Flow Oriented Modeling
• Structured analysis and design
• Top-down methodology
• Graphical technique depicting information flows and the transformations that are applied as data moves from input to output

Modeling Tools
• Context Diagram
• Data flow diagram
• Entity-relationship diagram
• Control-flow diagram
• State-transition diagram
• Data dictionary
• Process specification (PSPEC)
• Control Specification (CSPEC)

Steps
• Develop Context Diagram -- diagram 0
• Decompose the Process into high level processes
• In Parallel
  – Develop Data Flow Diagram(s)
  – Develop Entity-Relationship Diagram
  – Develop State-Transition Diagram
• Define data stores
  – normalization
• Develop Data Dictionary
• Finalize DFD, ER, STD
• Develop Process Specifications
  – PDL, Decision Tables or Trees
• Perform Transformational Analysis
  – Develop Structure Charts

Data Flow Diagrams
• Hierarchically structured
• each level in the hierarchy shows increased detail
  – each level continues the same inputs/outputs as previous level
• data dictionary is used to document the data flowing
  – leaves diagrams less cluttered
• do not show control: iteration or selection
• each level of the diagram must fit on one page

Usage Rules
• a data flow is either output or input but not both
• if 2 data flows exist between two nodes (either process bubbles, external entities, or data stores) the data flowing must be different
• must be a transformation (process bubble) between nodes
• each process must have both input and output

Finding Errors at a glance

Reading a Data Flow Diagram
• Start in upper left hand corner with lowest numbered process and move to right
• follow the output then the input to next in numbered sequence
• continue until entire diagram has been traveled
Level 1 diagram for Video system
Building the Data Flow Diagram

- Provides an indication of how data is transformed as it moves through the system
- Depicts the functions and sub-functions that transform data
- Start with the context diagram
- Decompose the system into 5-7 sub-processes
- Level 0 diagram depicts the 5-7 sub-process and the data stores used by the sub processes
- Check for consistency with the context diagram
- Each sub-process is then decomposed into sub-functions which are then diagramed
- For each process bubble on any diagram there is an accompanying PSPEC depicting detailed logic

Steps in Developing a Data Flow Diagram

- establish conceptual view
  - identify the outputs and their sinks
  - identify the inputs and their sources
- define top level processes
  - 5-7 sub functions
  - where data is transformed - not stored
- diagram each top level process
- define data stores
- build single diagram -- level 0

Defining the Top Level Processes

- determine the events that drive the system
  - examine each external entity and ask what effects their actions have on the system
  - examine each event and determine if all instances of the event involve the same data
  - event lists must include normal and abnormal processing
    Consistency Checking with the Context Diagram
  - each input flow is needed by the system to recognize that an event has occurred, or is needed to produce a response to an event
  - each output flow is the response to an event
  - each non temporal event should have input from which the system can detect that the event has occurred (control events)
Context Diagram for an Automatic Teller Machine

User
- card pin #
- operation amount
- card receipt cash

ATM
- verify account
- transactions
- balance

Bank
- accounts
Level 0 Data Flow Diagram for an Automatic Teller Machine

1. Validate Customer Access
   - Card, pin number
   - validation info
   - Customer

2. Obtain details of transaction
   - Selections, amount, (cash)
   - authorization
   - Transaction info

3. Validate transaction
   - transaction info

4. Process transaction
   - card, receipt, (cash)
   - account info
   - Bank

5. Reject transaction
   - rejected transaction
   - card and receipt

Rejected customer

Customer validation

Account validation

Validation info
Context Diagram

Customer

Available publications
Subscriptions and personal info
Payment
Vacations

Newspaper Delivery System

Daily delivery list
Payment
Bills
Pick-up list

Publishers

Available publications
Invoice
Orders

Newsagent

Summary listing

Delivery Person
Data Modeling

- **Describe the logical, not physical makeup of the data**
- **Database**
  - Collection of related information which can be implemented using standard file techniques or a Database Management System
- **Describe the associations between the entities and a strategic overview of data**
  - Specify the data objects, their attributes, and the relationships between them
- **Entity**
  - Thing that exists and is distinguishable
  - Anything we store data about
  - Real world objects with common properties
- **Instance**
  - Particular occurrence in an entity
  - Videos
    - “Office Space”
- **Relationship between entities**
  - Connection between entities
  - Example customer-video
    - Rents
  - Cardinality
    - Indicates # of instances in one class which can be associated with instances in another
    - One-one, one-many, many-many
  - Modality
    - Association between instances is mandatory or optional
- **Attributes**
  - Defines the properties of an entity
    - Key -- unique identifier
    - Descriptive
    - Referential – used to tie one entity with another

