Lecture 15:
Structured Modeling Methods

Basics of Structured Analysis

- Notations used
- Modeling Process

Variants

- SADT
- SASS
- SSADM
- SRD

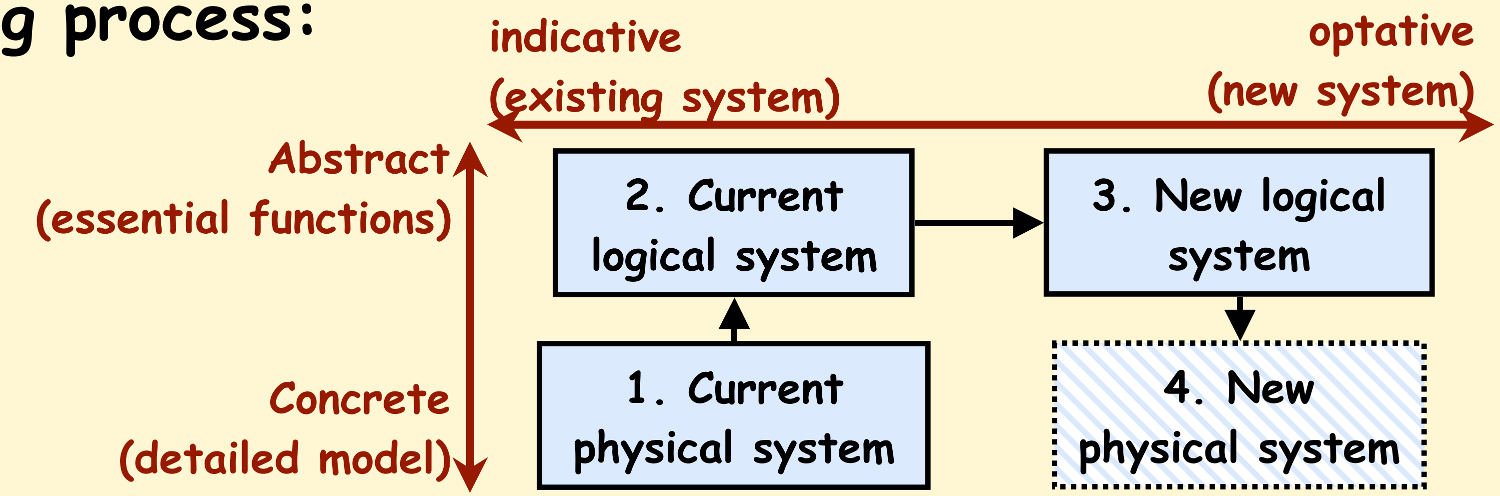
Advantages and Disadvantages

Structured Analysis

Definition

- Structured Analysis is a data-oriented approach to conceptual modeling
- Common feature is the centrality of the dataflow diagram
- Mainly used for information systems
  - variants have been adapted for real-time systems

Modeling process:



- Model of current physical system only useful as basis for the logical model
- Distinction between indicative and optative models is very important:
  - Must understand which requirements are needed to continue current functionality, and which are new with the updated system

Central Concepts

Source: *Adapted from Svoboda, 1990, p257*

Process (data transformation)

- activities that transform data
- related by dataflows to other processes, data store, and external entities.

Data flow

- indicate passage of data from output of one entitie to input of another
- represent a data group or data element

Data store

- a place where data is held for later use
- Data stores are passive: no transformations are performed on the data

External entity

- An activity outside the target system
- Acts as source or destination for dataflows that cross the system boundary
- External entities cannot interact directly with data stores

Data group

- A cluster of data represented as a single dataflow
- Consists of lower level data groups, or individual elements

Data element

- a basic unit of data

Modeling tools

Source: *Adapted from Svoboda, 1990, p258-263*

Data flow diagram

- Context diagram (“Level 0”)
  - whole system as a single process
- Intermediate level DFDs decompose each process
- Functional primitives are processes that cannot be decomposed further

