEMENT BY GLOTMAN	
07/08/88	INSPECTION: LOWER COMMON WALL REINF.(BELOW S.O.G.) BY GLOTMAN	
07/29/88	INSPECTION OF 4 PARKING COLUMNS BY GLOTMAN	

Figure 4.12a - Inspection Report

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
SUMMARY REPORT

2020 HIGHBURY - TESTING REPORT

Date	Test	Test Remarks
** Trade: GENERAL CONTRACTOR		
* Activity: F&P EXT WALLS/COLS: PARKADE + INT. WALLS		
07/04/88	CONCRETE CYLINDER TESTS FOR COLUMNS BY MTS	
07/13/88	35 MPA CONCRETE CYLINDER TESTS FOR COLS BY MTS	
07/13/88	25 MPA CONCRETE CYLINDER TEST FOR WALLS BY MTS	
07/20/88	CONCRETE CYLINDER TESTS FOR N. WALL BY MTS	
07/25/88	35 MPA CONCRETE CYLINDER TESTS FOR COL.(C13,D11,F13) BY MTS	
07/26/88	35 MPA CONCRETE CYLINDER TESTS FOR WALLS LINE 7 & M BY MTS	
08/05/88	35 MPA CYLINDER TESTS FOR COLUMNS F3,C3,D5,F-D6 BY MTS	

Figure 4.12b - Testing Report

Normally, unless difficulties were encountered on a job site, the number of reports illustrated above would not be generated. Instead, only the hard copy Daily Site Report (see Figure 4.13) would be printed out for the superintendent to verify (each page must be signed by the superintendent for legal purposes) and filed away. This form is essentially a condensed version (with minor modifications) of the proposed daily site report forms (in section 2.2). It is actually being developed by Dr. Alan Russell as a conventional (pencil and paper) site updating tool. Field implementation of this form is presently under way. Nevertheless, as illustrated by Figure 4.13, it seems to be appropriate for representing the information collected by the proposed daily site report forms. Its coding system (a, b, c, ... 1, 2, 3, ...) enables proper attachment of comment to the associated information item with the usage of minimal sheet space. That is, remarks for each information item can be captured without having to provide a comment space after each.

4.3.5 INTERPRETING THE OUTPUT REPORTS

Once a substantial database has been built up, variance analyses may be carried out in order to derive a "hit list" of typical general project problems, activity delay problems, problem sources, and problem activities.

J. C. Scott Construction Ltd.

REPCON™

5th & HIGHBURY

DAILY SITE REPORT - WEDNESDAY, 01 JUN 88

Superintendent:

Report Date : 1988-12-02
File Used : d:hibury
Progress As Of : 1988-10-17
Revision Number : 0

WORK ENVIRONMENT DATA

Weather Conditions :
a) (AM) : Clear [ ] Cloudy [X] Rain [X] Snow [ ]
b) (PM) : Clear [ ] Cloudy [X] Rain [X] Snow [ ]
c) Temperature : High __13__C Low __9__C
d) Precipitation : _12.0_mm
e) Wind : _____kph

Site Conditions :
f) Ground conditions : Poor [X] Fair [ ] Good [ ]
g) Storage on site : Poor [X] Fair [ ] Good [ ]
h) Access to site : Poor [ ] Fair [ ] Good [X]

Comments : f) DUE TO RAIN & CLAY_____
_____g) DUE TO THE NATURE OF THE JOB (FOR ANOTHER 6-8 WKS
_____UNTIL S.O.G. IS POURED)_____

OTHER

a) Inspections : _____
and Tests _____
b) Visitors : _____
_____
c) Accidents : _____
_____
d) Deliveries : Concrete _____cubic metres
_____1) OCEAN CEMENT (PIP. DIV.): 1 MAIN CATCH BASIN____
_____& 1 STORM DRAIN SUMP PUMP_____
e) Field Orders : _____
_____
f) Back Charges : _____
_____
Comments : _____
_____
_____

WORK FORCE DATA

Trade	Supervision # (a)	Skill (b)	Tradesmen # (c)	Suff (d)	Skill (e)	T/D (f)
6 GENERAL CONTRAC	1	GG	5	Y	FG	N
01 EXCAVATION TRAD	1	GG	1	Y	GG	N
03 REINFORCING STE	1	GG	2	Y	GG	N
16 ELECTRICAL TRAD	1	GG	0	Y		N

Comments : G)e) 2 GOOD AND 3 NOT SO GOOD; TRYING TO WEED OUT__
_____03)d) HERE 'TIL 10:00 AM THEN LEFT W/O NOTICE_____
_____

WORK PROGRESS AND PROBLEMS

TRADE / ACTIVITY / LOCATIONS SCHEDULED FOR 88-06-01	GIVE TODAY'S STATUS (F,I,O,S)	PROBLEM SOURCE CODES	REMARKS RE PROBLEMS	ESTIMATE OF TIME LOST MHRS	DAYS	ACTION CODE
6 GENERAL CONTRACTOR - J. C. SCOTT CONSTRUCTION LTD.						
G205FN F&P PERIMETER PILECAPS	FN / I	14	14) MUST REDESIGN TWO FTGS DUE TO SUPER'S ERROR DURING PILING!	/	/	
G210FN F&P COLUMN FTGS/PILECAPS	FN / O					
G215FN F&P CRANE FOOTING	FN / O					
01 EXCAVATION TRADE CONTRACTOR - CAMPBELL CARTAGE						
0122FN EXCAVATE COL FTGS/PILECAPS	FN / I					
0124FN EXCAVATE CORE FOOTING	FN / S		- RATE OF PRODUCTION IS FASTER THEN EXPECTED			
0126FN EXCAVATE STRIP FOOTINGS	FN / I					
03 REINFORCING STEEL - LAFARGE STEEL (UNITED REINFORCING)						
0321FN REINFORCE PERIMETER PILECAPS	FN / O	2	2) ONLY MADE 19/40 CAGES OF REBAR FOR PILES THEN LEFT	/	/	
0322FN REINFORCE COLUMN FTGS/PILECAPS	FN / S	2	2) AS ABOVE	/	/	
16 ELECTRICAL TRADE CONTRACTOR - NIGHTINGALE ELECTRICIAN						
163100 TEMPORARY POWER	00 / SF		- TEMP. POWER FOR 2 TRAILERS & HOOKED UP GANG BOX (100')			

ACTIVITY LOCATION STATUS CODES : F = Finished, I = Idle, O = On-going, S = Started
PROBLEM SOURCE CODES :
WAITING DELAYS : (1) Materials (2) Manpower (3) Tools (4) Equipment (5) Access (6) Inspection (7) Information/Decisions
SITE CONDITIONS : (8) Weather (9) Access (10) Storage (11) Ground
REWORK : (12) Design Error (13) Prefab Error (14) Field Error
CHANGES : (15) Owner Error (16) Design Error (17) Contractor Error
QUALITY : (18) Materials (19) Workmanship (20) Drawings
ACTION CODES :
(1) Backcharge (2) Issue Memo (3) Extra Work Order

Figure 4.13 - Daily Site Report (Hard Copy)

Moreover, correlation could be postulated, for example, to determine whether or not quantitative links exist between site conditions and individual activity performances. Then, the ultimate goal is to establish critical control values (eg. indices) to act as early warning indicators for signifying specific problems.

Variance Analyses

The underlying purpose of performing variance analyses is so that project managers can identify problem trends such as:

- the most common types of activity problems and the ones with the greatest time lost and man-hours lost;
- the most common sources of activity problems and the ones with the greatest time lost and man-hours lost;
- the activities that encountered the most problems and the ones with the greatest time lost and man-hours lost;
- the trades that encountered the most problems and the ones with the greatest time lost and man-hours lost;
- the most common types of unusual developments (at the site level) and the ones with the greatest time lost;
- the most common sources of unusual developments (at the site level) and the ones with the greatest time lost; and
- the activities that were interrupted the most.

The results in Figures 4.14a to 4.16 were obtained from manually analyzing the daily site reporting data for the aforementioned high-rise project (that is, these outputs are

not computer generated; but obviously, they should be in the future).

Activity Problems data from Figure 4.9 were used for the variance analyses in Figures 4.14a to 4.14d.

In Figure 4.14a, different types of activity problems are ranked, in descending order, according to their time lost and man-hour lost. It is interesting to note that there were actually two occurrences of **Unexplained or Unnecessary Move** which contributed no time lost or man-hour lost. One may ask how can there be a problem without having time lost or man-hour lost. In fact, in a the court of law, a judge would most likely dismiss the problem since there were no consequential damages. Fortunately, this data correctly represents that particular event. The fact is that a subtrade's crew took off only after a few hours of work (no man-hour lost for the subtrade on those particular activities) without informing the site superintendent. However, the two activities that they were working on were not delayed (no time lost) because they were not critical. Nevertheless, an important lesson from this discussion is that if a legitimate problem is encountered on site, the superintendent should, whenever possible, make time lost and man-hour lost estimates in order to enhance the credibility of the data. Different sources of activity problems, different affected activities, and different affected trades

J. C. SCOTT CONSTRUCTION

2020 HIGHBURY - VARIANCE ANALYSIS OF ACTIVITY PROBLEMS BY PROBLEM TYPE
(PERIOD FROM 06/01/88 TO 08/16/88)

ACTIVITY PROBLEM TYPE	NUMBER OF OCCURRENCES	% OF TOTAL EST'D TIMELOST	% OF TOTAL EST'D MAN-HOURS LOST
Weather	6	24.94	/
Delays Due to Waiting for Information/Decisions	3	23.02	/
Delays Due to Waiting for Fellow Crew Members	4	19.18	/
Delays Due to Waiting for Materials:Warehouse/Vendor	5	12.71	/
Mandatory Change Order /Extra Work	2	11.51	/
Delays Due to Waiting for Other Crews	1	3.84	/
Equipment Breakdown	2	1.92	/
Others	5	1.92	/
Rework Due to Field Error or Damage	3	0.96	/
Unexplained or Unnecessary Move	2	0	/

Figure 4.14a - Variance Analysis of Activity Problems by Problem Type

are ranked in a similar way in Figures 4.14b, 4.14c, and 4.14d respectively.

Activity problem sources, as shown in Figure 4.14b, could range from **Weather** and **Site Conditions** to any party that caused an activity problem in the project (namely, the **Owner**, **Consultants**, **General Contractor**, **Subtrades**, **Suppliers**, **Utilities**, and **Government Agency**). In order to facilitate computer retrieval of such information, it is necessary to attach a **Responsibility Code** (see Figure 4.14bi) to each activity problem. That is, it is not enough to know that there is a problem associated with a certain activity because Party A's problem could have been caused by Party B. Since Responsibility Code was not originally proposed, it should be added to the Activity Information Form (see Figure 4.14bii) and to the Delay / Rework Information Screen (see Figure 4.14biii).

The affected activities listed in Figure 4.14c represent only those activities that were directly affected by the activity problems. Nevertheless, a problem on a particular day could affect more than one activities concurrently (a form of **ripple effect**). For example, Figure 4.6b shows that on 06/03/88 United Reinforcing did not have enough workers on site to have the footings ready for pour in the morning. This problem hindered both activities 0321FN and 0323FN. However, ripple effect in the form of

J. C. SCOTT CONSTRUCTION

2020 HIGHBURY - VARIANCE ANALYSIS OF ACTIVITY PROBLEMS BY PROBLEM SOURCE
(PERIOD FROM 06/01/88 TO 08/16/88)

ACTIVITY PROBLEM SOURCE	NUMBER OF OCCURRENCES	% OF TOTAL EST'D TIMELOST	% OF TOTAL EST'D MAN-HOURS LOST
Weather	6	24.94	/
United Reinforcing	6	23.02	/
Glotman & Simpson	3	19.18	/
Site Conditions	4	11.51	/
Canwest	2	9.59	/
Glotman & Simpson/Waisman Dewar, Grout & Carter	1	7.67	/
Rempel	4	3.12	/
Clairmont	2	0.96	/
J. C. Scott Construction	3	0	/
Hardy	1	0	/
Throry	1	0	/

Figure 4.14b - Variance Analysis of Activity Problems by Problem Source

Problem Source	Responsibility Code
Weather	
. Temperature	10
. Precipitation	11
. Wind	12
Site Conditions	
. Access	20
. Storage	21
. Ground	22
Owner	30
Consultants	
. Project Manager	40
. Architect	41
. Structural	42
.	.
.	.
General Contractor	50
Subtrades	
. Excavation	60
. Forming	61
. Reinforcing	62
.	.
.	.
Suppliers	
. Lumber	70
. Reinforcing Steel	71
. Structural Steel	72
.	.
.	.
Utilities	
. Water	80
. Sewage	81
. Electricity	82
.	.
.	.
Government Agencies	
. City Street: Engineering	90
. Fire Marshall	91
. Health Inspector	92
.	.
.	.

Figure 4.14bi - Sample Responsibility Codes

ACTIVITY INFORMATION

Initials: _____

Activity Description: _____ Code: _____

Activity Scope (quantity/unit/description): _____

_____

Construction Method: _____

Activity Status: started/in progress/idle/finished/started & finished

Work Performed Today: _____

Rate of Production: excellent/satisfactory/unsatisfactory
(quantify if possible) _____
Why "unsatisfied" ?

	Resp. Code	Estimated Lost Time /Man-Hrs.
. Rework Due to:		
- Design Error: _____	(____)	(____days/____)
- Prefab. Error: _____	(____)	(____days/____)
- Field Error or Damage: _____	(____)	(____days/____)
. Change Orders/Extra Work:		
- Owner Initiated: _____	(____)	(____days/____)
- Mandatory: _____	(____)	(____days/____)
- Contractor Initiated: _____	(____)	(____days/____)
. Delays Due to Waiting for:		
- Materials: warehouse/vendor _____	(____)	(____days/____)
- Tools: _____	(____)	(____days/____)
- Construction Equipment: _____	(____)	(____days/____)
- Information/Decisions: _____	(____)	(____days/____)
- Other Crews: _____	(____)	(____days/____)
- Fellow Crew Members: _____	(____)	(____days/____)
. Equipment Breakdown (downtime): _____	(____)	(____days/____)
. Unexplained or Unnecessary Move: _____	(____)	(____days/____)
. Late Inspection: _____	(____)	(____days/____)
. Strike/Job Action: _____	(____)	(____days/____)
. Weather: _____	(____)	(____days/____)
. Others: _____	(____)	(____days/____)

Quality of Work: good/fair/poor _____
. Inspections: _____
. Tests: _____

Figure 4.14bii - Modified Activity Information Form

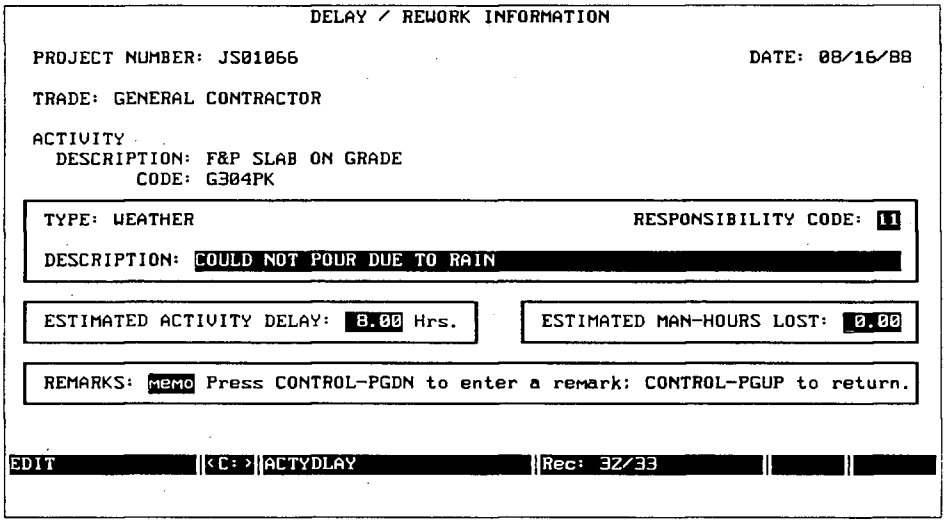

Figure 4.14biii - Modified Delay / Rework Information Screen

J. C. SCOTT CONSTRUCTION

2020 HIGHBURY-VARIANCE ANALYSIS OF ACTIVITY PROBLEMS BY AFFECTED ACTIVITY
(PERIOD FROM 06/01/88 TO 08/16/88)

AFFECTED ACTIVITY	NUMBER OF OCCURRENCES	% OF TOTAL EST'D TIMELOST	% OF TOTAL EST'D MAN-HOURS LOST
F&P Ext Walls/Cols: Parkade + Int. Walls	6	19.71	/
Reinforce Core Walls + Wing Walls: Pkde	2	19.18	/
Waterproofing Core	3	13.43	/
F&P Strip Footings + Int. Step Ftgs.	2	7.67	/
F&P Slab On Grade	2	7.67	/
Excavate Core Footing	1	7.67	/
Reinforce Slab On Grade	1	5.76	/
F&P Crane Footing	2	3.84	/
Reinforce Perimeter Pilecaps	2	3.84	/
Reinforce Column Ftgs/ Pilecaps	2	3.84	/
Excavate Drain Tiles, U/G Plumbing	2	2.49	/
Backfill/Grading	2	1.92	/
Drain Tile, U/G Plumbing	2	1.53	/
F&P Core Walls + Wing Walls: Pkde	2	1.44	/
F&P Perimeter Pilecaps	1	0	/
Reinforce Crane Footing/ Anchor Bolts	1	0	/

Figure 4.14c - Variance Analysis of Activity Problems by Affected Activity

effects on subsequent activities were not considered in the analysis. Likewise, even though the affected trades listed in Figure 4.14d are only those who inherited direct consequences from the activity problems, a problem such as lost of temporary power (would be classified as **Equipment Breakdown**) could affect all of the trades on site at the same time.

