Analysis Modeling

Oleh :

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Analysis Modeling: Where to Begin?

- A statement of scope can be acquired from:
  - the FAST working document
  - A set of use-cases
- the statement of scope must be "parsed" to extract data, function and behavioral domain information

Statement of Scope

- a relatively brief description of the system to be built
  - indicates data that are input and output and basic functionality
  - indicates conditional processing (at a high level)
  - implies certain constraints and limitations

Identifying Objects and Operations

- define "objects" by underlining all nouns in the written statement of scope
  - producers/consumers of data
  - places where data are stored
  - "composite" data items
- define "operations" by double underlining all active verbs
  - processes relevant to the application
  - data transformations
- consider other "services" that will be required by the objects

Data Modeling and Entity Relationship (E-R) Diagramming

Why Data Modeling?

- examines data objects independently of processing
- focuses attention on the data domain
- creates a model at the customer's level of abstraction
- indicates how data objects relate to one another

What is a Data Object?

Object **—something that is described by a set of attributes (data items) and that will be manipulated within the software (system)**

- **each instance of an object (e.g., a book) can be identified uniquely (e.g., ISBN #)**
- **each plays a necessary role in the system i.e., the system could not function without access to instances of the object**
- **each is described by attributes that are themselves data items**

Typical Objects

- ***external entities*** **(printer, user, sensor)**
- ***things*** **(e.g, reports, displays, signals)**
- ***occurrences or events*** **(e.g., interrupt, alarm)**
- ***roles*** **(e.g., manager, engineer, salesperson)**
- ***organizational units*** **(e.g., division, team)**
- ***places*** **(e.g., manufacturing floor)**
- ***structures*** **(e.g., employee record)**

Data Objects and Attributes

A data object contains a set of attributes that act as an aspect, quality, character-istic, or descriptor of the object

object: automobile

attributes:
make
model
body type
price
options code

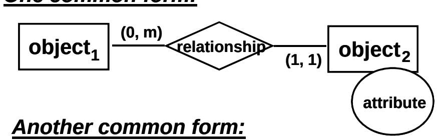
What is a Relationship?

relationship **—indicates "connectedness"; a "fact" that must be "remembered" by the system and cannot or is not computed or derived mechanically**

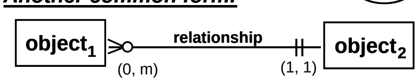
- **several instances of a relationship can exist**
- **objects can be related in many different ways**

ERD Notation

One common form:



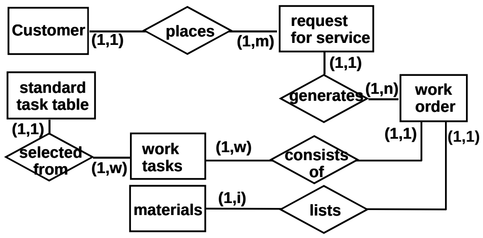
Another common form:



Building an ERD

- **Level 1—model all data objects (entities) and their "connections" to one another**
- **Level 2—model all entities and relationships**
- **Level 3—model all entities, relationships, and the attributes that provide further depth**

The ERD: An Example



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Creating a Flow Model

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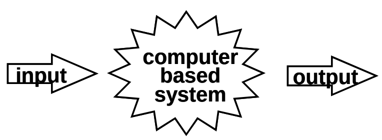
The Flow Model

Every computer-based system is an information transform ....



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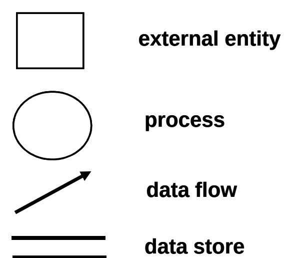
Flow Modeling Notation



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External Entity

A producer or consumer of data

Examples: a person, a device, a sensor

Another example: computer-based system

Data must always originate somewhere and must always be sent to something

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Process

A data transformer (changes input to output)

Examples: compute taxes, determine area, format report, display graph

Data must always be processed in some way to achieve system function

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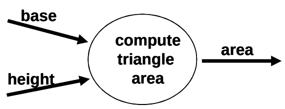
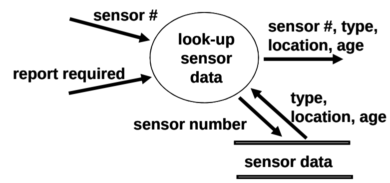
Data Flow

Data flows through a system, beginning as input and be transformed into output.



