Structured Analysis

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In any programming project, there are three areas of partition: Analysis, Design, and Implementation. All three of these areas can benefit from a systematic, structured approach.

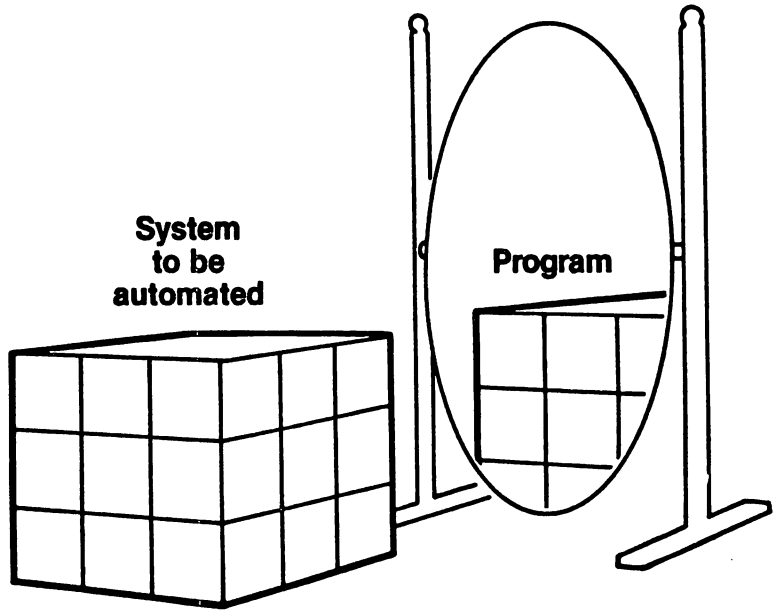
Today we will discuss Structured Analysis. In our discussion, our underlying assumption will be that we are called upon to design (automate) a new system in order to replace an existing system.

ALL OF US WHO ARE INVOLVED WITH PROGRAMMING AND PROGRAMMERS ARE CONCERNED WITH MAKING SURE THAT THE CODE WHICH IS WRITTEN ADEQUATELY AND APPROPRIATELY REPRESENTS THE SYSTEM WHICH IS TO BE AUTOMATED.

STRUCTURED ANALYSIS IS A METHOD TO ACHIEVE THAT GOAL.

Our Goal:

The program written must truly represent the system to be automated.



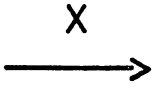
SOME TOOLS OF

STRUCTURED ANALYSIS

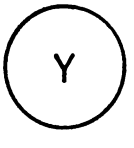
- DATA FLOW DIAGRAMS (DFD'S)
- DATA DICTIONARY
- STRUCTURED ENGLISH

DFD NOTATION

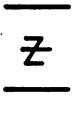
1. DATA FLOWS, REPRESENTED BY NAMED ARROWS



2. PROCESSES, REPESENTED BY NAMED CIRCLES I.E. ("BUBBLES")



3. FILES, REPRESENTED BY NAMED STRAIGHT LINES



4. DATA SOURCES AND SINKS, REPRESENTED BY NAMED BOXES

DFD'S

I. A LANGUAGE

II. AN EXCELLENT TECHNIQUE FOR UNCOVERING MISUNDERSTANDINGS DURING THE ANALYSIS PHASE OF A PROJECT.

COMMENTARY

HOW DO YOU ANALYZE A SYSTEM?

YOU TALK. YOU TALK TO THE PEOPLE

WHO ARE PART OF THE SYSTEM. YOU

ASK THEM WHAT IT IS THAT THEY DO.

Discussing "how things work" with a participant in a system can often lead to confusion. Quite naturally, there are multiple views of the system. Each participant in the system views the situation from his own vantage point. Thus, analysis derived from discussion with one participant will often conflict with analysis derived from discussion with another participant.

For example:

DESCRIPTION OF A "HOSPITAL SYSTEM"

A PATIENT COMES INTO THE HOSPITAL AND CHECKS IN. IF HE IS REALLY SICK, HE DOESN'T CHECK IN HIMSELF BUT HE'S PUT INTO A WHEELCHAIR AND SENT RIGHT UP TO A ROOM (UNLESS HE'S AN EMERGENCY-ROOM PATIENT). THEN THE DOCTOR ORDERS ALL THE LAB TESTS HE NEEDS.