Unusual Developments data from Figure 4.8 were used to produce the variance analyses in Figures 4.15a and 4.15b. Different types of unusual developments and different sources of unusual developments are ranked, in descending order, according to their time lost in Figures 4.15a and 4.15b respectively. Again, a number of items in the two figures have zero time lost entries which could greatly reduce their usefulness in claims preparation. However, they could still be valuable documentation and useful early warning indicators for project managers. Moreover, it must not be forgotten that in order to facilitate computer retrieval of unusual developments by problem sources (Figure 4.15b), a Responsibility Code (from Figure 4.14bi) should be recorded with each unusual development. Thus, the Site / Environment Information Form and the Unusual Developments Screen should be modified to make provision for the Responsibility Code (see Figures 4.15bi and 4.15bii).

J. C. SCOTT CONSTRUCTION

2020 HIGHBURY - VARIANCE ANALYSIS OF ACTIVITY PROBLEMS BY AFFECTED TRADE
(PERIOD FROM 06/01/88 TO 08/16/88)

AFFECTED TRADE	NUMBER OF OCCURRENCES	% OF TOTAL EST'D TIMELOST	% OF TOTAL EST'D MAN-HOURS LOST
J. C. Scott Construction	21	46.28	/
United Reinforcing	8	32.61	/
Throry	3	13.43	/
Campbell Cartage	1	7.67	/

Figure 4.14d - Variance Analysis of Activity Problems by Affected Trade

J. C. SCOTT CONSTRUCTION

2020 HIGHBURY - VARIANCE ANALYSIS OF UNUSUAL DEVELOPMENTS BY PROBLEM TYPE
(PERIOD FROM 06/01/88 TO 08/16/88)

TYPE OF UNUSUAL DEVELOPMENT	NUMBER OF OCCURRENCES	% OF TOTAL EST'D TIMELOST
Overall Job Delays	9	100
Potential Problems	10	0
Other Unusual Developments	7	0
Disputes	5	0

Figure 4.15a - Variance Analysis of Unusual Developments by Problem Type

J. C. SCOTT CONSTRUCTION

2020 HIGHBURY-VARIANCE ANALYSIS OF UNUSUAL DEVELOPMENTS BY PROBLEM SOURCE
(PERIOD FROM 06/01/88 TO 08/16/88)

SOURCE OF UNUSUAL DEVELOPMENT	NUMBER OF OCCURRENCES	% OF TOTAL EST'D TIMELOST
Glotman & Simpson/Waisman Dewar, Grout & Carter	3	71.94
Clairmont	1	14.39
Canwest	2	10.79
Weather	3	2.88
J. C. Scott Construction	10	0
United Reinforcing	3	0
Hardy	2	0
Site Conditions	2	0
Northern West Elevators	1	0
Fraser River Piling	1	0
Rempel	1	0
Sterling Cooper	1	0
Van Maren	1	0

Figure 4.15b - Variance Analysis of Unusual Developments by Problem Source

SITE / ENVIRONMENT INFORMATION

Initials: _____

Project: _____

Project No.: _____

Date: _____

Superintendent: _____

Weather (AM): clear/cloudy/rainy/snowy; other _____
(PM): clear/cloudy/rainy/snowy; other _____

Temperature (Hi/Lo): _____ /_____ ^{o}C

Precipitation: _____ mm

Wind: _____ Kph

Site Conditions:

- Access to Site: poor/fair/good _____
- Storage on Site: poor/fair/good _____
- Ground Conditions: poor/fair/good _____

Unusual Developments: yes/no	Resp. Code	Estimated Time Lost
. Strikes/Job Actions: yes/no	(____)	(____days)
. Potential Problems: yes/no	(____)	(____days)
. Delays: yes/no	(____)	(____days)
. Disputes: yes/no	(____)	(____days)
. Others	(____)	(____days)

Figure 4.15bi - Modified Site / Environment Information Form

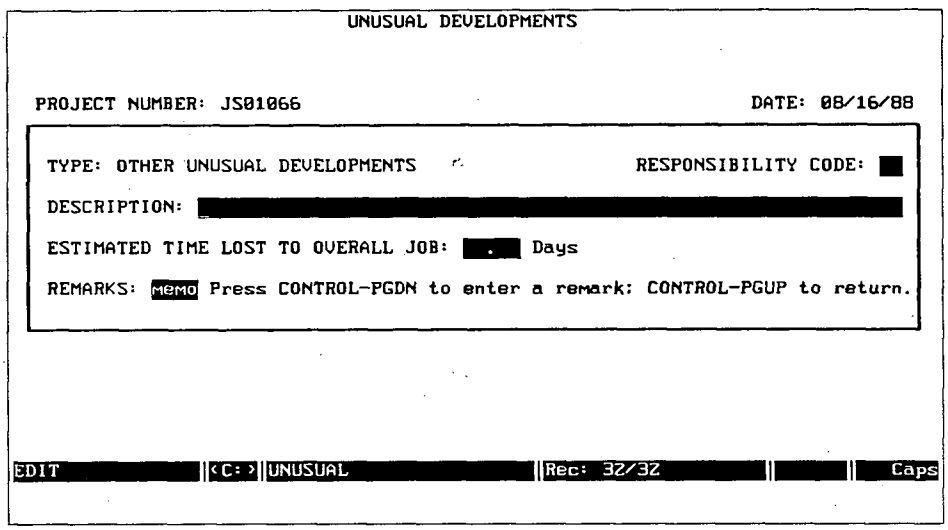

Figure 4.15bii – Modified Unusual Developments Screen

Activity Status data such as that shown in Figure 4.5b were used to produce the activity interruptions analysis in Figure 4.16. All activities that were started and finished within the reporting period of 06/01/88 to 08/16/88 and with an activity duration of more than one day were examined. The activities are listed in the order of the greatest percentage of idle time over the entire activity duration. The project manager's job would then be to justify the idle time associated with each activity. For example, by looking at the Variance Analysis of Activity Problems by Affected Activity (Figure 4.14c) concurrently with this analysis, one can see that **Reinforce Strip Ftgs. + Int. Step Ftgs.** was interrupted the most (44 out of 49 days) yet it did not register a single activity problem (in Figure 4.14c). Thus, if this activity was not completed on schedule, one may assume that it was delayed by its predecessor activities. Whereas, if the activity was finished on time, the high degree of interruption was probably expected because the activity was most likely planned to be interruptible from the start.

Postulating Correlations

So far the analyses have been focused on problem trending by the most common types and sources and the most often affected activities and trades. The next step is to investigate whether or not correlations exist between these problems and overall job or individual activity

J. C. SCOTT CONSTRUCTION

2020 HIGHBURY - ACTIVITY INTERRUPTIONS ANALYSIS
(FOR ACTIVITIES THAT WERE STARTED & FINISHED WITHIN THE REPORTING PERIOD OF 06/01/88 TO 08/16/88 AND WITH ACTIVITY DURATION > 1 DAY)

ACTIVITY DESCRIPTION	NUM. OF IDLE DAYS	TOTAL ACT. DURATION	% OF TIME IDLE
Reinforce Strip Ftgs.+ Int. Step Ftgs.	44	49	89.80
Undergrnd. Serv.:Storm/Swge. Drns.	16	23	69.57
Reinforce Col. Ftgs./Pilecaps	13	20	65.00
F&P Strip Ftgs.+ Int. Step Ftgs.	32	50	64.00
Excav. Drain Tiles, U/G Plumb.	12	20	60.00
F&P Suspended Slab in Elevator Pit	4	8	50.00
F&P Core Walls	5	11	45.45
Reinforce Core Walls	2	5	40.00
Waterproofing Core	1	4	25.00
Elect. S.O.G. U/G	0	2	0
Excav. Slab Thickening (Divider Beams)	0	2	0
Reinforce Crane Ftg./Anch. Bolts	0	2	0
Reinf. Suspended Slab in Elevator Pit	0	2	0
Erect Tower Crane	0	3	0
Excavate Core Footing	0	4	0
Reinforce Core Footing	0	4	0
Reinf. Core Walls + Wing Walls: Pkde	0	6	0
F&P Core Footing	0	8	0
F&P Core Walls + Wing Walls: Pkde	0	11	0

Figure 4.16 - Activity Interruptions Analysis

performances. In order for the DSRS to perform formal correlation analyses, it would require built-in statistical analysis and graphical capabilities. But since extensive progress measurements for productivity analysis is not one of the major objectives of this proposed daily site report, the number of performance indicators available for correlation analyses are limited. Thus, the following study is somewhat crude in that it is based on some very simple comparisons between estimated (benchmark) and actual performances.

Certain correlations may be postulated by comparing estimated with actual performances (with problem indicators). Since benchmark values are not included as part of the DSRS, they must be retrieved from other sources such as a computerized Scheduling System. However, writing an interface for marrying the DSRS with the computerized Scheduling System used by J. C. Scott Construction would be beyond the scope of this report. Therefore, benchmark values shown hereafter for discussion purposes are purely fictitious.

For most general contractors, a graphical representation of the cumulative concrete poured versus the cumulative manpower expended for form and pour activities would give a good gross indication of job progress. Such a plot has been prepared from the database for 2020 Highbury

(see Figure 4.17a). The figure shows that the job is significantly behind schedule (using the fictitious **estimated curve**). The next step is to postulate the correlations between each type of delay and concrete productivity. This could be done by plotting the same graph with problem indicators overlaid along the **actual curve**. If a particular problem tends to show up prior to the unanticipated plateaus (deviation from the original plan) on the **actual curve** then a correlation may exist between the problem and concrete productivity. An example of such a plot is shown in Figure 4.17b where the two overlays of **Weather Problem** and **Delays Due to Waiting for Information/Decisions** have been included.

An alternative format for the above analysis is to plot cumulative concrete poured against time. The basis for comparison now becomes concrete production instead of concrete productivity (see Figure 4.18). In order to obtain the **estimated curve** for such a plot, the project schedule must have scheduled pour dates and their expected quantities. This obviously means that the superintendent must feel comfortable with committing these values. In the present industry, it is often difficult to get the superintendent to simply adopt a computerized schedule. Therefore, another level of refinement might not be reasonably obtained from the site as yet.

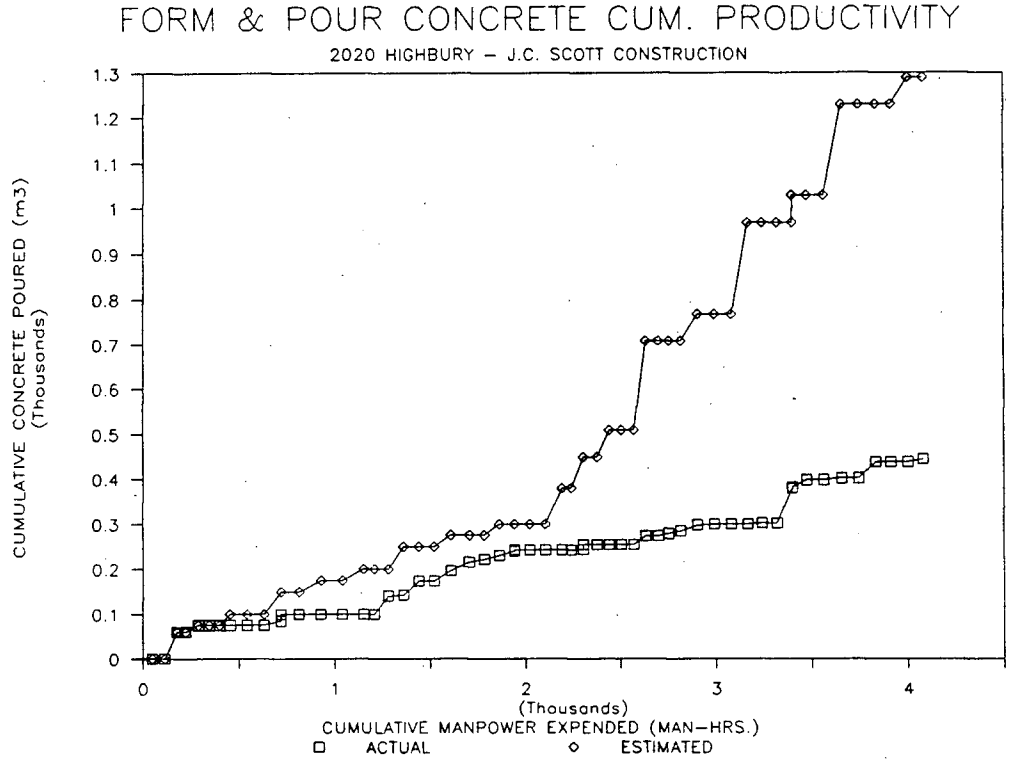

Figure 4.17a - Cumulative Concrete Poured vs. Cumulative Manpower Expended

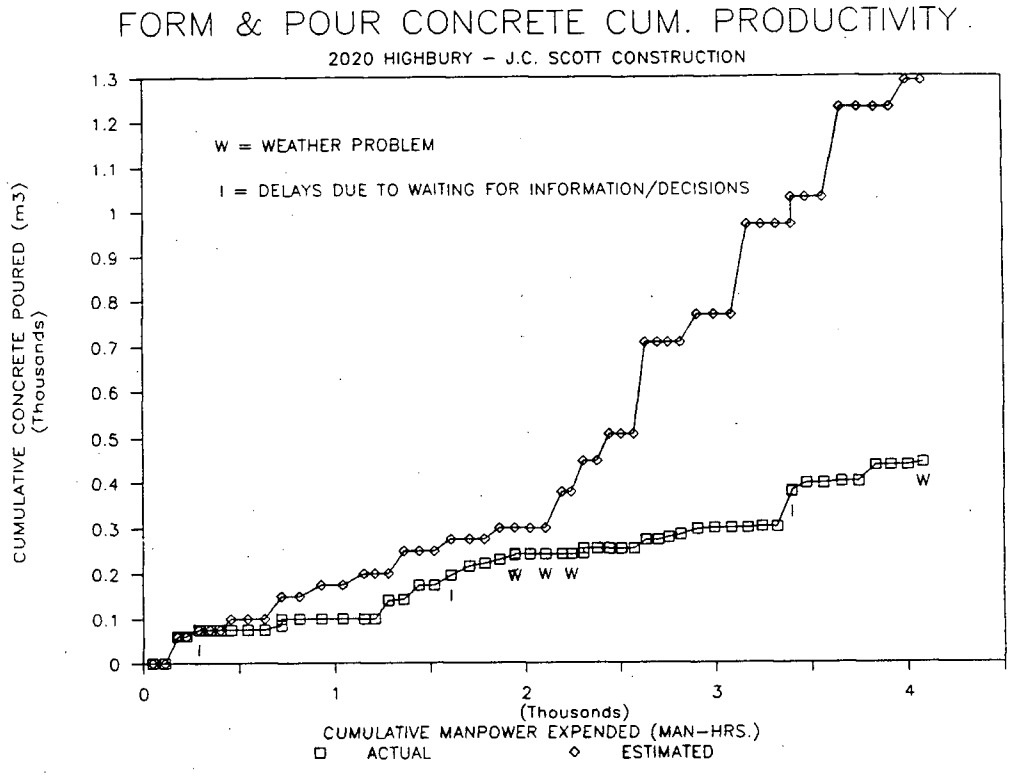

Figure 4.17b - Cumulative Concrete Poured vs. Cumulative Manpower Expended with Overlaid Problem Indicators