Data Stores

Data is often stored for later use.



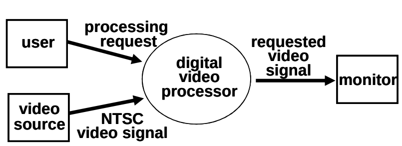
Data Flow Diagramming: Guidelines

- all icons must be labeled with meaningful names
- the DFD evolves through a number of levels of detail
- always begin with a context level diagram (also called level 0)
- always show external entities at level 0
- always label data flow arrows
- do not represent procedural logic

Constructing a DFD—I

- review ERD to isolate data objects and grammatical parse to determine "operations)
- determine external entities (producers and consumers of data
- create a level 0 DFD

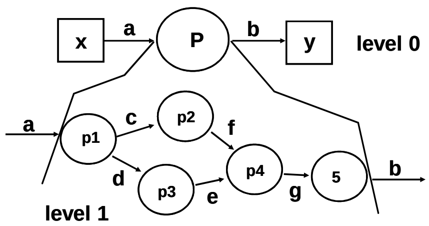
Level 0 DFD Example



Constructing a DFD—II

- write a narrative describing the transform
- parse to determine next level transforms
- "balance" the flow to maintain data flow continuity
- develop a level 1 DFD
- use a 1:5 (approx.) expansion ratio

The Data Flow Hierarchy



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Flow Modeling Notes

- each bubble is refined until it does just one thing
- the expansion ratio decreases as the number of levels increase
- most systems require between 3 and 7 levels for an adequate flow model
- a single data flow item (arrow) may be expanded as levels increase (data dictionary provides information)

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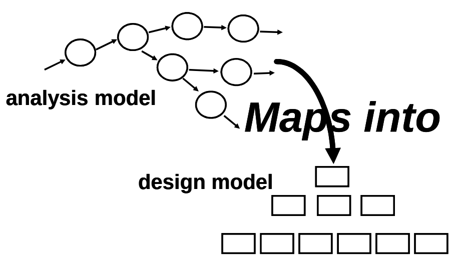
DFDs: A Look Ahead



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Behavioral Modeling and Process Specification

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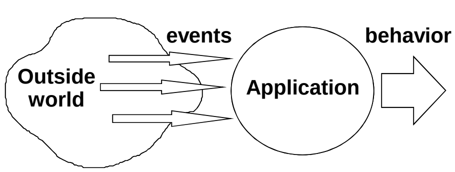
Behavioral Modeling



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The States of a System

- state—a set of observable circum-stances that characterizes the behavior of a system at a given time
- state transition—the movement from one state to another
- event—an occurrence that causes the system to exhibit some predictable form of behavior
- action—process that occurs as a consequence of making a transition

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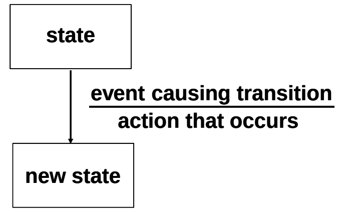
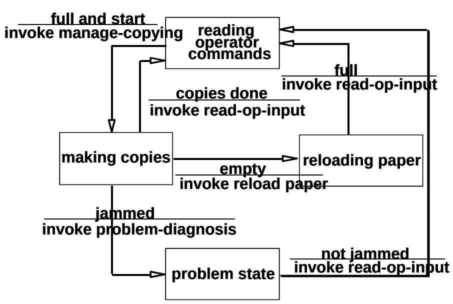
Behavioral Modeling

- ☐ make a list of the different states of a system (How does the system behave?)
- ☐ indicate how the system makes a transition from one state to another (How does the system change state?)
  - ⇦ indicate event
  - ⇦ indicate action
- ☐ draw a state transition diagram