Entity Relationship Diagram

- **Graphical representation of the data model**
- **Full blown diagram shows entities, relationships, and attributes**
- **Ours will only show entities, relationships. Attributes will be shown on Warnier-Orr diagram.**
- **Diagramming symbols**
- **Entity -- Labeled rectangle**
- **Relationship – arc connecting two entities**
  - Cardinality – labeled at both ends of the relationship arc
  - Modality – labeled at both ends of the relationship arc
Constructing E-R diagrams

• Iteratively
  – During elicitation ask customers to list “things” the applications addresses
    • Things may evolve into external entities, actors, or data objects
  – Taking each object individually determine if it is related to any other object
  – Create relationship pairs
    • Diagram the relationship, cardinality, and modality
    • Handle any many-many relationships
    • Build a single diagram from refined relationship pairs
E-R group relating to rent a video

Another E-R group relating to rent a video
Single Entity-Relationship Diagram
Newspaper System
Newspaper System ERD -- Finalized

- Publications
- Subscriptions
- Customer
- Cust_vacation
Warnier-Orr diagrams

- Method of representing hierarchical information
- Decomposition diagram
  - Horizontal rather than vertical
- Contains constructs for sequence, iteration and selection
- Brackets depict subordination
  - Functional breakdown of item at the head of the bracket
  - Sequence – top to bottom
  - Iteration – \((n)\), \((1,n)\), \((0,1)\), \((0,n)\)
  - Selection
    - + mutual inclusion – one or other or both
    - \(\oplus\) mutual exclusion – one or other but not both
### Figure 11.3  Sales contract.

**SALES CONTRACT**

**Contract No. 7094**

<table>
<thead>
<tr>
<th>Sold By</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbert H. Matlock</td>
<td>01/08/63</td>
</tr>
</tbody>
</table>

**Address**

- 1901 Kael Road
- Pima, Illinois 64726
- Phone: 003-259-3130
- Customer #: 18506

**Description**

- New Samick 6'2" Grand Piano model Q-1A
- # 620961 with Marantz P-101 # 11359

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
<th>Discount</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td># 620961</td>
<td>8000.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Amount**: 8000.00

**Trade-in Allowance**: 2500.00

**Sales Tax**

- 20.00%
- **Deposit**: 1000.00

**Final Balance**: 6000.00

**Please note**: All sales pending approval by management and verification of trade-in description.

If this contract is breached by the Buyer, the Seller may take appropriate legal action, or, at its option, retain the deposit as liquidated damages.

**Buyer's Signature**

---

### Figure 11.4  Warnier-Orr Diagrams

**Sales Contract**

- **Contract Number**
- **Date**
- **Salesperson**
- **Customer Information**
  - **Customer Number**
  - **Name**
  - **Address**
  - **City**
  - **State**
  - **Zip**
  - **Telephone**
- **Remarks**
- **Delivery Address**
- **Order Information**
  - **Part Number**
  - **Part Description**
  - **Price**
  - **Discount**
  - **Quantity Ordered**
  - **Amount**
- **Total Amount**
- **Trade-in Allowance**
- **Sales Tax**
- **Deposit**
- **Final Balance**

The sales contract shown in Fig. 11.3 is represented here by a Warnier-Orr diagram.
Warnier-Orr Diagram for the entity Publication of the Newspaper System

Publication

Publication_number

Title
Type

Frequency

Publisher

Name

Last
First

Address

Street
City
State
Zip

Phone
Contact_person

Last
First

Number_ordered

Publisher_price

Subscription_price

Monthly
Yearly
Warnier-Orr Diagram for the entity Video of Video's R Us
Warnier-Orr diagram for a receipt from system Video's R Us