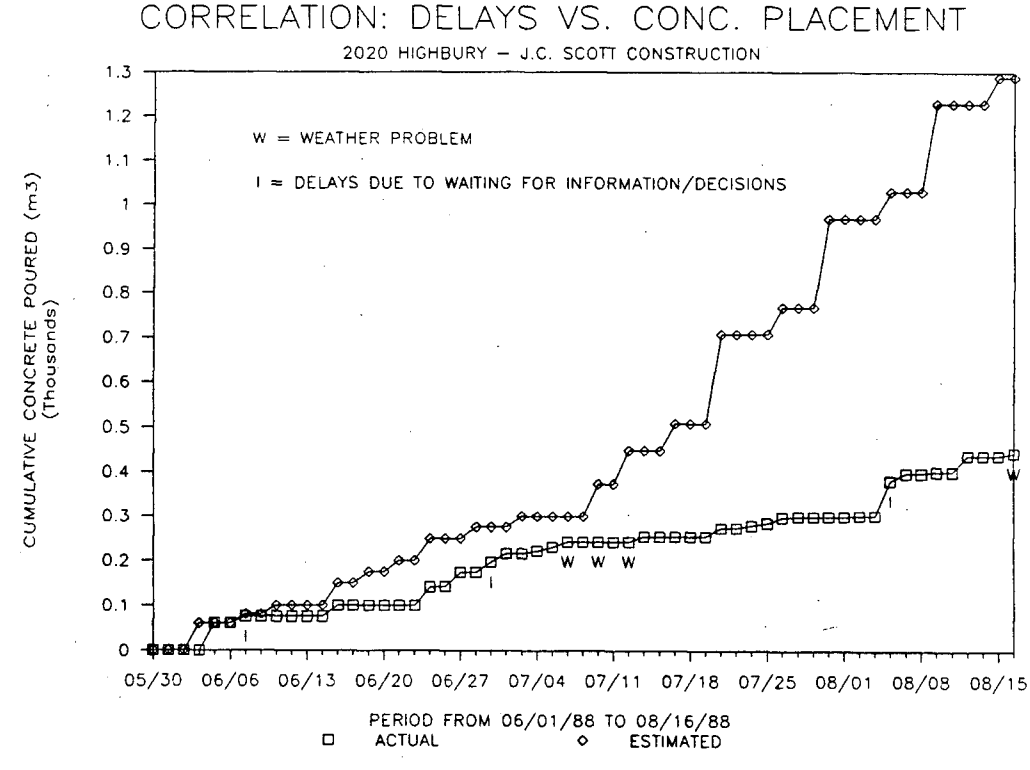

Figure 4.18 - Cumulative Concrete Poured vs. Time with Overlaid Problem Indicators

It must be noted that the above data on concrete productivity and production were collected while the project was still "coming out of the ground" (substructure of the building) which means that there were not many repetitive activities. Therefore, concrete pours at regular time intervals were not easy to schedule; as a result, it could be difficult to produce reasonable **estimated curves.** Whereas if the data were collected for the construction of the typical floors, very accurate pour dates (thus, **estimated curves**) could be generated as benchmarks for comparison. For example, if a five-day cycle is employed, there would be one concrete pour for the walls and columns early in the week and one for the slab at the end of the week.

On the other hand, in order to analyze subtrade performance in a similar fashion, standardized methods for measuring quantities, such as those used in productivity measurement and performance evaluation studies (see Figure 4.19 [43:31-42]), must be employed. But these measurements could be very time consuming which makes them unsuitable for daily reporting. Instead, these techniques should only be used on selected labour-intensive tasks where problems are likely to arise.

Method of Measuring Quantities	Explanation of Method
1) Units Completed	Eg. cu.yds. of excavation, number of ceiling tiles in place, etc.
2) Percent Completed	Subjective evaluation by foreman or superintendent
3) Level of Effort	Based on predetermined rules (eg. stages of formwork: erection, alignment, ... , cleaning)
4) Incremental Milestones	Eg. equipment installation, alignment and testing
5) Start/Finish Percentage	Applicable to tasks which lack readily definable intermediate milestones or for which the effort in terms of work-hours required is very difficult to estimate. Arbitrarily assign a percent complete to the start; and when the item is complete, 100 % completion is credited.

Figure 4.19 - Methods Available for Measuring Quantities

4.4 AN OVERVIEW OF THE PROPOSED DATA REPORTING SYSTEM

The Data Reporting System described hereafter has not been programmed. It is merely a conceptualization of a report generator and filter.

4.4.1 METHOD OF DATA RETRIEVAL

The popular **Hierarchical Menu Structure** (as used by Lotus 1-2-3 and dBASE III PLUS) is best suited for this application. Specific reports can be selected by going through a series of menus and questions as outlined below:

System Menus

Figure 4.20 shows the recommended first menu of the system. All of the major categories of information on the proposed daily site report as well as the two items of **Variance Analyses** and **Correlations** are listed here. To select the preferred output, the user would first move the highlight cursor to the appropriate item and hit <**return**>. Then if that category of information has more than one output available, a list of the graphs and reports are presented in a sub-menu (see Figures 4.21a to 4.21h) for the user to choose from. Upon selecting the desired output (with the highlight cursor again), a series of related specification questions would follow to narrow down the particular output of interest.