SOMETIMES MATERNITY PATIENTS GO TO THE LABOR-DELIVERY PART OF THE HOSPITAL RIGHT AWAY.

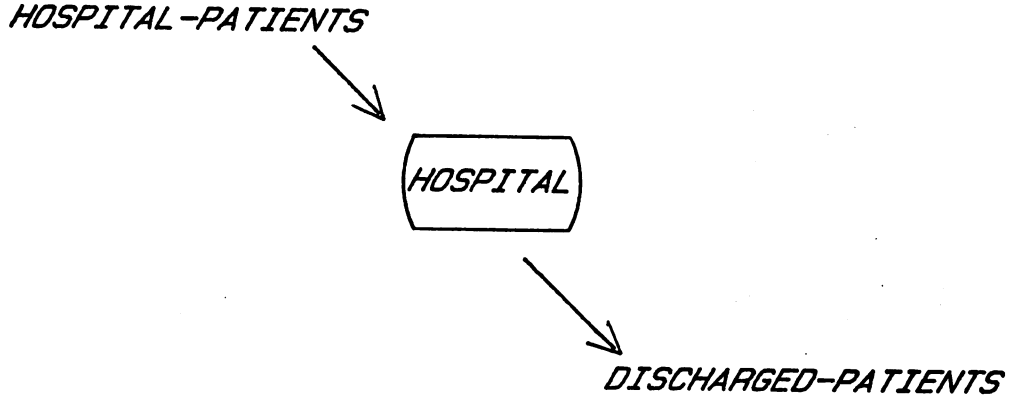
EMERGENCY ROOM PATIENTS HAVE TO WAIT IN THE EMERGENCY ROOM UNLESS THEY NEED TRAUMA CARE RIGHT AWAY.

AFTER TESTS AND X-RAYS ARE TAKEN, COPIES GO INTO THE CHART AND A COPY GOES TO MEDICAL RECORDS.

I AM CHIEF COOK IN THE HOSPITAL KITCHEN. ALL FOOD GOES THROUGH ME. EVERY DAY WE COOK BREAKFAST, LUNCH AND DINNER. WE COOK SPECIAL FOODS FOR PEOPLE WHO ARE ON SPECIAL DIETS, TOO. THAT'S THE HARDEST PART!

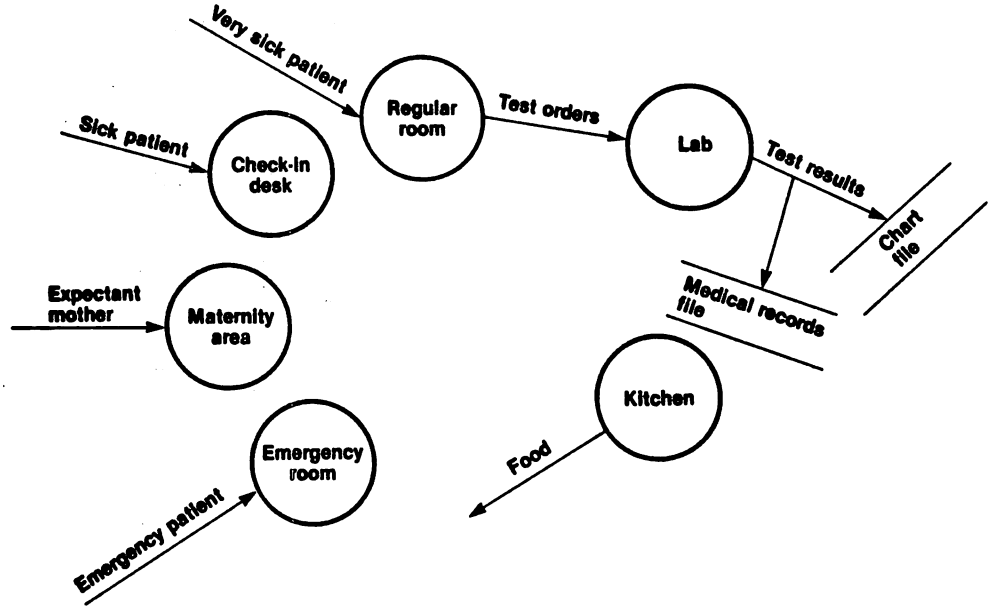
From this description, we can derive a "Top Level" of analysis:

HIGHEST LEVEL OF "HOSPITAL SYSTEM"



A "First Pass" DFD representing the HOSPITAL SYSTEM might look like this:

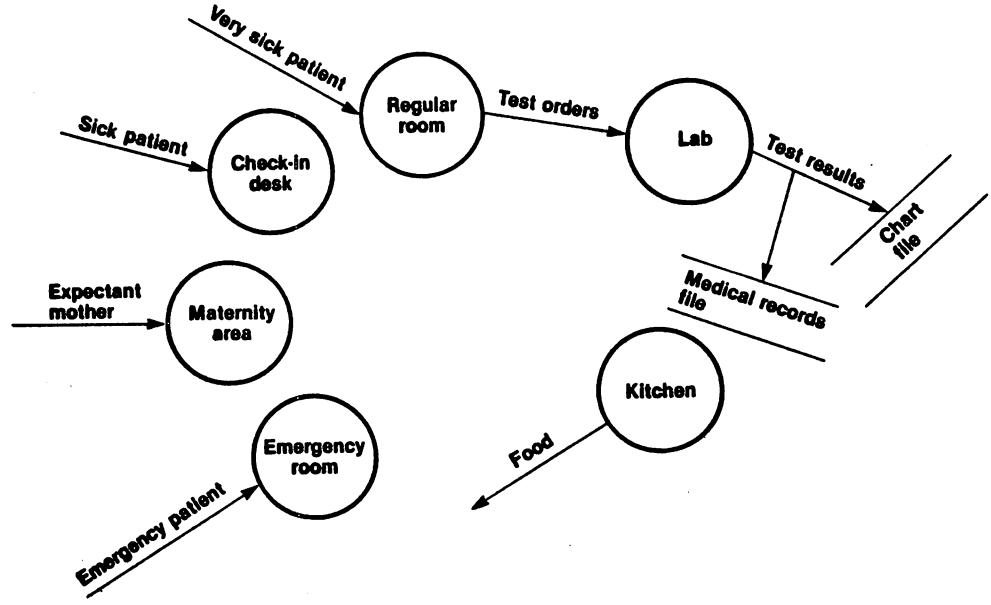
DFD of "Hospital System" Pass I (Taken from Verbal Report of a Participant)



As you can see, there are many empty spaces in our first pass DFD. From the description given us by our participant, we have created a DFD with data-flows entering process bubbles and no data exiting. We also have data flows coming out of process bubbles where no data ever entered.

Our "Tests for Correctness" which point out an incorrect DFD immediately point out to us that our understanding of this system is conceptually incorrect. And we (for the most part) know exactly what it is we don't understand.

DFD of "Hospital System" Pass I (Taken from Verbal Report of a Participant)

