EECS 222: Embedded System Modeling Lecture 11

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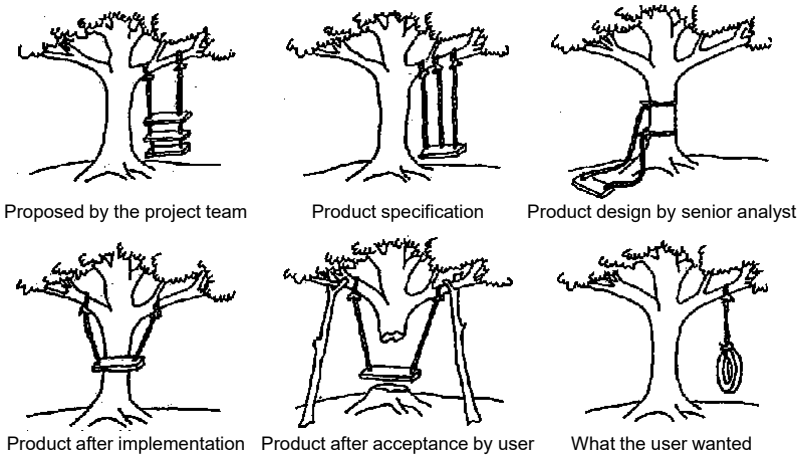
Lecture 11: Overview

- Embedded System Specification
  - Essential issues
  - Specification Modeling Guidelines
- Project Assignment 6
  - Structural Refinement of the DUT of the Canny Edge Detector
- Project Assignment 7
  - *Combined with Assignment 6!*

Essential Issues in Model Specification

- An Example ...



Proposed by the project team | Product specification | Product design by senior analyst

Product after implementation | Product after acceptance by user | What the user wanted

Source: unknown author

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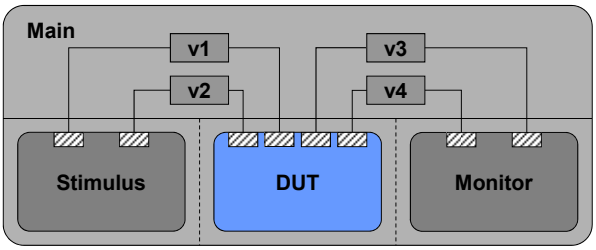
Specification Model

- Test bench
  - Main, Stimulus, Monitor
  - *Simulation only, no synthesis (no modeling restrictions)*
- DUT
  - Design under test
  - *Simulation and synthesis! (restricted by modeling guidelines!)*



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Specification Modeling Guidelines

- Specification Model = “Golden” Reference Model
  - first functional model in the top-down design flow
  - all other models will be derived from and compared to this one
- High abstraction level
  - no implementation details
  - unrestricted exploration of design space
- Purely functional
  - fully executable for functional validation
  - no structural information
- No timing
  - exception: timing constraints
- Separation of communication and computation
  - channels and behaviors/modules

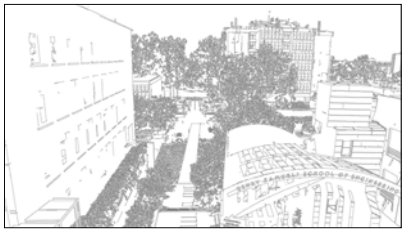
Specification Modeling Guidelines

- Computation: in Behaviors / Modules
  - Granularity: Leaf behaviors = smallest indivisible units
  - Hierarchy: Explicit execution order
    - Sequential, concurrent, pipelined, or FSM
  - Encapsulation: Localized variables, explicit port mappings
  - Concurrency: Potential parallelism explicitly specified
  - Time: Untimed (partial order only)
- Communication: in Channels
  - Communication: Standard channel library
  - Synchronization: Standard channel library
  - Dependencies: Data flow explicit in connectivity

EECS 222 Project

- Application Example: Canny Edge Detector
  - Embedded system model for image processing:
    Automatic Edge Detection in a Digital Video Camera

EngPlaza001.bmp



EngPlaza001_edges.pgm

  - Video taken by a drone hovering over UCI Engineering Plaza
    - Available on the server: **`~eecs222/public/video/`**
    - High resolution, 2704 by 1520 pixes
    - Video length 9 seconds, using 20 extracted frames for test bench model

Project Assignment 5

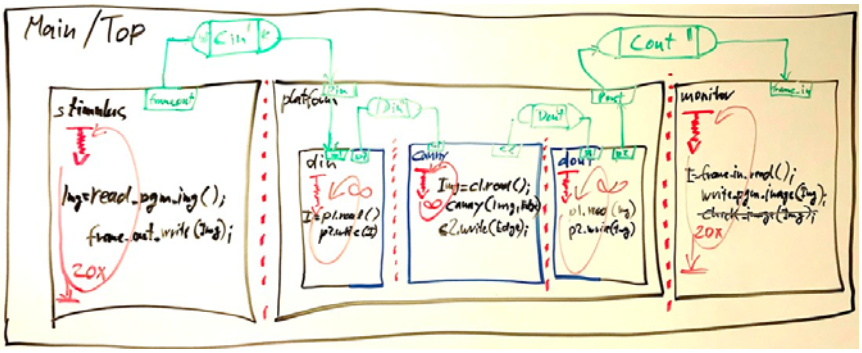
- Task: Structural Test Bench Model
  - Expected instance tree

```
Main / Top
|------ Stimulus stimulus
|------ Platform platform
|       |------ DataIn din
|       |------ DUT canny
|       \------ DataOut dout
\------ Monitor monitor
```

  - Communication via standard channels
    - SystemC: **`sc_fifo<IMAGE>`** based on class **`IMAGE`**
    - SpecC: **`c_img_queue`** based on typedef **`img`**
  - ➢ Pay attention to stack sizes!

Project Assignment 5

- Structural Test Bench for the Canny Edge Detector
  - Discussion on whiteboard: Top-level structure, platform for DUT



Project Assignment 6

- Task: Hierarchical DUT of the Canny Edge Detector
  - Refine the structural hierarchy of the DUT block
  - (skipped: refine the structural hierarchy of Gaussian Smooth)
- Steps
  1. Refine the DUT structure
     - Gaussian Smooth, Derivative, …, Apply Hysteresis
  2. Visualize the structural hierarchy of the model
     - (skipped: decomposition of Gaussian Smooth)
- Deliverables
  - **`canny.sc`** or **`canny.cpp`** (choose one!)
  - **`canny.tree`**
- Due: February 19, 2020, 6pm

Project Assignment 6

- Step 1: Refined hierarchy of the DUT block
  - Expected instance tree

```
Platform platform
|------ DataIn din
|------ DUT canny
|       |------ Gaussian_Smooth gaussian_smooth
|       |------ Derivative_X_Y derivative_x_y
|       |------ Magnitude_X_Y magnitude_x_y
|       |------ Non_Max_Supp non_max_supp
|       \------ Apply_Hysteresis apply_hysteresis
\------ DataOut dout
```


Project Assignment 6

- Structural model of the DUT of the Canny Edge Detector
  - Discussion on whiteboard: Refined DUT structure