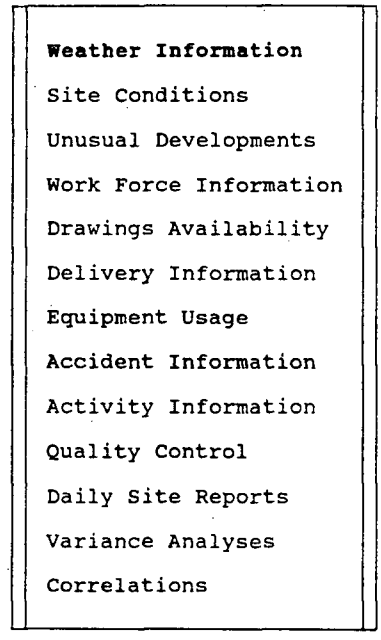

Figure 4.20 - Data Reporting System Main Menu

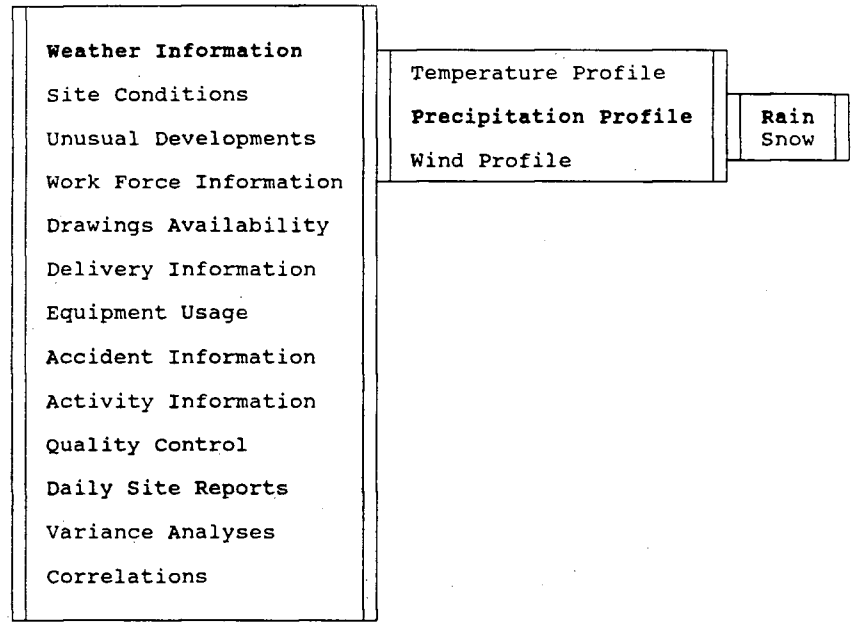

Figure 4.21a - Weather Information Sub-Menus

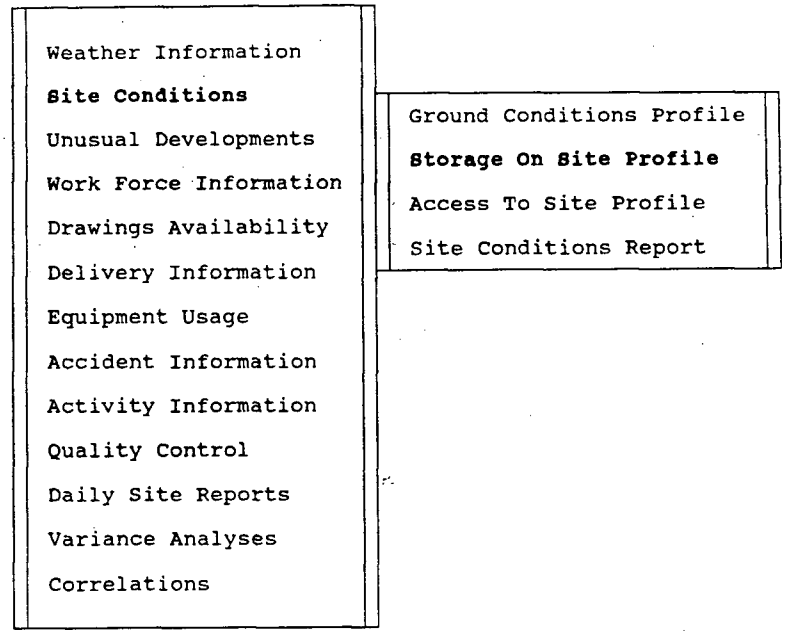

Figure 4.21b - Site Conditions Sub-Menu

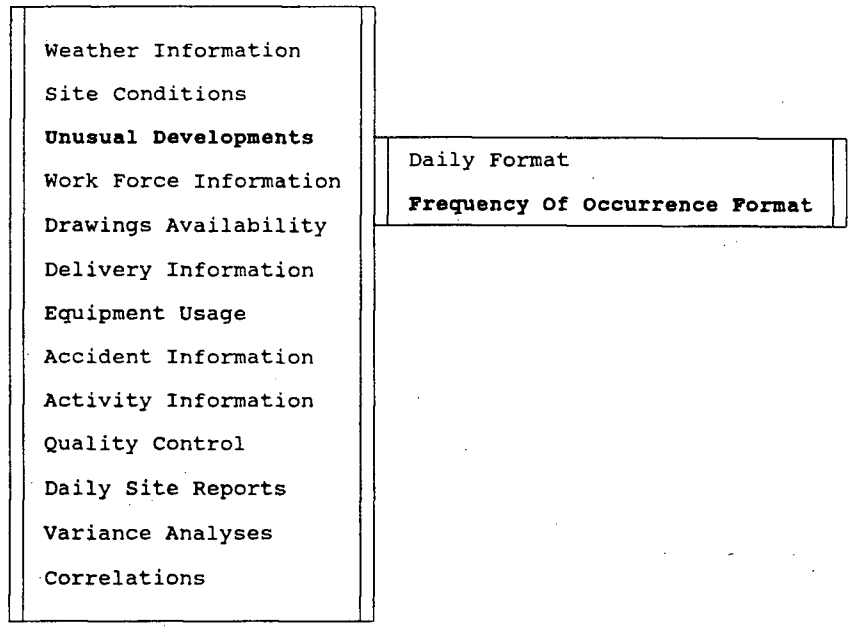

Figure 4.21c - Unusual Developments Sub-Menu

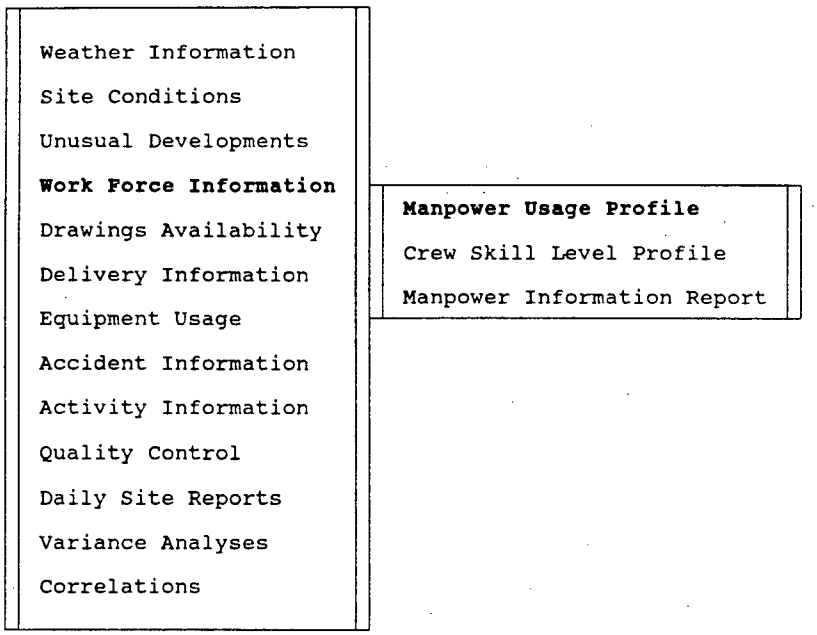

Figure 4.21d - Work Force Information Sub-Menu

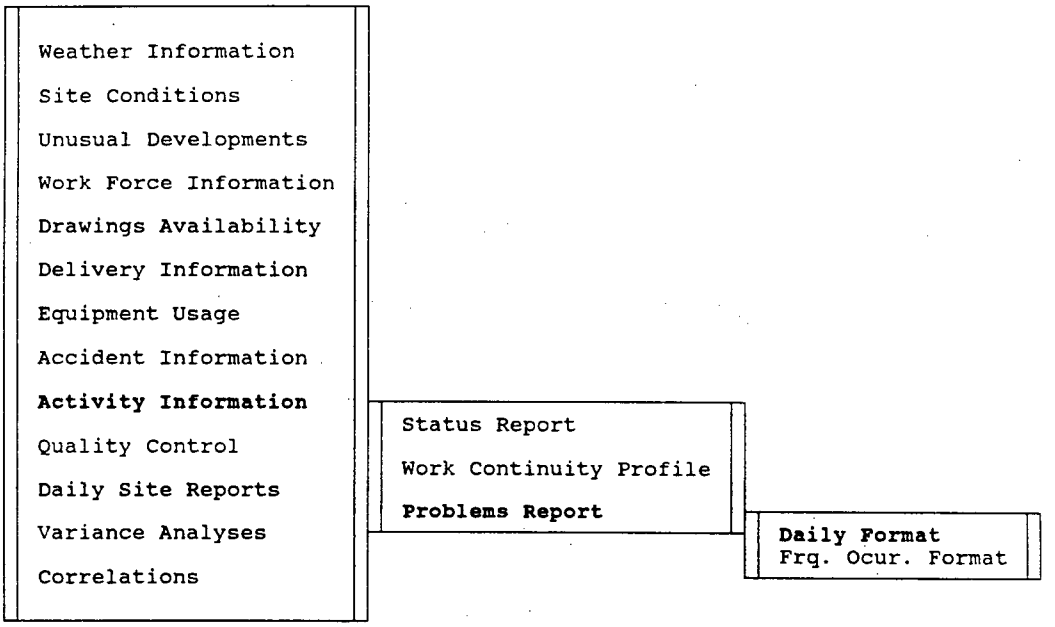

Figure 4.21e - Activity Information Sub-Menus

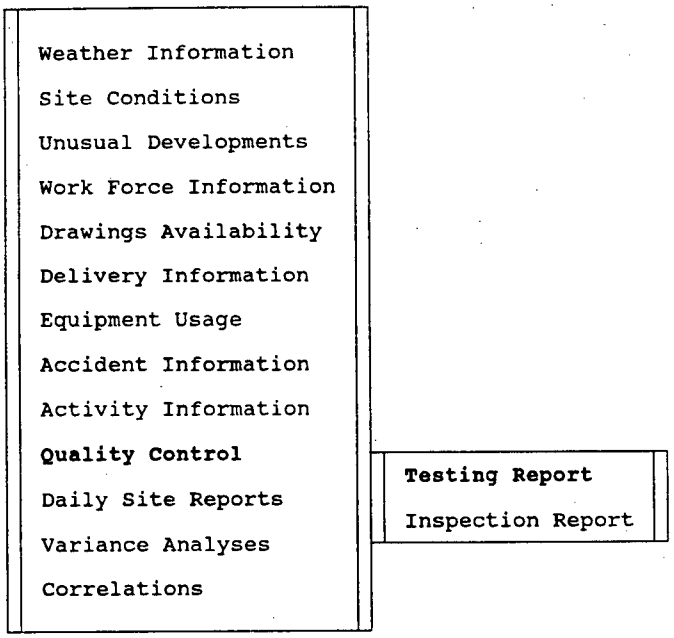

Figure 4.21f - Quality Control Sub-Menu

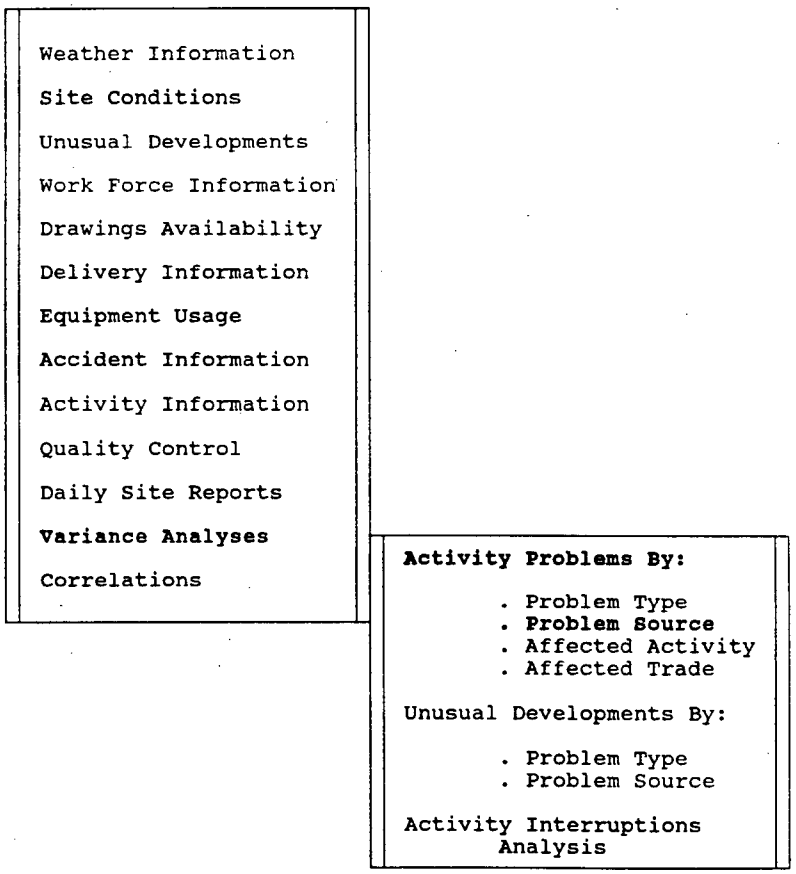

Figure 4.21g - Variance Analyses Sub-Menu

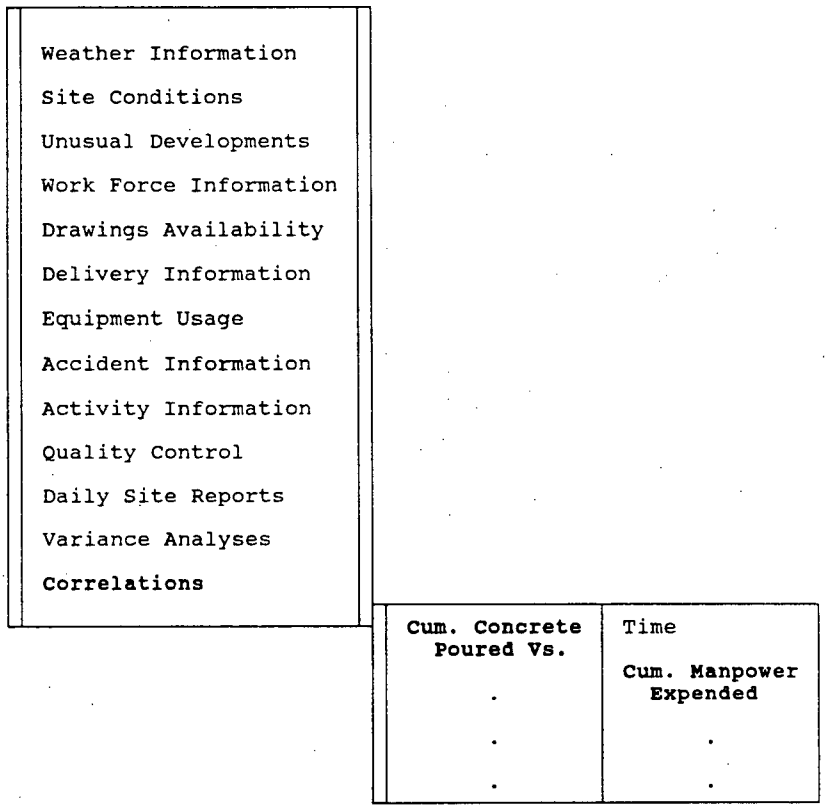

Figure 4.21h - Correlations Sub-Menu

Specification Questions

If daily site information from multiple projects are stored in the same database, the first specification question would always be: **"For which project?"**. The system can facilitate project selection by providing a project directory.

For Weather Information, Site Conditions, Unusual Developments, and Variance Analyses, the subsequent and final question would be: **"For what time span?"**. Date entries may be solicited in the format: **"From ___/___/___ to ___/___/___"**. If only one date is entered, only information for that particular day is generated.

For Work Force Information, Drawings Availability, and Accident Information, an additional question, **"For which trade?"**, should be posed prior to the final request regarding time span. Again, this entry should be expedited with a list of trades to select from. This list should be limited to the trades on file for the specified project.

For Delivery Information, yet another specification can be requested. **"Material Description"** should be solicited between the trade and time span requests. Similarly, **"Equipment Description"** should be provided for Equipment Usage. The system should present a list of equipment items

from the specified project for the user to choose from.

For Activity Information and Quality Control, the specification questions should be as follows: **"For which project?"**, **"For which trade?"**, **"For what time span?"**, and **"For which activity?"**. By indicating the trade and the time span first, the system can display the shortest list of activities for selection.

In order to retrieve the Daily Site Report, the user only needs to specify the **Project** and the **Date.**

Finally, a Correlation output is selected with regard to its **Project, Time Span**, and **Problem Types.**

The specifications that are required to isolate and generate each specific output are shown in Tables 4.1a and 4.1b. For example, according to Table 4.1a, the system would prompt the user to enter the following information in order to retrieve the sample Testing Report in Figure 4.12b:

1) For which project? ===> **2020 HIGHBURY;**
2) For which trade? ===> **GENERAL CONTRACTOR;**
3) For what time span? ===> From **06/01/88** to **08/16/88;** and
4) For which activity? ===> **F&P EXT WALLS/COLS: PARKADE + INT. WALLS.**

Output	Proj	Trade	Material Descrptn	Eqipment Descrptn	Time Span	Activity	Date
Weather Information							
- Temp. Profile	X				X		
- Precip. Profile							
. Rain	X				X		
. Snow	X				X		
- Wind Profile	X				X		
Site Conditions							
- Grd. Conds. Profile	X				X		
- Storage On Site Profile	X				X		
- Access To Site Profile	X				X		
- Site Conds. Report	X				X		
Unusual Developments							
- Daily Format	X				X		
- Frq. Ocur. Format	X				X		
Work Force Information							
- Manpower Usage Profile	X	X			X		
- Crew Skill Level Prof.	X	X			X		
- Manpower Info. Report	X	X			X		
Drawings Availab'lty Report	X	X			X		
Material Delivery Report	X	X	X		X		
Equipment Usage Profile	X	X		X	X		
Accident Information Report	X	X			X		
Activity Information							
- Status Report	X	X			X	X	
- Work Continuity Profile	X	X			X	X	
- Problems Report							
. Daily Format	X	X			X	X	
. Frq. Ocur. Format	X	X			X	X	
Quality Control							
- Testing Report	X	X			X	X	
- Inspection Report	X	X			X	X	
Daily Site Report	X						X

Table 4.1a - Output Specifications 1

Output	Project	Time Span	Problem Types
Variance Analyses			
- Activity Problems By:			
. Problem Type	X	X	
. Problem Source	X	X	
. Affected Activity	X	X	
. Affected Trade	X	X	
- Unusual Developments By:			
. Problem Type	X	X	
. Problem Source	X	X	
- Activity Interruptions Analysis	X	X	
Correlations			
- Cum. Concrete Poured Vs. Cum. Manpower Expended	X	X	X
- Cum. Concrete Poured Vs. Time	X	X	X

Table 4.1b - Output Specifications 2

5.0 IMPLEMENTATION

5.1 ATTITUDE OF MANAGEMENT AND SITE PERSONNEL

As expected, J. C. Scott Construction agreed to this research without hesitation. In fact, the company has been benefiting from Dr. Russell's computerized scheduling [30] over the past few years; thus, it should perceive this research as another potential benefit to the firm. Invariably, it could receive increased job control without providing additional resources on site.

Motivating the site superintendent to cooperate with the research was a much more difficult and sensitive task. A project manager of the company had said that traditionally, the superintendent is simply handed the site and asked to build the structure. That is, superintendents are not told how to run their jobs. Therefore, it became necessary to clearly explain to Highbury's superintendent that I was not working for the company, and that he would not have to worry about me being there to report on his performance to senior management. J. C. Scott Construction's management then confirmed my claim by asking the superintendent to cooperate on the basis of helping a student complete his thesis.

5.2 MANUAL DATA COLLECTION

So far only the first phase of manual data collection has been discussed. However, due to J. C. Scott Construction's increasing interest in improved daily site reporting, a second phase of manual data collection was conceived during the course of this study.

5.2.1 THE FIRST PHASE - PERSONAL EXPERIENCE

The first phase of manual data collection ran from June 1, 1988 to August 16, 1988. Prior to June 1, a site meeting was set up with the superintendent, a management representative, Dr. Russell, and myself. The purpose of this meeting was to formally introduce the research to the superintendent and to seek his cooperation.

The superintendent, Mr. X, had been a subject of computer scheduling research on his previous job with the company. Therefore, he was used to having to periodically "entertain" researchers on site. And since we were prepared to be very flexible and only update whenever it was convenient for him, he agreed to cooperate. Mr. X felt that right after lunch at 12:30 pm would be the best time to conduct the site reporting because of these reasons:

. Instead of having to interrupt his work to do the

reporting, he could just spend a few extra minutes in the site office before going out into the field again for the afternoon.

. By early afternoon, he should have a fairly good idea of the progress of the day; and thus, he should be able to answer most of the questions on the forms. Any information that was overlooked could be captured on the following day.

Based on the above conditions, the first phase of manual data collection was officially launched on June 1.

Mr. X turned out to be extremely cooperative and helpful. On the first day, he showed me what information he usually collects in his own daily job log (all of which is already covered in my forms with the exception of equipment control) and told me how important it is to keep such a diary for legal purposes. Apparently he had been involved in a construction legal dispute in the past. As I got to know him better, he became more and more talkative. In addition to daily site reporting, he would tell me about some of his past jobs, explain activity sequencing, etc.. But most important of all, he was willing to admit his own mistakes (as shown in Figure 4.6b). This honesty could be vital to the accurate representation of activity problems. Unfortunately, Mr. X took a leave of absence on June 16. The project manager, Mr. Y, took over the job.

Prior to Mr. X leaving, I had met Mr. Y on site and he was introduced to the daily site report forms then. On his first day, Mr. Y recommended a couple of useful improvements

to my system. He said that I should ask for the corresponding activity information right after the work force information because he would like to deal with each trade only once (if we were to update all of the work force information first and all of the activity information second, then we would be going through the trades twice). For the Work Force Information form, he also suggested that "Sufficient (Manpower) to Meet Schedule" should be changed to "Sufficient (Manpower) to Meet Job Conditions".

The daily reporting sessions with Mr. Y were usually rather brief. He would not tell me anything unless I asked for it explicitly. In fact, the actual reporting time (not including interruptions such as telephone calls, visitors, etc.) was never longer than fifteen minutes. On days when he was very busy, I would just hang around the site until he was free or would ask for the information while following him around the site. Sometimes, I would have to spend more than two hours on site in order to get the information that I need. On occasion, he even asked me to fill in the information myself; and, he would check it the following day. But what I usually wound up doing was to let the foreman confirm the information at the end of the day. And, since I was recording job progress with a video camera everyday (short five-minute takes), I was also able to use the tape for missing data and data confirmation.

Actually, Mr. Y told me why he did not like to fill out daily site reports (including J. C. Scott Construction's own version). He felt that "paperwork, in general, do not improve job efficiency". As for the "Reasons for Unsatisfactory Rate of Production" list on the Activity Information Form, he said that he and most other site superintendents (especially younger guys who are planning to keep their job for a while) would not tell me anything that could be used against themselves. He concluded by saying that effective site management is really knowing how to deal with people.

Nevertheless, the variance analyses in section 4.3.5 show that the daily site report (of section 2.2) did capture a fair number of problems during the course of this research. However, in order to determine the accuracy and comprehensiveness of these problem descriptions, one would have make **estimated** versus **recorded** comparisons on time lost and man-hours lost. The estimated values are simply the totals found in Figures 4.8 and 4.9. Whereas the recorded values would have to be derived from the Scheduling System (actual vs. planned durations) and the Cost Control System (actual vs. planned manpower expenditure).

In general, both superintendents seemed to be more comfortable with providing qualitative responses over quantitative ones. A possible explanation for this

behaviour is that they could be worry about senior management holding them to the estimated quantities.

5.2.2 THE SECOND PHASE

Implementation of the second phase of manual data collection began in late December, 1988. The main difference between the first phase and the second phase is that the latter arose from the company's interest in this tool. After reviewing some of the sample outputs (from section 4.3), the company's project management realized the potential of such a system. They then urged Dr. Russell and myself to design a new form, preferably only one page in length, for actual site implementation.

The project managers would be responsible for selling this form to their superintendents who would be completing the daily site report as a standard company form. Therefore, simplicity and length were the two most important considerations in the design of this form. We were told that the information requested had to be very straight forward and free of cross-referencing. Also, the length of the form should be minimized because the superintendents do not like paperwork in general, and the time required to fill out such a form may mean time lost for supervision.

After two formal meetings and several discussions with

the project managers, a new daily site report form was designed for site implementation (see Figure 5.1). The information requested by this form includes most, many of the items discussed in section 2.2. The major difference is its **PROBLEM SOURCE CODES.** Instead of classifying activity problems by type as in Figure 2.4, the project managers felt that the first thing they would like to know is where the problems are coming from. This led to classification by problem sources (eg. weather, site conditions, owner, etc.).

As for the method of data input, the company plans to adopt **The Basic 2-Stage System** (as discussed in section 3.4.1) whereby the project managers will be doing the actual data input into the computer. Since this system will be used on at least four of the company's current high-rise projects, a substantial database could be built up fairly quickly. Then, correlation analyses and variance analysis interpretation should be carried out.