Data dictionary

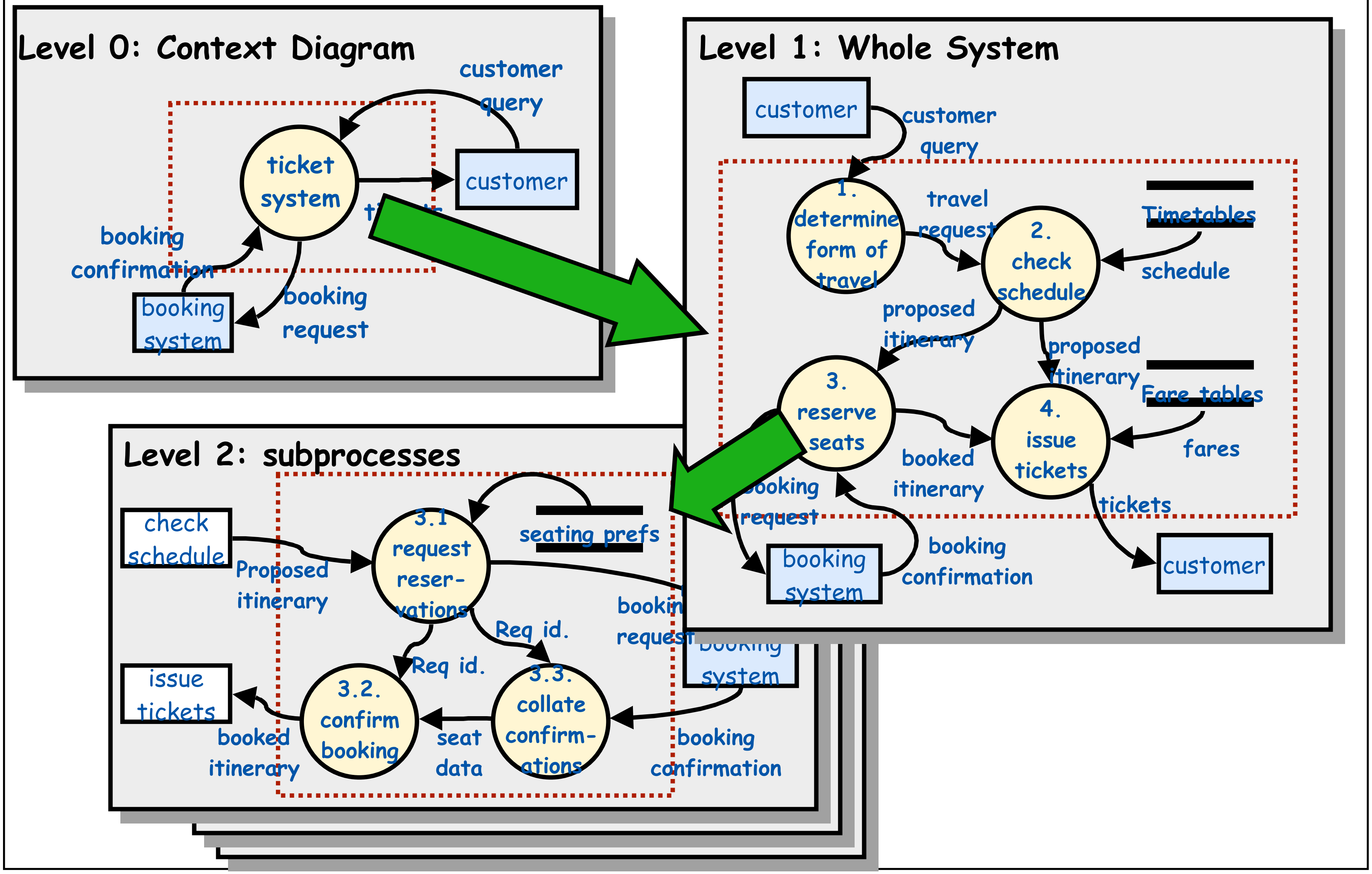
- Defines each data element and data group
- Use of BNF to define structure of data groups

Primitive Process Specification

- Each functional primitive has a “mini-spec”
- These define its essential procedural steps
- Expressed in English narrative, or some form of pseudo-code

Structured Walkthrough

Hierarchies of DFDs



Data Dictionary & Process Specs

Source: *Adapted from Svoboda, 1990, p262-4*

Example Data Dictionary

```
Mailing Label =
    customer_name +
    customer_address

customer_name =
    customer_last_name +
    customer_first_name +
    customer_middle_initial

customer_address =
    local_address +
    community_address + zip_code

local_address =
    house_number + street_name +
    (apt_number)

community address =
    city_name + [state_name |
    province_name]
```

Example Mini-Spec

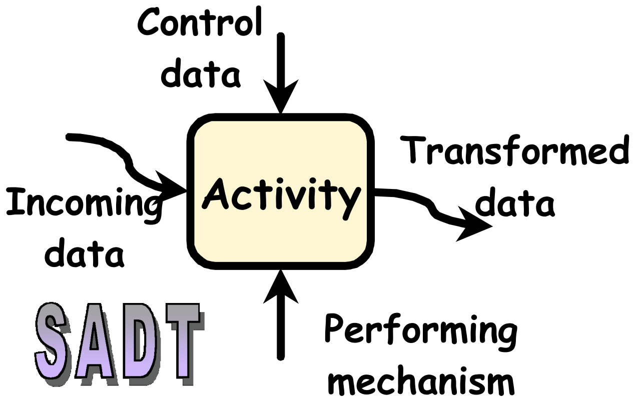
```
FOR EACH Shipped-order-detail
    GET customer-name + customer-
    address
    FOR EACH part-shipped
        GET retail-price
        MULTIPLY retail-price by
            quantity-shipped
        TO OBTAIN total-this-order
CALCULATE shipping-and-handling
ADD shipping-and-handling TO
    total-this-order
    TO OBTAIN total-this-invoice
PRINT invoice
```