State Transition Diagram Notation



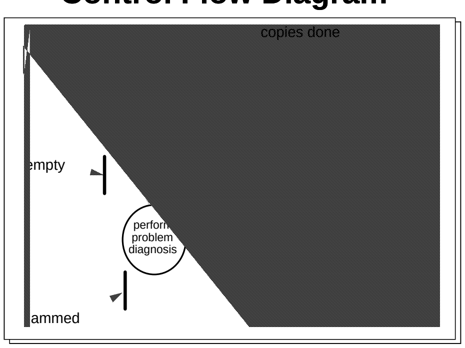
State Transition Diagram



The Control Model

- ❑ the control flow diagram is "superimposed" on the DFD and shows events that control the processes noted in the DFD
- ❑ control flows—events and control items—are noted by dashed arrows
- ❑ a vertical bar implies an input to or output from a control spec (CSPEC) — a separate specification that describes how control is handled
- ❑ a dashed arrow entering a vertical bar is an input to the CSPEC
- ❑ a dashed arrow leaving a process implies a data condition
- ❑ a dashed arrow entering a process implies a control input read directly by the process
- ❑ control flows do not physically activate/deactivate the processes—this is done via the CSPEC

Control Flow Diagram



Control Specification (CSPEC)

The CSPEC can be:

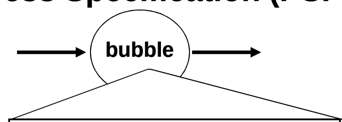
- ❑ state transition diagram (sequential spec)
- ❑ state transition table
- ❑ decision tables
- ❑ activation tables

} combinatorial spec

Guidelines for Building a CSPEC

- ❑ list all sensors that are "read" by the software
- ❑ list all interrupt conditions
- ❑ list all "switches" that are actuated by the operator
- ❑ list all data conditions
- ❑ recalling the noun-verb parse that was applied to the software statement of scope, review all "control items" as possible CSPEC inputs/outputs
- ❑ describe the behavior of a system by identifying its states; identify how each state is reach and defines the transitions between states
- ❑ focus on possible omissions ... a very common error in specifying control, e.g., ask: "Is there any other way I can get to this state or exit from it?"

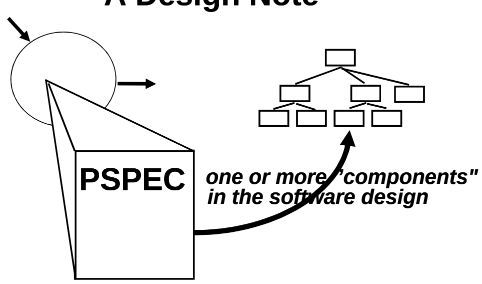
Process Specification (PSPEC)



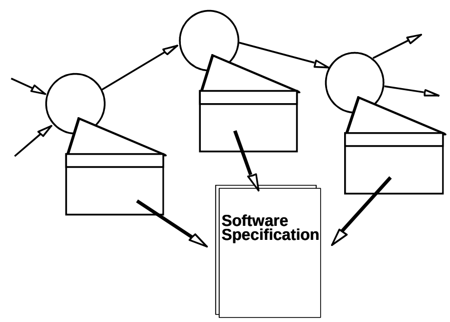
PSPEC

- ❑ narrative
- ❑ pseudocode (PDL)
- ❑ equations
- ❑ tables
- ❑ diagrams and/or charts

A Design Note



Creating Mini-Specs



Real-Time Analysis Methods

- ❑ each introduces its own notation, but all
  - ⇦ propose an approach for representing control and separating it from data
  - ⇦ provide a mechanism for specifying events, states, and distributed processing
  - ⇦ begin at the analysis level and work to derive processor assignments, tasks and program architectures

Real-Time Analysis & Design Methods

- ❑ Gomaa, H., Software Design Methods for Concurrent and Real-Time Systems, Addison-Wesley, 1995.
- ❑ Harel, D. et al, "STATEMATE: A Working Environment for the Development of Complex Reactive Systems, IEEE Trans. Software Engineering, vol. 16, no. 3, April, 1990, pp. 403-414.
- ❑ Hatley, D.J. and I.A. Pirbhai, Strategies for Real-Time System Specification, Dorset House, 1987.
- ❑ Selic, B., G. Gullekson, and P. Ward, Real-Time Object-Oriented Modeling, Wiley, 1994.
- ❑ Shumate, K. and M. Keller,, Software Specification and Design—A Disciplined Approach For Real-Time Systems, Wiley 1992.
- ❑ Ward, P.T. and S.J. Mellor, Structured Development for Real-Time Systems, 3 volumes, Yourdon Press, 1985, 1986.