5.3 COMPUTERIZED DATA COLLECTION

Two of J. C. Scott Construction's superintendents were interviewed with regard to using a computer in the site office. Mr. X, the original superintendent on 2020 Highbury, agreed that, eventually, there will be a computer on every construction site as a management aid. Mr. Z, a

YOUR CONSTRUCTION COMPANY LTD.

REPCON SAMPLE HIGHRISE PROJECT

REPCON™

DAILY SITE REPORT - FRIDAY, 30 DEC 88

Report Date : 1989-04-11
File Used : C:\VERSION1\PROJ03\SAMPLE
Progress As Of : 1988-06-30
Revision Number : 0

Superintendent:

Please sign : _____

WORK ENVIRONMENT DATA

Weather Conditions :

a) (AM) : Clear [ ] Cloudy [ ] Rain [ ] Snow [ ]
b) (PM) : Clear [ ] Cloudy [ ] Rain [ ] Snow [ ]
c) Temperature : High _____C Low _____C
d) Precipitation : _____mm
e) Wind : _____kph

Site Conditions :

f) Ground conditions : Poor [ ] Fair [ ] Good [ ]
g) Storage on site : Poor [ ] Fair [ ] Good [ ]
h) Access to site : Poor [ ] Fair [ ] Good [ ]

Comments : _____

OTHER

	ACT CODE
i) Inspections and Tests : _____	
j) Visitors : _____	
k) Accidents : _____	
l) Deliveries : Concrete _____cubic metres	
m) Site Instructions : _____	

Comments : _____

WORK FORCE DATA

IRC Trade	Supervision # (n)	Supervision Skill (o)	Tradesmen # (p)	Tradesmen Suff (q)	Tradesmen Skill (r)	Tradesmen T/O (s)
G GENERAL CONTRAC		NA				
04 REINFORCING STE						
09 ROOFING						
10 PRECAST CONCRET						
11 WINDOWS AND EXT						
12 DRYWALL						
15 MECHANICAL (PLU						
16 ELECTRICAL						

Comments : _____

WORK PROGRESS AND PROBLEMS

TRADE / ACTIVITY	LOCATION STATUS (F,I,O,P,S)	PROBLEM & RESP CODES (PC-RC) (SEE CODES BELOW)	REMARKS RE INSPECTIONS, DELIVERIES AND PROBLEMS	PROBLEM RESULTS TIME LOST MH-HRS	TIME LOST DAYS	ACTION CODE
G GENERAL CONTRACTOR - YOUR CONSTRUCTION COMPANY LTD						
G251SW FORM & POUR PLANTERS/WALLS	SW					
04 REINFORCING STEEL - ART'S REINFORCING						
0426SW REINFORCE PLANTERS/WALLS	SW					
09 ROOFING - WATER-TITE INC.						
0921RF INSTALL ROOFING	RF					
10 PRECAST CONCRETE - CONFORCE PRECASTERS						
100100 INSTALL PRECAST PANELS	MN					
11 WINDOWS AND EXTERIOR DOORS - CLEAR-SIGHT INC.						
110100 INSTALL WINDOWS & DOORS	7					
12 DRYWALL - RELIABLE DRYWALL						
120100 INSTALL STEEL STUDDING	5					
15 MECHANICAL (PLUMBING,VENTILATION) - SMITH & JONES MECHANICAL						
150100 ROUGH-IN SPRINKLER SYSTEM	8					
150200 ROUGH-IN VENTILATION SYSTEM	10					
16 ELECTRICAL - LIGHTNING ELECTRICAL INC.						
160200 ELECTRICAL ROUGH-IN	3					
**** OTHER ACTIVITIES**						

ACTIVITY STATUS CODES	PROBLEM CODES (PC) WEATHER	SITE CONDITIONS	OWNER	CONSULTANTS	GC/SUBTRADES	SUPPLIERS	UTILITIES/CITY	ACTION CODES
F = Finished	(10) Temperature	(20) Ground	(30) Decisions	(40) Drawings	(50) Manpower	(60) Deliveries	(70) Permits	(1) Telephone
I = Idle	(11) Precipitation	(21) Storage	(31) Changes	(41) Decisions	(51) Workmanship	(61) Quality	(71) Connections	(2) Letter
O = On-going	(12) Wind	(22) Access		(42) Changes	(52) Materials	(62) Amount	(72) Inspections	(3) Memo
P = Postponed				(43) Inspections	(53) Management		(73) Tests	(4) Backcharge
S = Started				(44) Tests	(54) Tools/Equipment			(5) Extra Work Order
				(45) Error	(55) Error			

Figure 5.1 - Sample Daily Site Report for the Second Phase of Manual Data Collection

superintendent on one of the jobs in the second phase of manual data collection, was also very positive about the possibility of using a computerized daily site reporting system. He said that if he is given sufficient training (he even suggested night courses), he would be willing to operate a computer in his site office. He added that **help menus** should be available because he often forgets the built-in functions of the keys.

In light of these favourable comments, it is interesting to note that Mr. X is in his mid fifties and Mr. Z is already in his early sixties. This simply shows that computer technology, if introduced gradually, is not always overwhelming to the older generation (and possibly computer illiterate) superintendents.

5.4 FEEDBACK ON OUTPUTS FROM PROJECT MANAGEMENT

5.4.1 FEEDBACK FROM THE FIRST PHASE OF MANUAL DATA COLLECTION

As mentioned in section 5.3, the results of the first phase of manual data collection have already been reviewed by the project management of J. C. Scott Construction.

From the precipitation profile, the project manager realized that the project received an unusually high amount

of rain for that time of the year. As a result, they proceeded with acquiring actual weather reports from the weather bureau for time extension claims from the owner.

In addition, the project manager noticed that actual ground conditions were worse than indicated by the ground conditions profile. This brought up one major shortcoming of the proposed system. Anywhere qualitative subjective ratings are required, inconsistency is bound to show up at one time or another. Similarly, the general contractor crew skill level was also thought to be worse than indicated by the output profile. However, this misrepresentation could be partly due to the superintendent's reluctance to rate his own work force in order to avoid labour conflicts on site and in the future. In fact, during the second project management meeting for the implementation of the second phase of manual data collection, a project manager said that superintendents have a tendency to hold back on what they say. One of the firm's superintendents actually told his project manager that he did not want to rate his foreman. He added that if the foreman is not up to par, they would settle it between the two of them.

Thus, a more robust method of capturing subjectively rated responses must be found. Namely, there is a need to categorize such information items (as site conditions, crew skill level, quality and detailing of drawings, rate of

production at the activity level, and quality of work) for more quantitative assessment. Dr. Russell proposed a solution that is currently being tested in the second phase of manual data collection. By soliciting entries for estimated time lost and man-hours lost for all possible problem sources at the activity level, quantitative consequences of problems that were subjectively rated before could now be established as well (refer to **PROBLEM SOURCE CODES** in Figure 5.1). Then, for example, the superintendent could not possibly give consistently good skill ratings for his men and at the same time have slow rates of production (time lost) for their activities if no other problems were encountered. At any rate, calibration of subjective responses should be further investigated.

5.4.2 FEEDBACK FROM THE SECOND PHASE OF MANUAL DATA COLLECTION

At this stage of the second phase of manual data collection, only a couple of weeks of data have been collected. Nevertheless, one project manager insisted that sample outputs for each project must be prepared for the respective superintendents in order to keep them motivated on this subject of daily site reporting. He said that it is very important to let the superintendents know that what they have been diligently filling out is being looked at and analyzed by management.

Since a refined DSRS is not yet available at this time, a possible temporary solution is to set up a similar dBASE system as the one used for this thesis on J. C. Scott Construction's computer network to perform the aforementioned data processing.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The five thesis objectives outlined in section 1.1 have all been fulfilled in the course of this research:

1) Important construction information that can be reasonably collected on a daily basis was identified and justified for the proposed daily site report by studying a number of the present daily site reports used in the industry and with input from the project managers and superintendents of J. C. Scott Construction;

2) Two sets of short and concise daily report forms were designed for field testing: a 3-form report (see Figures 4.15bi, 2.3, and 4.14bii) and a 1-page report (see Figure 5.1);

3) Two phases of manual data collection were implemented for testing the daily report forms and gathering information for data analyses. In the first phase, I solicited daily site information from the superintendent and entered the data into the 3-form report. In the second phase, the superintendents filled out the 1-page report directly;

4) Chapter 3.0 presents a framework for the Data Collection System. Special attention was given to ascertain the most efficient data organization scheme (a combination of the two data storage schemes shown in Figure 3.1) and the most appropriate method of data input (Direct Computer Input). A prototype implementation was programmed on dBASE III PLUS to evaluate some of the proposed features of the system and to facilitate data analyses. Once a custom interface is written, the DSRS could automatically update the computerized Scheduling System if the two share the same activity

and responsibility coding systems; and

5) Chapter 4.0 gives an overview of the Data Reporting System. Sample outputs were generated with the data collected from the first phase of manual data collection. Both text and graphical outputs are utilized for straight data echoing and processed information. The outputs are presented in three different formats: Daily, Time Series, and Frequency of Occurrence. At this time, a prototype Data Reporting System has not been programmed. Most of the outputs were obtained from dBASE III PLUS and Lotus 1-2-3 (where the data in the latter were imported from the former via a built-in dBASE III PLUS function).

However, in its present form, the need for few improvements was revealed:

1) Responses could be better structured and standardized. For example, the Data Collection System should have built-in standard menus of weather descriptions, trades, delivery items, construction equipment, activities, inspections, and tests to facilitate data entry. Similarly, the Data Reporting System would benefit from menus of projects, trades, delivery items, construction equipment, activities, and problem types;

2) Subjective problem ratings should be modified into quantitative entries as much as possible; namely, site conditions (access, storage, and ground conditions), trade skill level and manpower level, availability and quality of drawings, and quality of work performed. Otherwise, subjective responses should be calibrated for more consistent and accurate ratings; and

3) Performance indicators must be established for subtrades in order to postulate correlations between their performances and job problems. Simplified versions (so that they can be implemented on a daily basis) of some of Figure 4.19's methods available for measuring quantities might be suitable.

Even though the ultimate goal of the DSRS is to do away with written reports and work directly with the computer,

manual data collection should not be completely ruled out at this time because it is not yet an industry norm to have a site computer. Thus, Figure 6.1 presents a complete picture of the DSRS under two possible methods of data collection.

In addition, the data collected in this study could be used to generate an as-built activity breakdown and sequencing for the project (see Figure 6.2). This information would be valuable to both contractors and researchers. Firstly, short duration activities that were not included as part of the schedule could be picked up by the daily report, thus enabling the scheduler to better scope the next similar job. Secondly, this information could be inserted into the database of an expert system for high-rise construction scheduling.

6.2 RECOMMENDATIONS FOR FURTHER RESEARCH

An immediate task that should follow this research is to analyze the data collected from the second phase of manual data collection. Aside from the various straight data echoing reports and variance analysis outputs, it might be possible to establish some correlations and critical control values (eg. indices to act as early warning indicators for signifying specific problems) given the substantial size of the new database. Efforts should first be spent on the identification of more performance

Method of Data Collection	Field Tasks	Office Tasks
Manual Data Collection (without a computer on site)	1) Superintendent files daily site report on paper (either the 3-form report of Figs. 4.15bi, 2.3, & 4.14bii OR the 1-page report in Fig. 5.1).	2) Field data is entered into the Computerized Data Collection System. 3) Outputs are retrieved from the Computerized Data Reporting System.
Computerized Data Collection (with a computer on site)	1) Superintendent enters daily site report information directly into the Computerized Data Collection System. 2) The system automatically generates a hard copy of the daily site report for the superintendent to verify.	3) Outputs are retrieved from the Computerized Data Reporting System.

Figure 6.1 - A Complete Picture of the DSRS

Page No. 1
04/21/89

J. C. SCOTT CONSTRUCTION
ACTIVITY BREAKDOWN AND SEQUENCING

2020 HIGHBURY - FROM 06/01/88 TO 08/18/88

Activity Start Date	Trade	Activity Code	Activity Description
06/01/88	GENERAL CONTRACTOR	G220FN	F&P CORE FOOTING
06/01/88	UNITED REINFORCING	0322FN	REINFORCE COLUMN FTGS/PILECAPS
06/01/88	CAMPBELL CARTAGE	0124FN	EXCAVATE CORE FOOTING
06/01/88	NIGHTINGALE ELECTRICIAN	163100	TEMPORARY POWER
06/02/88	UNITED REINFORCING	0323FN	REINFORCE CRANE FTG/ANCH BOLTS
06/06/88	GENERAL CONTRACTOR	G225FN	F&P STRIP FOOTINGS
06/07/88	GENERAL CONTRACTOR	G302PK	F&P EXT WALLS/COLS: PARKADE
06/07/88	UNITED REINFORCING	0326FN	REINFORCE STRIP FOOTINGS
06/07/88	UNITED REINFORCING	0324FN	REINFORCE CORE FOOTING
06/08/88	GENERAL CONTRACTOR	G303PK	BACKFILL/GRADING
06/10/88	NORTHERN WEST ELEVATORS		INSTALL BOLTS FOR ELEVATOR MACHINERY IN CORE
06/10/88	CLAIRMONT PLUMBING		INSTALL PUMP SUMP IN ELEVATOR MACHINE ROOM
06/13/88	GENERAL CONTRACTOR	G230PK	F&P CORE WALLS
06/14/88	GENERAL CONTRACTOR	G308FN	INSTALL CATCH BASIN/PUMP SUMP
06/14/88	UNITED REINFORCING	0325PK	REINFORCE EXT WALLS/COLS:PKDE
06/16/88	COUPAL (CRANE)	212100	ERECT TOWER CRANE
06/17/88	NIGHTINGALE		CRANE POWER
06/21/88	UNITED REINFORCING	0327PK	REINFORCE CORE WALLS
06/22/88	COUPAL		INSTALL WARNING WHISTLE ON CRANE
06/27/88	COUPAL		CHECK CRANE CAPACITY
07/04/88	THRORY WATERPROOFING	1921PK	WATERPROOFING CORE
07/07/88	GENERAL CONTRACTOR	G309FN	DRAIN TILE, U/G PLUMBING
07/12/88	GENERAL CONTRACTOR	G202FN	EXCAV. DRAIN TILES, U/G PLUMB.
07/13/88	CLAIRMONT MECHNICAL LTD.	1521PK	UNDERGRND SERV:STORM/SWGE DRNS
07/14/88	GENERAL CONTRACTOR		F&P SUSPENDED SLAB IN ELEVATOR PIT
07/21/88	UNITED REINFORCING		REINFORCE SUSPENDED SLAB IN ELEVATOR PIT
07/27/88	GENERAL CONTRACTOR		F&P CORE WALLS + WING WALLS: PKDE
07/27/88	GENERAL CONTRACTOR		INSTALL CROSSING GRATE SUMP
07/28/88	GENERAL CONTRACTOR	G304PK	F&P SLAB ON GRADE
07/29/88	UNITED REINFORCING		REINFORCE CORE WALLS + WING WALLS: PKDE
08/03/88	UNITED REINFORCING		REINFORCE SLAB ON GRADE
08/08/88	GENERAL CONTRACTOR	G305MN	F&P MAIN FLR. SLAB
08/11/88	GENERAL CONTRACTOR		EXCAVATE SLAB THICKENING (DIVIDER BEAMS)
08/11/88	NIGHTINGALE		ELECT. S.O.G. U/G

Figure 6.2 - Activity Breakdown and Sequencing

indicators and other significant variables that are suitable for such analyses. Then regression techniques such as the least-squares method could be employed to construct appropriate correlation models.

So far, only manual data collection has been implemented. But as mentioned earlier, the ultimate goal is to be able to directly input the daily information into the computer on site. This would require cooperation from the field personnel. The prototype Data Collection System in dBASE III PLUS should be adequate for trial implementation because it does not rely on having to be interfaced with a Scheduling System. However, this also means that the computer schedule would not be automatically updated. Complete interfacing with a computerized Scheduling System should, therefore, be on the agenda for future research.

In addition, standard company and industry forms such as the daily time sheet and the Workers' Compensation Board's accident report form could be programmed into the Data Collection System.

Future research should also include a prototype Data Reporting System that is able to produce both text and graphical outputs. The system should have a built-in statistical analysis capability for correlation analyses. Moreover, a user manual should be prepared to accompany the

complete prototype DSRS for field implementation.