Source: Adapted from Svoboda, 1990, p264-5

DFD variants

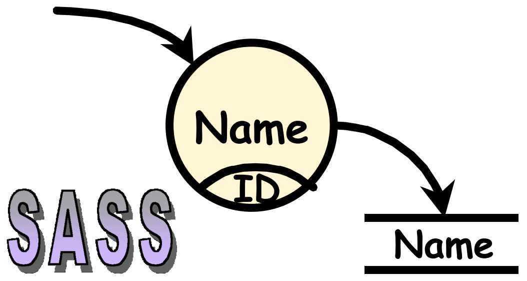
Structured Analysis and Design Technique (SADT)

- Developed by Doug Ross in the mid-70's
- Uses activity diagrams rather than dataflow diagrams
- Distinguishes control data from processing data



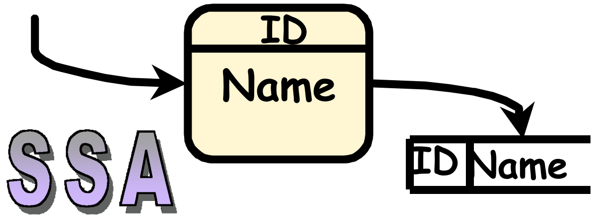
Structured Analysis and System Specification (SASS)

- Developed by Yourdon and DeMarco in the mid-70's
- 'classic' structured analysis



Structured System Analysis (SSA)

- Developed by Gane and Sarson
- Notational style slightly different from Yourdon & DeMarco
- Adds data access diagrams to describe contents of data stores



Structured Requirements Definition (SRD)

- Developed by Ken Orr in the mid-70's
- Introduces the idea of building separate models for each perspective and then merging them

SASS methodology

Source: *Adapted from Davis, 1990, p83-86*

1. Study current environment

draw DFD to show how data flows through current organization

label bubbles with names of organizational units or individuals

2. Derive logical equivalents

replace names with action verbs

merge bubbles that show the same logical function

delete bubbles that don't transform data

3. Model new logical system

Modify current logical DFD to show how info will flow once new system is in place

Don't distinguish (yet) which components will be automated

4. Define a number of automation alternatives

document each as a physical DFD

Analyze each with cost/benefit trade-off

Select one for implementation

Write the specification

Source: *Adapted from Davis, 1990, p72-75*

Alternative Process Model: SRD

1. Define a user-level DFD

interview each relevant individual in the current organization

- actually a role, rather than an individual

Identify the inputs and outputs for that individual

Draw an 'entity diagram' showing these inputs and outputs

2. Define a combined user-level DFD

Merge all alike bubbles to create a single diagram

Resolve inconsistencies between perspective

3. Define the application-level DFD

Draw the system boundary on the combined user-level DFD

Then collapse everything within the boundary into a single process

4. Define the application-level functions

label the inputs and outputs to show the order of processing for each function

- I.e. for function A, label the flows that take part in A as A1, A2, A3,...

Later developments

Later work recognized that:

- development of both current physical and current logical models is overkill
- top down development doesn't always work well for complex systems
- entity-relationship diagrams are useful for capturing complex data

Structured Analysis / Real Time (SA/RT)