The Data Dictionary

- ❑ a quasi-formal grammar for describing the content of data that the software will process and create
- ❑ a notation for describing control data and the values that control data can take, e.g., "on," or "off"
- ❑ a repository that also contains "where-used" / "how used" information
- ❑ a notation that can be represented manually, but is best developed using CASE tools

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Building a Data Dictionary

Name:	the primary name of the composite data item
Aliases:	other names for the data item
Where used:	data transforms (processes) that use the composite data item
How used:	the role of the data item (input, output, temporary storage, etc.
Description:	a notation for representing content (presented on next slide)
Format:	specific information about data types, pre-set values (if known)

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Data Dictionary Notation

<table>
<tr><th><u>Notation</u></th><th><u>Meaning</u></th></tr>
<tr><td>=</td><td>is composed of</td></tr>
<tr><td>+</td><td>and</td></tr>
<tr><td>[|]</td><td>either-or</td></tr>
<tr><td>{ }^{n}</td><td>n repetitions of</td></tr>
<tr><td>(...)</td><td>optional data</td></tr>
<tr><td>* ... text ...*</td><td>delimits a comment</td></tr>
</table>

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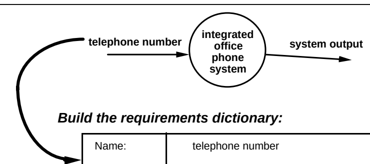
Data Dictionary Example



Build the requirements dictionary:

<table>
<tr><td>Name:</td><td>telephone number</td></tr>
<tr><td>Aliases:</td><td>phone number, number</td></tr>
<tr><td>Where/How used:</td><td>read-phone-number (input)
display-phone-number (output)
analyze-long-distance-calls (input)</td></tr>
<tr><td>Description:</td><td>telephone no. = [local extension | outside no. | 0]
outside no. = 9 + [service code | domestic no.]
service code = [211 | 411 | 611 | 911]
domestic no. = ((0) + area code) + local number
area code = *three numeral designator*</td></tr>
<tr><td>Format:</td><td>alphanumeric data</td></tr>
</table>

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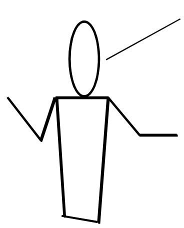
Writing the Software Specification



Everyone knew exactly what had to be done until someone wrote it down!

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Specification Guidelines

- ❑ use a layered format that provides increasing detail as the "layers" deepen
- ❑ use consistent graphical notation and apply textual terms consistently (stay away from aliases)
- ❑ be sure to define all acronyms
- ❑ be sure to include a table of contents; ideally, include an index and/or a glossary
- ❑ write in a simple, unambiguous style (see "editing suggestions" on the following pages)
- ❑ always put yourself in the reader's position, "Would I be able to understand this if I wasn't intimately familiar with the system?"

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Specification Guidelines

Be on the lookout for persuasive connectors, ask why?
keys: *certainly, therefore, clearly, obviously, it follows that ...*

Watch out for vague terms
keys: *some, sometimes, often, usually,ordinarily, most, mostly ...*

When lists are given, but not completed, be sure all items are understood
keys: *etc., and so forth, and so on, such as*

Be sure stated ranges don't contain unstated assumptions
e.g., *Valid codes range from 10 to 100.* Integer? Real? Hex?

Beware of vague verbs such as *handled, rejected, processed, ...*

Beware "passive voice" statements
e.g., *The parameters are initialized.* By what?

Beware "dangling" pronouns
e.g., *The I/O module communicated with the data validation module and its contol flag is set.* Whose control flag?

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Specification Guidelines

When a term is explicitly defined in one place, try substituting the definition forother occurrences of the term

When a structure is described in words, draw a picture

When a structure is described with a picture, try to redraw the picture to emphasize different elements of the structure

When symbolic equations are used, try expressing their meaning in words

When a calculation is specified, work at least two examples

Look for statements that imply certainty, then ask for proof
keys; always, every, all, none, never

Search behind certainty statements—be sure restrictions or limitations are realistic

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