As the site computer becomes an industry standard and with the advent of more sophisticated technology (data entry via touch screen terminals, video monitors, voice recognition hardware, OCR scanners, etc.) more comprehensive information may be practically collected by the daily site report. Such features as productivity measurements, drawings control, equipment control, change order control, and integration with the Cost Control System may eventually be considered for the DSRS.

BIBLIOGRAPHY

[1] Abbot, G., Seminar on "Project Control Software", Vancouver, B.C., Mar. 1988.

[2] Alexander, P., Errdman Handbook to the Bible, Errdmans Publishing Co., 1973, pp. 153-154.

[3] Baran, N., "dBASE IV: A Paradox Killer?", Byte, McGraw-Hill, Inc., Peterborough, NH., Apr. 1988, pp. 113-114.

[4] Barrie, D.S. and Paulson, B.C., Professional Construction Management, McGraw-Hill, Inc., 2nd ed., New York, 1984.

[5] Borcherding, J.D. and Garner, D.F., "Work Force Motivation and Productivity on Large Jobs", Journal of the Construction Division, ASCE, Vol. 107, No. CO3, Sept. 1981, pp. 443-453.

[6] Brewster, C., Daily Site Reporting System (SRS), CE 520, The University of British Columbia, Apr. 1986.

[7] Chang, L.M. and Borcherding, J.D., "Craftsman Questionnaire Sampling", Journal of Construction Engineering, ASCE, Vol. 112, No. 4, Dec. 1986, pp. 543-556.

[8] Chong, C.L. and Kung, H.S., Computerized Site Reporting System Using Symphony, CE 520, The University of British Columbia, Apr. 1986.

[9] Diekmann, J.E. and Nelson, M.C., "Construction Claims: Frequency and Severity", Journal of Construction Engineering and Management, ASCE, Vol. 111, No. 1, Mar. 1985, pp. 74-81.

[10] Guevara, J.M., Boyer, L.T., "Communication Problems Within Construction", Journal of Construction Division, ASCE, Vol. 107, No. CO4, Dec. 1981, pp. 551-557.

[11] Guiltinan, J.P., "Contractor Motivations, Constraints and Decision Making Patterns: Implications for Project Management", A Decade of Project Management: Selected Readings from the Project Management Quarterly 1970 through 1980, PMI Publications, Drexel Hill, PA., 1981, pp. 324-329.

[12] Hawkes, R., Daily Site Reports, CE 520, The

University of British Columbia, Apr. 1988.

[13] Hoffman, T.F., Daily Site Reporting System, CE 520, The University of British Columbia, Apr. 1986.

[14] Hohns, H.M., "Effects of Management on Productivity in Construction", A Decade of Project Management: Selected Readings from the Project Management Quarterly 1970 through 1980, PMI Publications, Drexel Hill, PA., 1981, pp. 356-357.

[15] Jaafari, A. and Mateffy, V.K., "Games People Play with Cost Control in Australia", Journal of Construction Engineering, ASCE, Vol. 112, No. 4, Dec. 1986, pp. 566-581.

[16] Jaeggle, B., Superintendent/Project Manager, J. C. Scott Construction Ltd., Interview with Author, Vancouver, B.C., June 17, 1988.

[17] Johnson, E. and Nenninger, F., Specification for a Computerized Contract Administration Information System, CE 520, The University of British Columbia, Apr. 1984.

[18] Kallros, M. and Fagerstrom, G., Design of a Computerized Daily Site Reporting and Analysis System, CE 520, The University of British Columbia, Apr. 1986.

[19] Klein, G., Superintendent, J. C. Scott Construction Ltd., Interview with Author, Vancouver, B.C., June 1, 1988.

[20] Kraiem, Z.M. and Diekmann, J.E., "Representing Construction Contract Legal Knowledge", Journal of Computing in Civil Engineering, ASCE, Vol. 2, No. 2, Apr. 1988, pp. 202-211.

[21] Leblond, G.T. and Cobb, D.F., Using 1-2-3, Que Corp., Indianapolis, 1983.

[22] Lester, J.L., "Project Documentation and Management Using Jobsite Microcomputers", ASCE National Convention Proceedings, ASCE, Oct. 1984, pp. 1-7.

[23] Louie, D.T., Research Engineer, City of Vancouver Engineering, Interview with Author, Vancouver, B.C., July 8, 1988.

[24] Marr, L. and Wang, H., Daily Site Reporting: A Micro Computer System, CE 520, The University of British Columbia, Apr. 1986.

[25] Mason, R.O. and Mitroff, I.I., "A Program for Research on Management Information Systems", Management Science, Vol. 19, No. 5, Jan. 1973, pp. 475-487.

[26] McGowan, N., Lecturer of CE 523: Project Management for Construction, Lecture on "Management Information Systems", The University of British Columbia, Nov. 9, 1987.

[27] Means, R.S., "Administration and Scheduling: Project Administration", Means Forms, R.S. Means Co., Inc., Kingston, MA., 1986.

[28] Monk, R.J., SIRT - "Site Inspection Reporting Tool", CE 520, The University of British Columbia, Apr. 1988.

[29] Neil, J.M., "A Cost Engineering Approach to Bid Preparation", Proceedings of the ASCE Convention & Exposition, Atlanta, Oct. 23-25 1979, ASCE, Oct. 1979, pp. 1-18.

[30] Peer, G.A., "Software Fills the Bill", Heavy Construction News, Maclean Hunter Ltd., Vol. 33, No. 2, Feb. 1989, pp. 18-24.

[31] Peer, S., "An Improved Systematic Activity Sampling Technique for Work Study", Construction Management and Economics, No. 4, 1986, pp. 151-159.

[32] "Project Management at the Calgary 1988 Winter Olympics", Engineering Digest, Canadian Engineering Publications Ltd., Vol. 34, No. 1, Feb. 1988, pp. 18-20.

[33] Revay and Associates Ltd., The Causes and Settlement of Construction Contract Disputes: Claims -- When and How, Revay and Associates Ltd., Ottawa, 1978.

[34] Robinson, R., Micros Go Afield, ASCE, New York, 1985.

[35] Rogge, D.F., "Delay Reporting for Productivity Improvement", Proceedings of the First Northwest Regional Symposium, PMI West Coast B.C. Chapter, Mar. 1984, pp. C.5.1-C.5.25.

[36] Rogge, D.F., "Delay Reporting Within Cost Accounting System", Journal of Construction Engineering and Management, ASCE, Vol. 110, No. 2, June 1984, pp. 289-292.

[37] Russell, A.D. and Triassi, E., "General Contractor

Project Control Practices and MIS", Journal of the Construction Division, ASCE, Vol. 108, No. CO3, Sept. 1982, pp. 419-437.

[38] Russell, A.D., Advanced Planning and Control Technologies for Housing Construction, The University of British Columbia, Mar. 1989, pp. 4.1-4.19.

[39] Schlick, H., "Project Integrated Management System (PRIM)", Journal of the Construction Division, ASCE, Vol. 107, No. CO2, June 1981, pp. 361-372.

[40] Sharad, D., "About Delays, Overruns and Corrective Actions", A Decade of Project Management: Selected Readings from the Project Management Quarterly 1970 through 1980, PMI Publications, Drexel Hill, PA., 1981, pp. 315-319.

[41] Task Committee on Application of Small Computers in Construction of the Construction Division, "Application of Small Computers in Construction", Journal of Construction Engineering and Management, ASCE, Vol. 111, No. 3, Sept. 1985, pp. 173-189.

[42] Tenah, K.A., "Construction Personnel Role and Information Needs", Journal of Construction Engineering and Management, ASCE, Vol. 112, No. 1, Mar. 1986, pp. 33-48.

[43] Thomas, H.R. and Kramer, D.F., The Manual of Construction Productivity Measurement and Performance Evaluation, The Pennsylvania State University, Dec. 1987.

[44] Thomas, H.R., Sanders, S.R. and Horner, R.M.W., Procedures Manual for Collecting Productivity and Related Data of Labor-Intensive Activities on Commercial Construction Projects, The Pennsylvania State University and The University of Dundee, Jan. 1988.

[45] Tse, R. and Yong J., Daily Site Reporting System, The University of British Columbia, Mar. 1988.

[46] Tucker, R.L., Rogge, D.F., Hayes, W.R. and Hendrickson, F.P., "Implementation of Foreman-Delay Surveys", Journal of Construction Division, ASCE, Vol. 108, No. CO4, Dec. 1982, pp. 577-591.

[47] Wawruck, W., Guest Lecturer of CE 523: Project Management for Construction, Lecture on "Human Factors on Project Management", The University of British Columbia, Oct. 19, 1987.

[48] Wilson, R.L., "Prevention and Resolution of Construction Claims", Journal of Construction Division, ASCE, Vol. 108., No. CO3, Sept. 1982, pp. 390-405.

APPENDIX A

DAILY SITE REPORTS PRESENTLY USED IN THE INDUSTRY

DAILY CONSTRUCTION REPORT

JOB NO. 1066

DATE March 28/85

PROJECT 1066

HOURS WORKED AM P

ARCHITECT

WEATHER Showers

TEMPERATURE AM P

CODE NO.	WORK CLASSIFICATION	FOREMEN	CARPENTERS	LABORERS	SUB-CONTR'S	TOTAL MEN
01000	General Conditions					
02120	Site Work: Demolition					
02000	Excavation & Dewatering					
02170	Footings					
	Roads, Walks & Landscaping					
	Caissons & Piling					
02800	Drainage & Utilities					
03000	Formwork					
04000	Concrete: Formwork					
04410	Placing					
	Reinforcing					
	Precast					
04900	Equipment					
05000	Carpentry: Rough					
06000	Carpentry: Finish					
08700	Doors & Windows					
	Glass & Glazing					
09010	Acoustical Ceilings					
09210	Drywall					
09230	Finishes: Lath, Plaster&Stucco					
09260	Electrical					
09280	Conveying Systems/Elevators					
09360	Floor Covering					
09390	Metals: Structural					
	Decks					
	Handrail					
	Miscellaneous & Ornamental					
09490	Insulation					
09610	Mechanical: Plumbing					
	HVAC					
09650	Masonry: Brick & Stone work					
	Block & Tile					
09690	Painting & Wallpapering					
09830	Roofing & Siding					
09940	Tile & Terrazzo					
09970	Waterproofing/Roofing:					
	Furnishings					
	Special Construction					

DESCRIPTION OF WORK

[illegible]

CUTTING [illegible]
[illegible]
WORK. RE [illegible]
ON SAT [illegible] 26/[illegible]
[illegible]
TO [illegible]
[illegible] OUT
[illegible] TO BACKFILL
THIS AREA.
POSSIBLE EXCAVATION EXTRA.

[illegible]
[illegible]
[illegible]

ON SATURDAY [illegible]
AT THE #2 TOWER.
[illegible]
[illegible]
GO DOWN IN [illegible] TO
BACKFILL THIS [illegible]
[illegible]
[illegible].

[illegible]
[illegible]
[illegible] TO [illegible]
[illegible]
THROUGH 2-3 FT [illegible]
[illegible]
TO FINISH [illegible] I ASK.
M. STUBBRICS IF I COULD
[illegible] THIS WORK [illegible]
[illegible]
TO FINISH [illegible] AS HE
[illegible] NOT WORK ON THIS
[illegible]
M STUBBRICS SAID [illegible]
NOTE.
10 TO 20 [illegible] THIS
[illegible]
TO DIG OUT [illegible]
FINISH [illegible] FOR
[illegible].

TEMP. POWER READY
[illegible].

EQUIPMENT AND TOOLS ON PROJECT	NUMBER	DESCRIPTION OF OPERATION	TOTAL HOURS

EQUIPMENT RENTAL-ITEM	TIME IN	TIME OUT	SUPPLIER	REMARKS/RATE

MATERIAL	QUANTITY	QUANTITY TO DATE	SUPPLIER	USE
CONCRETE				
SAND				
GRAVEL				
LUMBER				
EXCAVATION				

CHANGE ORDERS, BACKCHARGES AND/OR EXTRA WORK

VERBAL DISCUSSIONS AND/OR INSTRUCTIONS/ UNUSUAL SITUATIONS

VISITORS TO SITE

JOB REQUIREMENTS / INFORMATION RECEIVED OR REQUIRED

SIGNED

DAILY JOB LOG REPORT

DATE Jan 23/84

JOB:

JOB NO: 83-561

A/E:

LOCATION:

SUPT.: Bill Gower

WEATHER: Rain (Heavy) 29.8mm TEMP: (A.M.) 4°C (P.M.) 5°C

VISITORS: Dave Buchanan & Gordon
Dickie of Const. Agy.

AREAS WORKED: Completed excavation #2 Poured first section of pour see letter to D Mustsaac. Backfill U/S work on reinforced earth walls.

MAN POWER:

SUB:	NO. OF MEN	SUB:	NO. OF MEN
Stephenson	24		
I & W	8		
De Fazio	5		
Valley	3		
Roselli	2		
Ansan	2		

EQUIPMENT: Sterling - 40T Crane — McRae's - Water pump
Barry Ichtemichuk — De Fazio 1-235 Hoe, 2-225 Hors, 10 trucks, 3 rollers,
Valley - 20T Crane — Roselli - 1-120' Concrete Pump

MATERIAL DELIVERIES: Blue & White — Ocean - 35mpa - 15m,
Efco — - 30mpa - 91.6m
Metro Canada Bearing Plate, Const. - Agg - 4-20' Road Base
3 - pump sand & 1 20' Clean crush

NOTES: (PROBLEMS) (DELAYS-BY WHO) (DIRECTIVES - BY WHO) (ACCIDENTS)

#2 excavation. water from ground required 3 24" pumps
D Mustsaac inspector rejected sand see letter to CA
DeFazio on standby all day 2 loads crush gravel.
Call from city not to close Fielding keep open as much as possible.
Heavy rain slowed work down.
Flag persons controlled traffic on the Diversion.

(5)

DAILY JOB DIARY & PROGRESS REPORT

Project: Swan Hills Hospital

Project Number: E F M 0 1 7

Accidents ☐ (See Below) DAY: Thursday 06 MO | 07 DD | YR

Weather: Sunny and Warm High 25 °F °C Low 21 °F °C

Rain/Snow: _____ MM IN Wind: _____ MPH KPH

Visitors: None

Site Working Conditions: ☒ Good ☐ Bad ☐ Unusual (See Below)

Unusual Developments: *(Problems, shortages, delays, etc.)* These developments may cause a delay in your work schedule and increase the cost of completing our work. The development which occurred may not seem unusual to you, but ask yourself, would it be unusual to an outsider.

Work Area & Progress Today:

Note work which is presently in progress. Use a second page if you require more space or additional pages. Do not allow the space provided to limit your report.

Understandings with owners, architects, engineers, inspectors, sub-contractors:

Agreements reached are to be documented as these may have a future effect on your work schedule or quality of work performed.

Other pertinent information:

Each page of your Daily Job Diary is to be signed. This historical account of your project has no value without your signature.

_____

Superintendent

JOB [illegible]E & LOCATION
(stamp)

DAILY [illegible]ORT

DAILY REPORT NO. ______

Day of Week ______ Today's Date ______

Low ______ High ______ Temp. ______

— WEATHER CONDITIONS

RAIN	Describe
SNOW	
FREEZE	
MUDDY	
FAIR	ARCH. NOTIFIED ______

CONTRACT TIME ______ Cal. days ______
OFFICIAL START DATE ______
ORIGINAL COMPL. DATE ______
OFFICIAL C.O. DAYS ______ Cal. days ______

VISITORS:

MATERIAL OR INFORMATION NEEDED:

ACCIDENTS

BACKCHARGES

NAME	AMOUNT	REASONS
	$	
	$	
	$	
	$	
	$	

CONCRETE REPORT

Total Concrete on Job:	cy
Total Concrete as of Last Report:	cy
Total Concrete Poured Today:	cy
Total Concrete Poured to Date:	cy

MASONRY REPORT

Unit	Total Units Required	Total Units Laid Today	Total Units Installed to Date
FACE BRICK	ea	ea	ea
COMMON BRICK	ea	ea	ea
4" BLOCK	ea	ea	ea
6" BLOCK	ea	ea	ea
8" BLOCK	ea	ea	ea
12" BLOCK	ea	ea	ea
HOLL. CLAY TILE	ea	ea	ea
SGT.	ea	ea	ea
	ea	ea	ea
	ea	ea	ea

PRE[illegible]

WORK BY GENERAL CONTRACTOR

CLASS	No. of Men	DESCRIBE TODAYS WORK (BRIEFLY)
FOREMEN:	ea.	
CARPENTERS	ea.	
LABORERS	ea.	
OPERATORS	ea.	
	ea.	
	ea.	
	ea.	