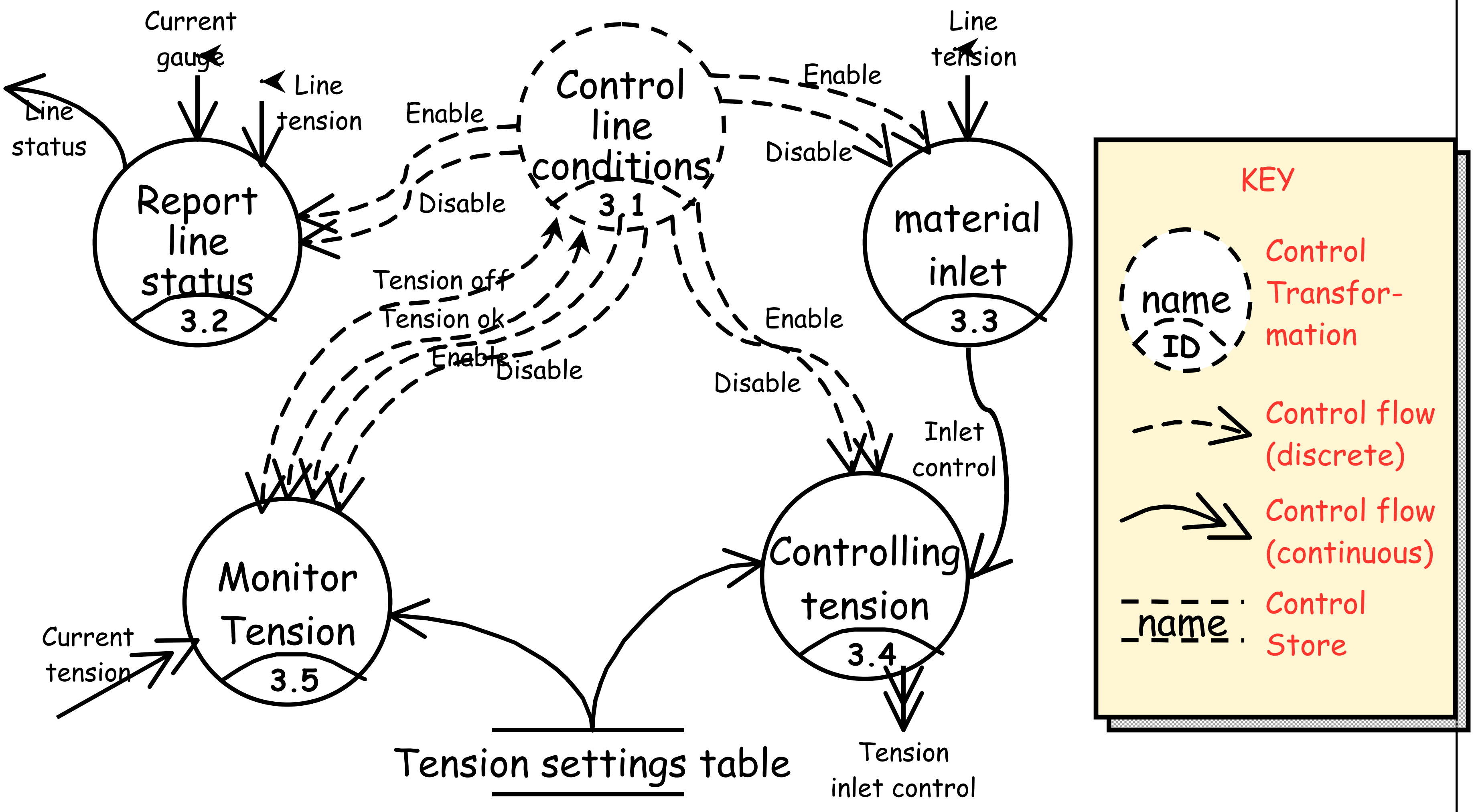
- Developed by Ward and Mellor in the mid-80's
- Extends structured analysis for real-time systems
  - Adds control flow, state diagrams, and entity-relationship models

Modern Structured Analysis

- Captured by Yourdon in his 1989 book
- Uses two models: the environmental model and the behavioral model
  - together these comprise the *essential* model
- Includes plenty of advice culled from many years experience with structured analysis

Real-time extensions

Source: *Adapted from Svoboda, 1990, p269*



Evaluation of SA techniques

Advantages

Source: *Adapted from Davis, 1990, p174*

- Facilitate communication.
- Notations are easy to learn, and don't require software expertise
- Clear definition of system boundary
- Use of abstraction and partitioning
- Automated tool support
  - e.g. CASE tools provide automated consistency checking

Disadvantages

- Little use of projection
  - even SRD's 'perspectives' are not really projection
- Confusion between modeling the problem and modeling the solution
  - most of these techniques arose as design techniques
- These approaches model the system, *but not its application domain*
- Timing & control issues are completely invisible
  - although extensions such as Ward-Mellor attempt to address this

References

van Vliet, H. “Software Engineering: Principles and Practice (2nd Edition)” Wiley, 1999.

In common with many authors, van Vliet does not separate structured analysis from structured design. This makes sense because the two are intended to be used together. Section 11.2.2 gives a nice overview of the whole process, based on Yourdon’s notations (SASS & descendents). He also gives a good introduction to SADT in section Section 9.3.3.

Svoboda, C. P. “Structured Analysis”. In Thayer, R. H and Dorfman, M. (eds.) “Software Requirements Engineering, Second Edition”. IEEE Computer Society Press, 1997, p255-274

Excellent overview of the history of structured analysis, and a comparison of the variants

Davis, A. M. “Software Requirements: Analysis and Specification”. Prentice-Hall, 1990.

This is probably the best textbook around on requirements analysis, although is a little dated now.