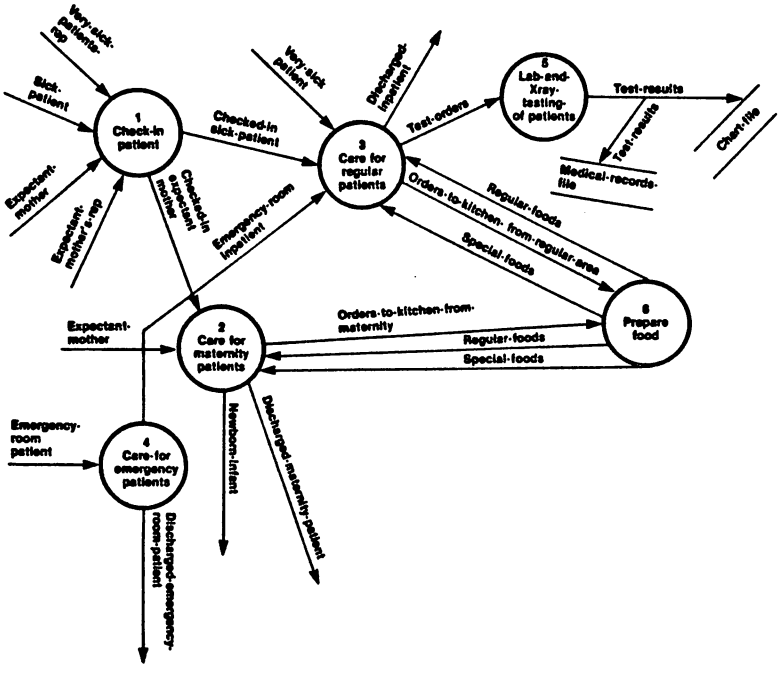


QUESTIONS WHICH COME UP WHEN TRYING TO ANALYZE THIS PASS 1 DFD

- WHAT HAPPENS TO A PATIENT WHO IS NOT VERY SICK? AFTER HE CHECKS IN, WHAT DOES HE DO?
- DOES A PATIENT WHO IS TOO SICK TO CHECK IN HIMSELF EVER GET CHECKED IN?
- DO EMERGENCY ROOM PATIENTS WHO DON'T NEED TRAUMA CARE EVER GET OUT OF THE EMERGENCY ROOM?
- HOW DOES A PATIENT (EITHER A REGULAR PATIENT, MATERNITY PATIENT, OR EMERGENCY ROOM PATIENT) EVER GET OUT OF THE HOSPITAL?
- HOW DOES THE KITCHEN KNOW WHAT SPECIAL FOODS ARE NEEDED? WHERE DOES THE FOOD GO ONCE IT LEAVES THE KITCHEN?

After asking those questions, we come to a DFD like this. True, it appears confusing. However, it is a pictorial representation of our system, a tool for discussion between the analyst and the participant.

DFD of "Hospital System" Pass II



We might wish to expand one of our process bubbles, in this case bubble number 5. (LAB AND XRAY TESTING OF PATIENTS).

Expansion of Bubble #5 in "Hospital System"

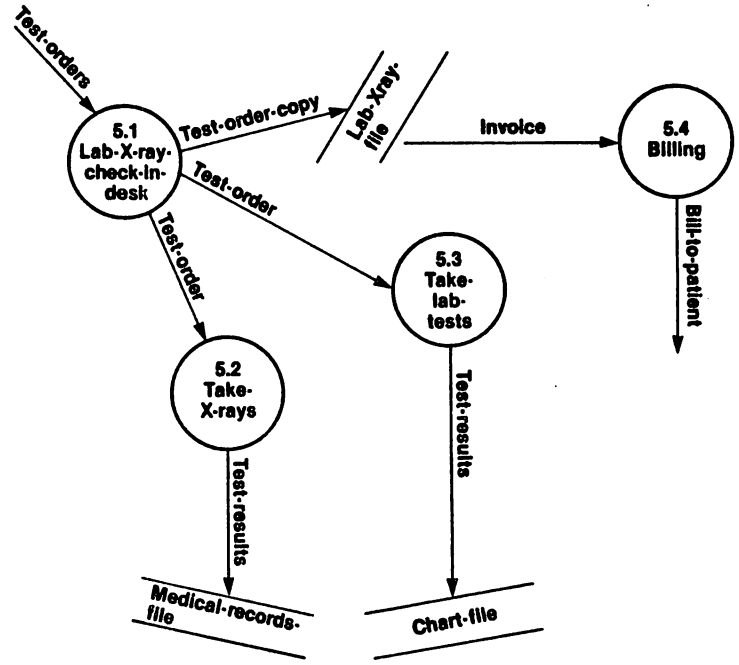


Diagram 5.0: Lab and X-Ray Testing of Data

Our "Test for Correctness" of this expanded DFD shows us that in the higher level DFD we had one input to process bubble #5 (TEST-ORDERS), and one output (TEST-RESULTS).

Here, however, we see two outputs! (TEST-RESULTS and BILL-TO-PATIENT).