WORK BY SUBCONTRACTORS

Name of Subcontractor	No. of Men	Describe Today's work (Briefly)
PLBG.	ea	
H.A.C.V.	ea	
ELECT.	ea	
	ea	
	ea	
	ea	
	ea	
	ea	
	ea	
	ea	
	ea	
	ea	
	ea	
	ea	
	ea	
	ea	

LABOR DIST.

CODE NO.	MONEY SPENT
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
	$
TOTAL	$

SUPT.: ______

EQUIPMENT REPORT
Use (R) for Rented

ITEM	No. on Job
VIBRATORS	ea
TROWEL MACHINES	ea
GRINDERS	ea
SKILL SAWS	ea
DRILLS	ea
BUCK HOIST	ea
DUMP TRUCK	ea
CRANE	ea
WELDING MACH.	ea
COMPRESSORS	ea
LEVELS	ea
TRANSIT	ea
TAMPS	ea
WATER PUMPS	ea
FARM TRACTOR	ea
FARM WAGONS	ea
DEWALT SAW	ea

JOB STATUS REPORT (WEEKLY)

DESCRIPTION	% Complete
GRADING	%
SUPERSTRUCT.	%
EXTERIOR WALLS	%
INTERIOR WALLS	%
ROOFING	%
GLAZING	%
MECH.	%
ELECT.	%
	%
	%

APPENDIX B

THE INFORMATION RETRIEVAL SYSTEM

(CITY OF VANCOUVER'S ENGINEERING DEPARTMENT)

ENGINEERING TECHNICIANS' MANUAL
STREETS AND LANES CONDITION FIELD SURVEY

The Streets and Lanes Condition Field Survey is made once a year by Engineering Technicians from the Materials Branch. Each Technician taking part in the survey is responsible for walking all streets and lanes in a particular area of the City, and recording the conditions they observe on an inventory update sheet. In this way data is updated annually on the condition of every roadway, curb, sidewalk, boulevard, shoulder, and lane on City right-of-way.

The data collected is used by the Streets Division for two main purposes:

1. To establish, estimate and prioritize next year's street maintenance program.

2. To promptly repair unsafe conditions.

An additional function of the data is to provide a historical record for legal claims against the City resulting from alleged street or lane hazards.

1. General

"Streets Inventory Field Update" sheets record the results of last year's survey in the top row of each set of boxes (printed by computer). These sheets are designed so that all items checked in the field for lanes and streets can be recorded on one sheet. Sheets are sorted into the east-west and north-south streets within each sub-district, and are numbered in sequence in the upper right-hand corner. Books, each containing one sub-district, are issued one at a time to each Technician. On completion of a book of these sheets it is returned, signed in, and another book is issued in order of priority. (Specific districts must be completed before December so estimates can be made for next year's street maintenance program).

Each "Streets Inventory Field Update" sheet may cover more than one "postal" hundred block segment of street. The extent of the information on any sheet is from intersection to intersection and considers address changes only by showing the hundred block range in the identification line at top of the sheet (example: 32-34 East Broadway).

In addition to completing the "Streets Inventory Field Update" sheets, Technicians must record and hand out notices for shrubs, branches, hedges, and foliage which encroaches onto pedestrian pathways (see Figure 2-blank notice). Allowance should be made for a tall pedestrian (approximately 7 feet vertical clearance), and for branches that may sag when wet. Encroaching hedges should be trimmed at least 1' clear from the edge of sidewalks.

2. Use of the "Streets Inventory Field Update" Sheet

2.A. Explanation of General information.

1) For each sheet the Technician's name and the date of the inspection must be printed in the spaces provided in the upper right corner.

2) If a digit appears after the "Coords" (co-ordinates) code in the box labelled "Side", it determines which roadway of a divided street the card refers to. A "1" in this location indicates the north or west roadway. A "2" indicates the south or east roadway. All undivided streets should have a "0" in this box.

3) The "Blk" (block), "Dir" (direction), "On Street" box indicates the location of the block by "postal" address. If it is a long block containing more than a single hundred block segment, the sheet will show the multiple hundred block notation as previously mentioned.

4) The "At Street" box records the cross street at the north or west end of the block. This reduces the need for constantly referring to the house addresses as the technician rates each block.

5) With the increase in the number of streets and lanes with Asphaltic Concrete (A.C.) Pavements, special care should be taken to assure that the "Surface Type" code is correct. This code is most significant in Streets maintenance budgetting (see Table 1, for a list of the codes).

6) The "Class" box indicates the functional classification of the road (e.g. arterial, residential, etc.). If the code is in error, Technicians should note this in the "Comments" box.

7) An asterisk (*) in any box indicates that the previous rate, type or defect was missing or incorrect and that the Technician should take special note to correct the error.

8) Separate 'change' boxes are provided for changes just below the computer printed rates and defects. The new or revised information is to be entered using red pencil into the boxes provided, without the old or incorrect information being crossed out. If repairs have been completed a defect is deleted by the use of a zero "0" in the appropriate box. It is very important that repaired defects are recorded this way. Any entire item to be deleted (e.g. lane) should have "delete" written through it without changing any of the individual defects for that item.

9) Special note should be made of errors or omissions occurring for items which do not have a 'change' box; simply write the correct information just below the area where the figures should appear. The changes in street type, width, class, co-ordinate, name, blocks, or district will be coded (by others) in the office with an "Office Update" sheet.

10) Roadway surface defects are grouped as "Asphalt Surface", "Concrete Surface", or "Both" (defects are found in both types of surface). Unless a street contains a mix of asphalt and concrete surfaces, entries should only be made under 2 of the 3 groups.

11) There must be either a curb rate or a shoulder rate but not both. There is a possible exception where a divided roadway has a boulevard rate on a center island without curbs.

12) There must always be a type 1, 2, 3, 4, 5 or 6 for sidewalks or boulevards. If the type is a 4 (concrete) there must be a sidewalk rate. For types 1, 2, and 3 there must be a boulevard rate. A boulevard rate may occur with a type 4 and 6 sidewalk.

2.B. Explanation of Defects and Ratings

2.B.1 Location

When recording defect classes, defect extents, and ratings, be sure that you are using the correct update sheet for that location:

Intersections

Intersection information is to be recorded only on the update sheet for the block of street to the west. In cases where there is no street west of an intersection, the intersection is included with the block to the north. (see Figure 1).

Lanes

If the sheet is for a street which has an east-west co-ordinate, the lane to the south which is running the same direction as the street is to be rated on that sheet. A north-south lane must be rated on the sheet for the north-south street to the west.

Two sets of boxes are provided for recording lane information on the update sheet. The first lane south or east of the road is lane No. 1, and should be recorded in the upper set of boxes. The second lane south or east is lane No. 2, and should be recorded in the lower set of boxes. See Figure 1 for an example of lane locations.

Eng.1020 MLH 88

STREETS INVENTORY FIELD UPDATE

INSPECTOR

CC | COORDS | SIDE | BLK | DIR | ON STREET | AT STREET | DIST | PAGE | DATE

01 (1) | (3–8) | (9) | | | | | | | Y Y | M M | D D

COMMENTS : SAMPLE

URGENT

ROADWAY :

ASPHALT SURFACE | BOTH | CONCRETE SURFACE

RATINGS

R (10) — 0-3

TYPE | WIDTH | CLASS | RAVELLING | BLEEDING | SHOVING | RUTTING | ALGTR WT | ALGTR NWT | TRANSVERSE | LONGITUDNL | FRACTURE | POLISHING | FAULTING | COR.CRACK | JNT FAILURE | SLR COND | SETTLING | PITTING | SCALING | CUTS | ADJ. M.H. | ADJ. V.B. | DR. HOLES | POT HOLES | SURF.TREAT. | IRREGULAR | ISLANDS | GRVL LANE | NO ST.CB | RATE 0-9

01 02 03 04 05 06 07 | 08 09 10 11 | 12 13 14 15 16 17 18 19 20 | 21 22 23 24 25 26 27 28 29 30 31 | 32

X (10) — 0-9 — EXTENT :

CURBS

OUT OF LINE | OUT OF ELEV | BROKEN | JOINTS | SCALING | RATE 0-9

33 34 35 36 37 38 | 39

SIDEWALKS

TYPE | TRIPS | OUT OF ELEV | BROKEN | FILLET | SETTLING | CUTS | CROSSING | SCALING | RATE 0-9

40 | 41 42 43 44 45 46 47 48 49 | 50

BLVDS.

ENCROACH | DRAINAGE | S/W APPR | GRD BLVD | RATE 0-9 | TILE

51 52 53 54 55 | 56 | 57

SHOULDERS

GRADE | LANE APPR | ADJ CB | DITCH TILE | NARROW | STEEP | RATE 0-9

58 59 60 61 62 63 64 | 65

0-3 — N. or W. side

0-3 — S. or E. side

66 67 68 69 70 71 | 72 | 73 | 74 75 76 77 78 79 80 81 82 | 83 | 84 85 86 87 88 | 89 | 90 | 91 92 93 94 95 96 97 | 98

LANE :

L (10) — 0-3

TYPE | WIDTH | CRACKING | ALLIGATOR | BLEEDING | RUTTING | SHOVING | RAVELLING | SETTLING | SCALING | JOINTS | CUTS | ADJ MH or CB | DRILL HOLES | POT HOLES | GRADE | STEEP | NO CB | CULVERT | ENCROACH | CURB | EXTRA LONG | DEEP DITCH | SURF.TREAT. | IRREGULAR | RATE 0-9 | LOCATION

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 | 25 | 26 — LANE NO 1

0-3 — LANE NO 2

27 28 29 30 31 32 33 34 35 36 37 38 38 40 41 42 43 44 45 46 47 48 49 50 | 51 | 52

LOCATION CODE	
1	S-S
2	S-L
3	L-S
4	L-L
5	S-DE
6	DE-S
7	L-DE
8	DE-L
9	DE-DE

APPENDIX C

dBASE SOURCE CODE FOR THE PROTOTYPE DATA COLLECTION SYSTEM

```
* Mainin.prg - main data input program for the Daily Construction Site
*              Reporting System (DSRS)

* Set up new working environment
CLEAR ALL
SET TALK OFF
SET BELL OFF

* Input Basic Daily Job Information
SELECT 1
USE dsr_head INDEX hdrprjno,hdrdate
SELECT 2
USE projname INDEX prjnamno
SELECT 1
SET RELATION TO project_no INTO projname
CLEAR
SET FORMAT TO head
APPEND BLANK
GO TOP
EDIT NEXT 1
SKIP -1

* Declare PROJECT_NO and DATE as global variables
PUBLIC name, num, dat
STORE projname->projectnam TO name
STORE project_no TO num
STORE date TO dat

* Input Site Conditions
SELECT 3
USE sitecond INDEX sitprjno,sitdate
SET FORMAT TO site
CLEAR
APPEND BLANK
REPLACE project_no WITH num
REPLACE date WITH dat
EDIT NEXT 1

* Input Unusual Developments
CLEAR
@ 7,10 SAY "UNUSUAL DEVELOPMENTS:"
@ 9,18 SAY ". Strikes/Job Actions"
@ 10,18 SAY ". Potential Problems"
@ 11,18 SAY ". Overall Job Delays"
@ 12,18 SAY ". Disputes"
@ 13,18 SAY ". Others"
@ 16,10 SAY " "
ACCEPT "          Were any of the above encountered today [Y/N]? [Y]: " TO more
IF LEN(more) = 0
   more = "Y"
ENDIF
IF (more = "Y") .OR. (more = "y")
   DO subin1 WITH "STRIKES/JOB ACTIONS","unusual","3","unsl","uslprjno","usldate
"
   DO subin1 WITH "POTENTIAL PROBLEMS","unusual","3","unsl","uslprjno","usldate"
   DO subin1 WITH "OVERALL JOB DELAYS","unusual","3","unsl","uslprjno","usldate"
   DO subin1 WITH "DISPUTES","unusual","3","unsl","uslprjno","usldate"
   DO subin1 WITH "OTHER UNUSUAL DEVELOPMENTS","unusual","3","unsl","uslprjno","
usldate"
ENDIF

* Set up infinite loop - DO WHILE .T. means Do while forever
SELECT 1
USE
SELECT 2
USE
```

```
SELECT 3
USE
DO WHILE .T.
   CLEAR
   @ 7,10 SAY "UPDATE WORK FORCE INFORMATION & ACTIVITY INFORMATION:"
   @ 10,18 SAY "1) Begin Updating"
   @ 12,18 SAY "2) Update an Additional Trade"
   @ 14,18 SAY "3) Finished Updating / Quit"

   * Initialize memory variable 'choice1'
   STORE " " TO choice1

   * Display prompt for user input into variable 'choice1'
   @ 17,10 SAY "Please make a choice: " GET choice1 PICTURE "9"
   READ

   * Based on above input, execute proper CASE
   DO CASE
      CASE choice1 = "1"
         DO subin2a
      CASE choice1 = "2"
         DO subin2b
      CASE choice1 = "3"
         * EXIT command continues program outside ENDDO
         EXIT
      OTHERWISE
         * OTHERWISE means none of the CASE statements were true
         @ 14,0 CLEAR
         @ 17,23 SAY "Sorry -- Invalid Entry."
         WAIT SPACE(22) + "Hit any key to try again."
   ENDCASE
ENDDO

USE
SELECT 1
USE
SELECT 2
USE
SELECT 3
USE

RETURN
```

```
* Subin1.prg - subroutine for the input of Unusual Developments

PARAMETERS phrase, file, workspace, frmtfile, prjndx, datndx
CLEAR
ACCEPT 'Any &phrase [Y/N]? [Y]: ' TO more1
IF LEN(more1) = 0
    more1 = 'Y'
ENDIF
SELECT &workspace
USE &file INDEX &prjndx, &datndx
SET FORMAT TO &frmtfile
DO WHILE (more1 = 'Y') .OR. (more1 = 'y')
    APPEND BLANK
    REPLACE project_no WITH num
    REPLACE date WITH dat
    REPLACE type WITH '&phrase'
    EDIT NEXT 1
    CLEAR
    ACCEPT 'Another record [Y/N]? [Y]: ' TO more1
    IF LEN(more1) = 0
        more1 = 'Y'
    ENDIF
ENDDO
RETURN
```

```
* Infowkfc.prg - subroutine for updating Work Force Information

SELECT 2
USE wkfcinfo index wkfprjno,wkfdate
SET FORMAT TO wkfc
CLEAR
APPEND BLANK
REPLACE project_no WITH num
REPLACE date WITH dat
REPLACE crewdscrtn WITH crew
EDIT NEXT 1
SKIP -1

* Input Delivery Information
DO subin3 WITH "Deliveries","delivery","2","deli","delprjno","deldate"

* Input Equipment Usage
DO subin3 WITH "Equipment Used","eqipment","2","eqip","eqpprjno","eqpdate"

* Input Accident Information
DO subin3 WITH "Accidents","accident","2","acci","accprjno","accdate"

USE
RETURN
```

```
* Infoacty.prg - subroutine for updating Activity Information

CLEAR
SELECT 1
SET FORMAT TO acti
APPEND BLANK
REPLACE projectnam WITH name
REPLACE project_no WITH num
REPLACE date WITH dat
REPLACE crewdscrtn WITH crew
REPLACE descrption WITH describe
REPLACE code WITH actnum
EDIT NEXT 1
SKIP -1

* Declare PRODUCTION as a memvar
STORE production TO product
STORE RTRIM(descrption) TO describe
STORE code TO actnum

* Menu for Reasons for Unsatisfactory Rate of Production
IF UPPER(product) = "U"
   SELECT 2
   DO WHILE .T.
      CLEAR
      @ 1,5 SAY "REASONS FOR UNSATISFACTORY RATE OF PRODUCTION:"
      @ 3,10 SAY " 1) Rework Due to Design Error"
      @ 4,10 SAY " 2) Rework Due to Prefabrication Error"
      @ 5,10 SAY " 3) Rework Due to Field Error or Damage"
      @ 6,10 SAY " 4) Owner Initiated Change Orders/Extra Work"
      @ 7,10 SAY " 5) Mandatory Change Orders/Extra Work"
      @ 8,10 SAY " 6) Contractor Initiated Change Orders/Extra Work"
      @ 9,10 SAY " 7) Delays Due to Waiting for Materials: warehouse/vendor"
      @ 10,10 SAY " 8) Delays Due to Waiting for Tools"
      @ 11,10 SAY " 9) Delays Due to Waiting for Construction Equipment"
      @ 12,10 SAY "10) Delays Due to Waiting for Information/Decisions"
      @ 13,10 SAY "11) Delays Due to Waiting for Other Crews"
      @ 14,10 SAY "12) Delays Due to Waiting for Fellow Crew Members"
      @ 15,10 SAY "13) Equipment Breakdown"
      @ 16,10 SAY "14) Unexplained or Unnecessary Move"
      @ 17,10 SAY "15) Late Inspection"
      @ 18,10 SAY "16) Strike/Job Action"
      @ 19,10 SAY "17) Weather"
      @ 20,10 SAY "18) Others"
      @ 21,10 SAY "19) No Further Reasons for Unsatisfactory Rate of Production"

      STORE "  " TO choice2

      @ 23,22 SAY "Please make a choice: " GET choice2 PICTURE "99"
      READ

      DO CASE
         CASE choice2 = "1 "
            DO subin4 WITH "REWORK DUE TO DESIGN ERROR"
         CASE choice2 = "2 "
            DO subin4 WITH "REWORK DUE TO PREFABRICATION ERROR"
         CASE choice2 = "3 "
            DO subin4 WITH "REWORK DUE TO FIELD ERROR OR DAMAGE"
         CASE choice2 = "4 "
            DO subin4 WITH "OWNER INITIATED CHANGE ORDERS/EXTRA WORK"
         CASE choice2 = "5 "
            DO subin4 WITH "MANDATORY CHANGE ORDERS/EXTRA WORK"
         CASE choice2 = "6 "
            DO subin4 WITH "CONTRACTOR INITIATED CHANGE ORDERS/EXTRA WORK"
         CASE choice2 = "7 "
            DO subin4 WITH "DELAYS DUE TO WAITING FOR MATERIALS: WAREHOUSE/VENDO
```

```
R"
         CASE choice2 = "8 "
            DO subin4 WITH "DELAYS DUE TO WAITING FOR TOOLS"
         CASE choice2 = "9 "
            DO subin4 WITH "DELAYS DUE TO WAITING FOR CONSTRUCTION EQUIPMENT"
         CASE choice2 = "10"
            DO subin4 WITH "DELAYS DUE TO WAITING FOR INFORMATION/DECISIONS"
         CASE choice2 = "11"
            DO subin4 WITH "DELAYS DUE TO WAITING FOR OTHER CREWS"
         CASE choice2 = "12"
            DO subin4 WITH "DELAYS DUE TO WAITING FOR FELLOW CREW MEMBERS"
         CASE choice2 = "13"
            DO subin4 WITH "EQUIPMENT BREAKDOWN"
         CASE choice2 = "14"
            DO subin4 WITH "UNEXPLAINED OR UNNECESSARY MOVE"
         CASE choice2 = "15"
            DO subin4 WITH "LATE INSPECTION"
         CASE choice2 = "16"
            DO subin4 WITH "STRIKE/JOB ACTION"
         CASE choice2 = "17"
            DO subin4 WITH "WEATHER"
         CASE choice2 = "18"
            DO subin4 WITH "OTHERS"
         CASE choice2 = "19"
            EXIT
         OTHERWISE
            @ 21,0 CLEAR
            @ 22,23 SAY "Sorry -- Invalid Entry."
            WAIT SPACE(22) + "Hit any key to try again."
      ENDCASE
   ENDDO
ENDIF

* Input Inspections associated with activity
DO subin5 WITH "Inspections","inspects","2","inspect","ispprjno","ispdate"

* Input Tests associated with activity
DO subin5 WITH "Tests","tests","2","test","tesprjno","tesdate"

SELECT 1

RETURN
```

```
* Subin2a.prg - begins updating Work Force Information & Activity Information.
*               It aids the user by recalling any activity that was in progress,
*               idle, or started on the last working day.

CLEAR
SELECT 1
USE actyinfo INDEX actprjno,actdate
STORE dat - 1 TO yesterday
LOCATE FOR (project_no = num) .AND. (date = yesterday) .AND. (status <> "FD") .A
ND. (status <> "SF")
IF EOF()
   DO WHILE EOF()
      yesterday = yesterday - 1
      LOCATE FOR (project_no = num) .AND. (date = yesterday) .AND. (status <> "F
D") .AND. (status <> "SF")
   ENDDO
ENDIF
DO subin2a1

SELECT 1
USE
SELECT 2
USE

RETURN
```

```
* Subin2a1.prg - the subroutine that does the actual updating of Work Force
*                Information & Activity Information for Subin2a.prg

* Declare the following memvars as global variables
PUBLIC crew, describe, actnum, lastfind

DO WHILE .NOT. EOF()
   CLEAR
   STORE RTRIM(crewdscrtn) TO crew
   ACCEPT "Any work performed by &crew [Y/N]? [Y]: " TO more2a1
   IF (LEN(more2a1) = 0) .OR. (UPPER(more2a1) = "Y")

      * Update Work Force Information
      DO infowkfc

      * Update Activity Information
      CLEAR
      more2a2 = "Y"
      DO WHILE UPPER(more2a2) = "Y"
         SELECT 1
         STORE RECNO() TO lastfind
         STORE descrption TO describe
         STORE code TO actnum
         DO infoacty
         GOTO lastfind
         CONTINUE
         IF RTRIM(crewdscrtn) = crew
            more2a2 = "Y"
         ELSE
            DO WHILE UPPER(more2a2) = "Y"
               CLEAR
               ACCEPT "Another activity for this trade [Y/N]? [Y]: " TO more2a2
               IF (LEN(more2a2) = 0) .OR. (UPPER(more2a2) = "Y")
                  more2a2 = "Y"
                  STORE "" TO describe
                  STORE "" TO actnum
                  DO infoacty
               ELSE
                  more2a2 = "N"
                  GOTO lastfind
                  CONTINUE
                  EXIT
               ENDIF
            ENDDO
         ENDIF
      ENDDO

   ELSE
      DO WHILE .T.
         STORE RECNO() TO lastfind
         STORE descrption TO describe
         STORE code TO actnum
         APPEND BLANK
         REPLACE project_no WITH num
         REPLACE date WITH dat
         REPLACE crewdscrtn WITH crew
         REPLACE descrption WITH describe
         REPLACE code WITH actnum
         REPLACE status WITH "ID"
         GOTO lastfind
         CONTINUE
         IF RTRIM(crewdscrtn) <> crew
            EXIT
         ENDIF
      ENDDO
   ENDIF


   ENDDO
   RETURN
```

```
* Subin2b.prg - updates Work Force Information & Activity Information for any
*               new trades or any returning trades starting new activities

* Input Work Force Information
SELECT 2
USE wkfcinfo index wkfprjno,wkfdate
SET FORMAT TO wkfc
CLEAR
APPEND BLANK
REPLACE project_no WITH num
REPLACE date WITH dat
EDIT NEXT 1
SKIP -1

* Declare CREWDSCRTN as a global variable
STORE crewdscrtn TO crew

* Input Delivery Information
DO subin3 WITH "Deliveries","delivery","2","deli","delprjno","deldate"

* Input Equipment Usage
DO subin3 WITH "Equipment Used","eqipment","2","eqip","eqpprjno","eqpdate"

* Input Accident Information
DO subin3 WITH "Accidents","accident","2","acci","accprjno","accdate"

* Input Activity Information
CLEAR
more2 = "Y"
DO WHILE (more2 = "Y") .OR. (more2 = "y")
   SELECT 1
   USE actyinfo INDEX actprjno,actdate
   SET FORMAT TO acti
   APPEND BLANK
   REPLACE projectnam WITH name
   REPLACE project_no WITH num
   REPLACE date WITH dat
   REPLACE crewdscrtn WITH crew
   EDIT NEXT 1
   SKIP -1

   * Declare PRODUCTION, DESCRPTION & CODE as global variables
   STORE production TO product
   STORE RTRIM(descrption) TO describe
   STORE code TO actnum

   * Menu for Reasons for Unsatisfactory Rate of Production
   USE
   IF (product = "U") .OR. (product = "u")
      DO WHILE .T.
         CLEAR
         @ 1,5 SAY "REASONS FOR UNSATISFACTORY RATE OF PRODUCTION:"
         @ 3,10 SAY " 1) Rework Due to Design Error"
         @ 4,10 SAY " 2) Rework Due to Prefabrication Error"
         @ 5,10 SAY " 3) Rework Due to Field Error or Damage"
         @ 6,10 SAY " 4) Owner Initiated Change Orders/Extra Work"
         @ 7,10 SAY " 5) Mandatory Change Orders/Extra Work"
         @ 8,10 SAY " 6) Contractor Initiated Change Orders/Extra Work"
         @ 9,10 SAY " 7) Delays Due to Waiting for Materials: warehouse/vendor"
         @ 10,10 SAY " 8) Delays Due to Waiting for Tools"
         @ 11,10 SAY " 9) Delays Due to Waiting for Construction Equipment"
         @ 12,10 SAY "10) Delays Due to Waiting for Information/Decisions"
         @ 13,10 SAY "11) Delays Due to Waiting for Other Crews"
         @ 14,10 SAY "12) Delays Due to Waiting for Fellow Crew Members"
         @ 15,10 SAY "13) Equipment Breakdown"
         @ 16,10 SAY "14) Unexplained or Unnecessary Move"
```

```
         @ 17,10 SAY "15) Late Inspection"
         @ 18,10 SAY "16) Strike/Job Action"
         @ 19,10 SAY "17) Weather"
         @ 20,10 SAY "18) Others"
         @ 21,10 SAY "19) No Further Reasons for Unsatisfactory Rate of Producti
on"

         STORE "  " TO choice2

         @ 23,22 SAY "Please make a choice: " GET choice2 PICTURE "99"
         READ

         DO CASE
            CASE choice2 = "1 "
               DO subin4 WITH "REWORK DUE TO DESIGN ERROR"
            CASE choice2 = "2 "
               DO subin4 WITH "REWORK DUE TO PREFABRICATION ERROR"
            CASE choice2 = "3 "
               DO subin4 WITH "REWORK DUE TO FIELD ERROR OR DAMAGE"
            CASE choice2 = "4 "
               DO subin4 WITH "OWNER INITIATED CHANGE ORDERS/EXTRA WORK"
            CASE choice2 = "5 "
               DO subin4 WITH "MANDATORY CHANGE ORDERS/EXTRA WORK"
            CASE choice2 = "6 "
               DO subin4 WITH "CONTRACTOR INITIATED CHANGE ORDERS/EXTRA WORK"
            CASE choice2 = "7 "
               DO subin4 WITH "DELAYS DUE TO WAITING FOR MATERIALS: WAREHOUSE/VE
NDOR"
            CASE choice2 = "8 "
               DO subin4 WITH "DELAYS DUE TO WAITING FOR TOOLS"
            CASE choice2 = "9 "
               DO subin4 WITH "DELAYS DUE TO WAITING FOR CONSTRUCTION EQUIPMENT"
            CASE choice2 = "10"
               DO subin4 WITH "DELAYS DUE TO WAITING FOR INFORMATION/DECISIONS"
            CASE choice2 = "11"
               DO subin4 WITH "DELAYS DUE TO WAITING FOR OTHER CREWS"
            CASE choice2 = "12"
               DO subin4 WITH "DELAYS DUE TO WAITING FOR FELLOW CREW MEMBERS"
            CASE choice2 = "13"
               DO subin4 WITH "EQUIPMENT BREAKDOWN"
            CASE choice2 = "14"
               DO subin4 WITH "UNEXPLAINED OR UNNECESSARY MOVE"
            CASE choice2 = "15"
               DO subin4 WITH "LATE INSPECTION"
            CASE choice2 = "16"
               DO subin4 WITH "STRIKE/JOB ACTION"
            CASE choice2 = "17"
               DO subin4 WITH "WEATHER"
            CASE choice2 = "18"
               DO subin4 WITH "OTHERS"
            CASE choice2 = "19"
               EXIT
            OTHERWISE
               @ 21,0 CLEAR
               @ 22,23 SAY "Sorry -- Invalid Entry."
               WAIT SPACE(22) + "Hit any key to try again."
         ENDCASE
      ENDDO
   ENDIF

   * Input Inspections associated with activity
   DO subin5 WITH "Inspections","inspects","2","inspect","ispprjno","ispdate"

   * Input Tests associated with activity
   DO subin5 WITH "Tests","tests","2","test","tesprjno","tesdate"
```

```
   CLEAR
   ACCEPT "Another activity for this trade [Y/N]? [Y]: " TO more2
   IF LEN(more2) = 0
      more2 = "Y"
   ENDIF
ENDDO
RETURN
```

```
* Subin3.prg - subroutine for the input of Delivery, Equipment & Accident
*              Information

PARAMETERS phrase, file, workspace, frmtfile, prjndx, datndx
CLEAR
ACCEPT 'Any &phrase [Y/N]? [Y]: ' TO more3
IF LEN(more3) = 0
    more3 = 'Y'
ENDIF
SELECT &workspace
USE &file INDEX &prjndx, &datndx
SET FORMAT TO &frmtfile
DO WHILE (more3 = 'Y') .OR. (more3 = 'y')
    APPEND BLANK
    REPLACE project_no WITH num
    REPLACE date WITH dat
    REPLACE crewdscrtn WITH crew
    EDIT NEXT 1
    CLEAR
    ACCEPT 'Another record [Y/N]? [Y]: ' TO more3
    IF LEN(more3) = 0
        more3 = 'Y'
    ENDIF
ENDDO
RETURN
```

```
* Subin4.prg - subroutine for the input of Reasons for Unsatisfactory Rate of
*              Production

PARAMETERS phrase
CLEAR
more4 = 'Y'
SELECT 2
USE actydlay INDEX adyprjno,adydate
SET FORMAT TO actd
DO WHILE (more4 = 'Y') .OR. (more4 = 'y')
    APPEND BLANK
    REPLACE projectnam WITH name
    REPLACE project_no WITH num
    REPLACE date WITH dat
    REPLACE type WITH '&phrase'
    REPLACE crewdscrtn WITH crew
    REPLACE activity WITH describe
    REPLACE code WITH actnum
    EDIT NEXT 1
    CLEAR
    ACCEPT 'Another problem of this type [Y/N]? [Y]: ' TO more4
    IF LEN(more4) = 0
        more4 = 'Y'
    ENDIF
ENDDO
USE
RETURN
```

```
* Subin5.prg - subroutine for the input of Inspections & Tests Information for
*              an activity

PARAMETERS phrase, file, workspace, frmtfile, prjndx, datndx
CLEAR
ACCEPT 'Any &phrase associated with &describe [Y/N]? [Y]: ' TO more5
IF LEN(more5) = 0
    more5 = 'Y'
ENDIF
SELECT &workspace
USE &file INDEX &prjndx, &datndx
SET FORMAT TO &frmtfile
DO WHILE (more5 = 'Y') .OR. (more5 = 'y')
    APPEND BLANK
    REPLACE project_no WITH num
    REPLACE date WITH dat
    REPLACE crewdscrtn WITH crew
    REPLACE actydscrtn WITH describe
    REPLACE code WITH actnum
    EDIT NEXT 1
    CLEAR
    ACCEPT 'Another record [Y/N]? [Y]: ' TO more5
    IF LEN(more5) = 0
       more5 = 'Y'
    ENDIF
ENDDO
USE
RETURN
```