Once again we immediately recognize an area of misunderstanding, and we return to talk to the participant in order to find out how the system really does work.

As we have seen, areas of misunderstanding can occur in data-flow path analysis. Also, there can be confusion about the exact definition of a particular data-flow file, or process bubble.

Structured Analysis contains a tool called the Data Dictionary, which attempts to eliminate ambiguity of definition.

DATA DICTIONARY

A SET OF DEFINITIONS FOR:

- DATA
- FILES
- PROCESS BUBBLES

USED IN DFD

Here are some examples of Data-flow definitions in the Data Dictionary.

EXAMPLES OF DD ENTRIES FOR "HOSPITAL SYSTEM"

```
HOSPITAL-PATIENT          = SICK PATIENT OR
(COMPOUND OR GROUP)         EXPECTANT MOTHER OR
                            EMERGENY-ROOM PATIENT OR
                            VERY SICK PATIENT

DOCTORS ORDERS            = TEST ORDERS
(ALIAS)

EMERGENCY-ROOM-PATIENT    = "FLU"
(PRIMITIVE DATA             "AUTO-ACCIDENT"
 ELEMENT)                   "HEART-PROBLEM"
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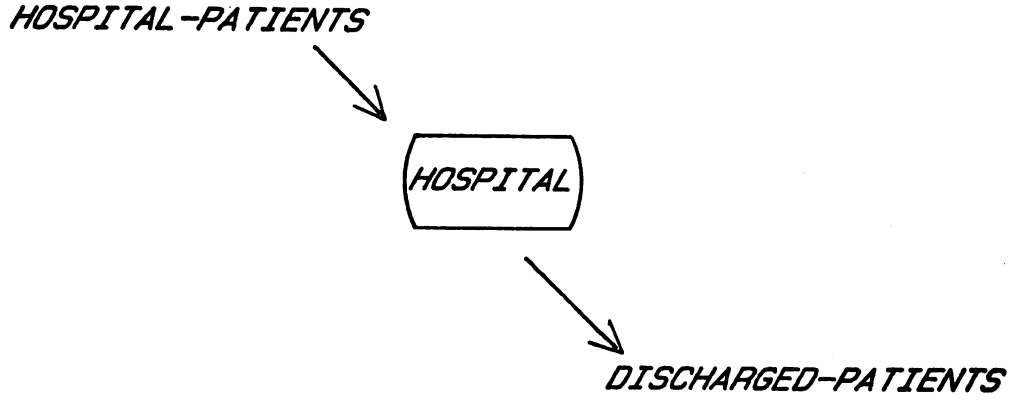
HIGHEST LEVEL OF "HOSPITAL SYSTEM"



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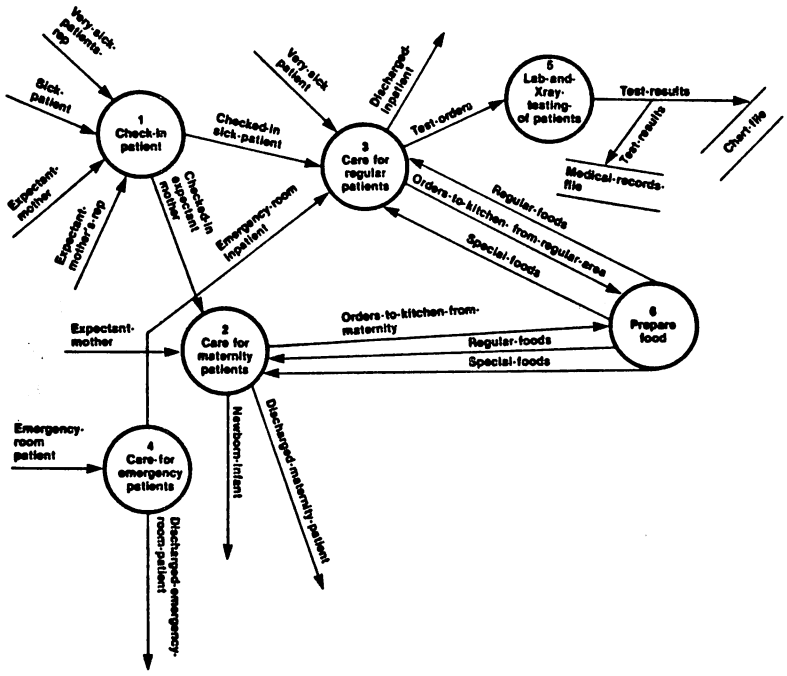
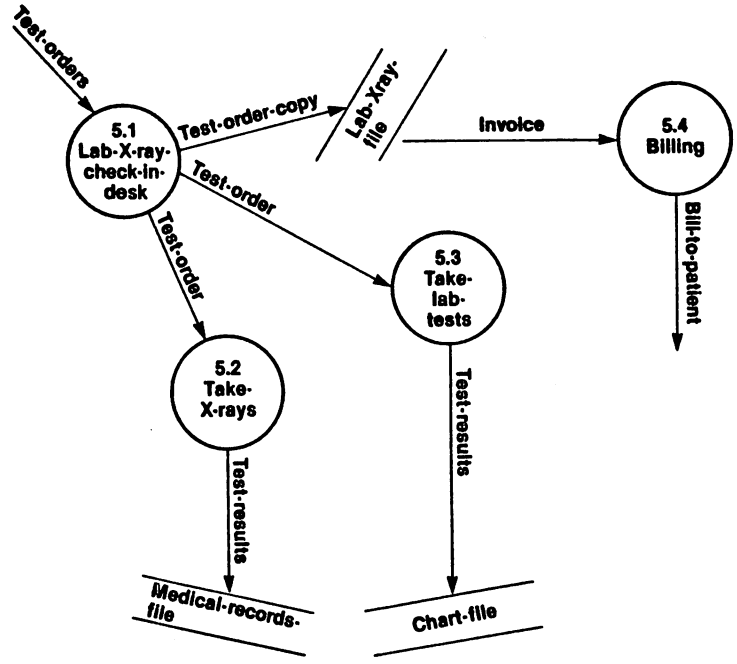


Expansion of Bubble #5 in "Hospital System"



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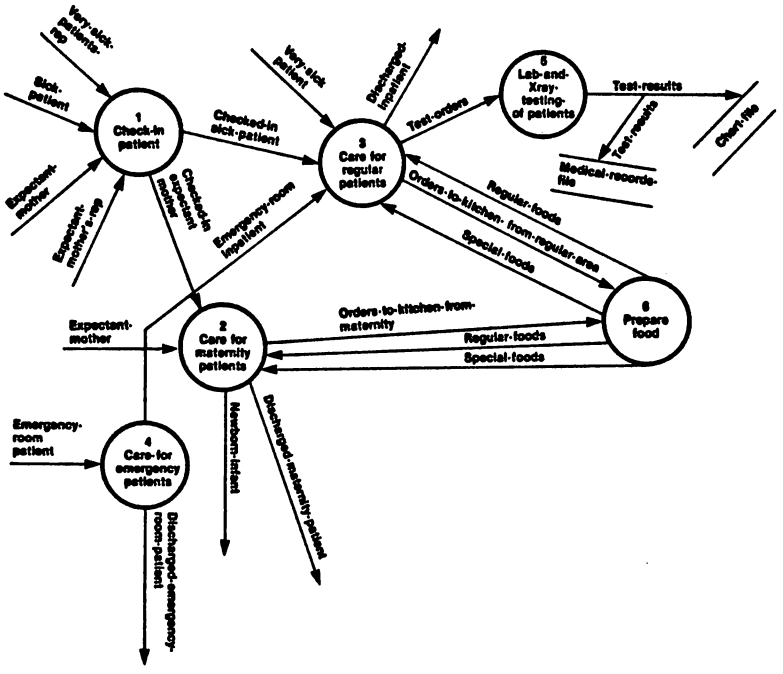
DFD of "Hospital System" Pass II



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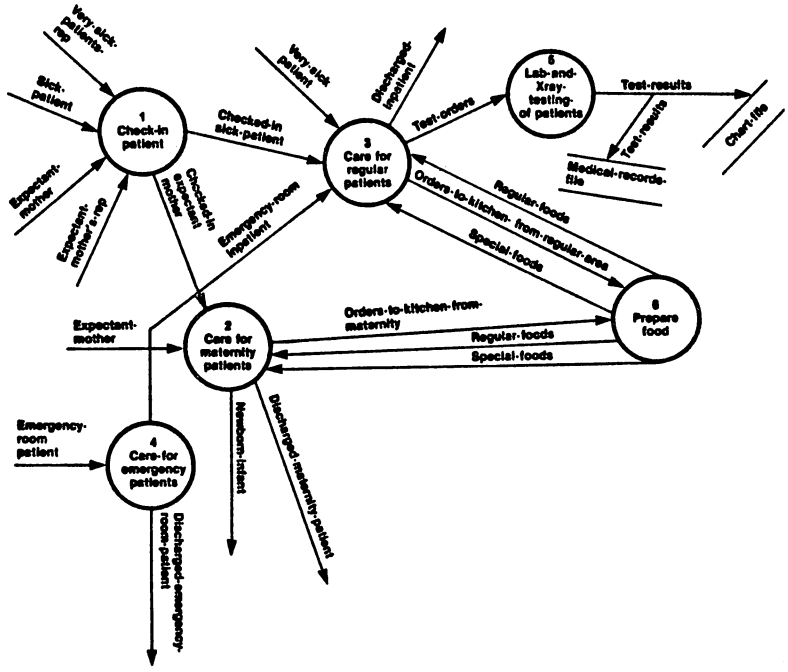


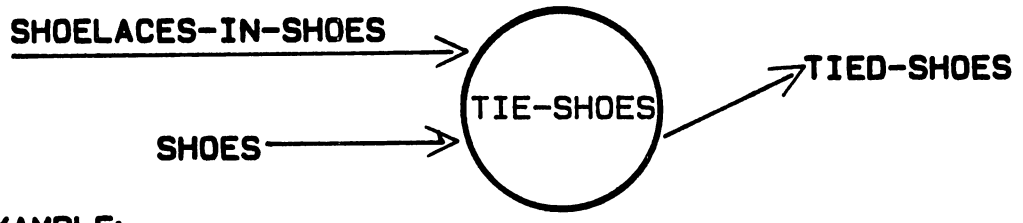
COMMENTARY

As we level our DFD for a system, each level of expansion shows more detail until we reach a level showing the primitive operations that act upon the data.

PRIMITIVE FUNCTIONS

PROCESS BUBBLES WHICH CAN NO LONGER BE EXPANDED REPRESENT PRIMITIVE FUNCTIONS WHICH ACT UPON THE DATA

EXAMPLE:



EXAMPLE:

Elements in the Data Dictionary which contain information about the process bubbles which are primitive functions are called Mini-Specs. Mini-Specs are written in Structured English.

Structured English

An Orthogonal Subset of English:

- Provides the minimum set of constructs needed to describe rules governing transformation of data flows for any functional primitive
- Provides one, and only one, possible way to describe rules governing transformation of data flows for any functional primitive

Policy for Preparing Foods

For each order-to-kitchen-from-regular area:

- For each special order:
  —Collect foods needed to fill order
  —Prepare foods
  —Send special foods back to appropriate room
- For each regular order:
  —Prepare foods
  —Send regular foods back to appropriate room.

In summary, structured specification consists of:

- DFDs — pictorially shows relationship within the system
- Data Dictionary — defines the data acted upon by the system
- Minispecs — describes the primitive function which make up the system. These are written in Structured English.

Our Data Dictionary is a rigorous description/definition of all Data Flows, files and primitive functions which occur in the DFD which was derived from our Structured Analysis of a system.

Structured Analysis is a large topic. In preparing this paper, the most difficult task was in deciding what information to leave out.

I would suggest if you have further interest in the topic of Structured Analysis and feel the technique could be of use to you that you consult the following references:

- *Structured Analysis and System Specification* by Tom De Marco, foreword by P. J. Plauger
- *The Practical Guide to Structured Systems Design* by Meilir-Page-Jones, foreword by Ed Yourdon.