

# Best Practices: Overview & Process-Oriented

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Using Modeling to Prepare for  
Changing Healthcare Needs

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# Two Important Concerns

- Building the right model
  - Level of depth & breadth: Where to stop in disaggregation?
  - Division between endogenous, exogenous & ignored
- Building the model right
  - For agent-based modeling, this involves consideration of software engineering principles

# Building the Model Right: Some Principles of Software Engineering

## Technical guidelines

- Eschew speculative complexity
- Use abstraction & encapsulation to simplify reasoning & development
- Name things carefully
- Design & code for transparency & modifiability
- Use configurable logging
- Document & create self-documenting results where possible
- Consider designing for flexibility
- Use defensive programming
- Use type-checking to advantage
  - Subtyping (and sometimes subclassing) to capture commonality
  - For unit checking (where possible)

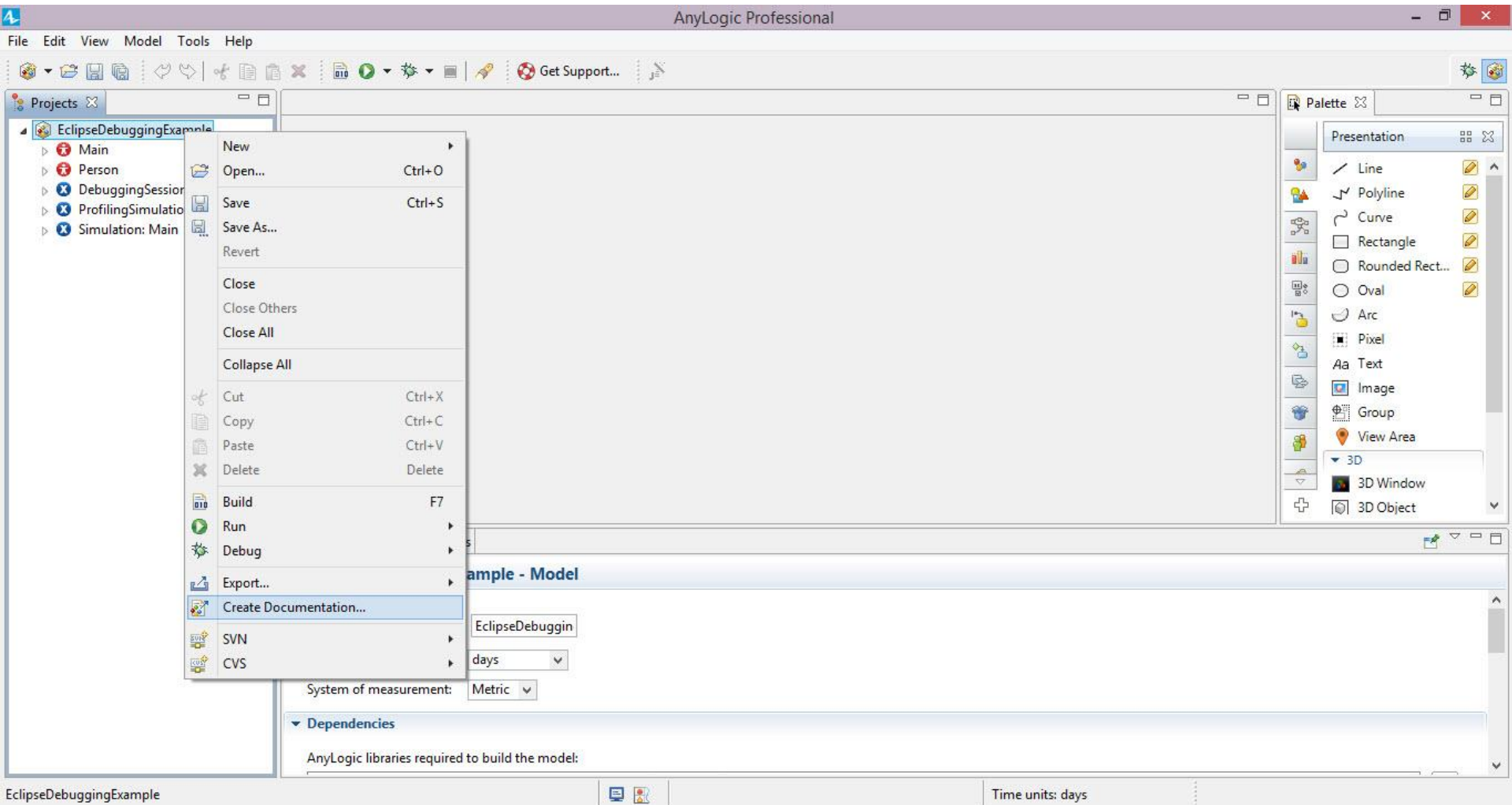
## Process guidelines

- Use peer reviews to review
  - Preliminary design/Code/Tests
- Where possible, perform simple tests to verify functionality
- Preserve successive distinct model versions
- Keep careful track of experiments
- Use tools for version control & documentation & referent integrity
- Integrate with others' work frequently & in small steps
- Use discovery of bugs to identify process weaknesses

# Process Suggestions

- Use discovery of bugs & oversights to find opportunities to improve Q & A and broader modeling process
- Use peer reviews (& especially inspections) to review
  - Preliminary design/Code/Tests
- Use tools for version control & documentation & referential integrity
  - Rigorous versioning
  - Document linkages between artifacts
- Keep careful track of experiments
- Strive for ongoing process improvement
- Use focused prototypes where appropriate
- Perform simple tests to verify functionality
- Integrate with others' work frequently & in small steps

# Generate Documentation



# Selecting Documentation Output

**Create Model Documentation**  
Create a document with description of all model elements and their properties

Document name: abmmmodelwithbirthdeath\_Documentation

Location: D:\Documents Browse...

Format: PDF - Portable Document Format

Orientation:  
 Portrait  
 Landscape

Paper Size: Letter

< Back   Next >   **Finish**   Cancel

# Example Documentation

abmmodelwithbirthdeath\_Documentation.pdf - Adobe Reader

File Edit View Window Help

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Tools Sign Comment

*EclipseDebuggingExample*

## Model: EclipseDebuggingExample

Name	Value
General	
Model Time Units	Day
Advanced	
Java Package Name	abmmodelwithbirthdeath
File Name	D:\workshop before 2013\Example Models\EclipseDebuggingExample\EclipseDebuggingExample.alp
Numerical methods	
Differentiation Equations Method	EULER
Algebraic Equations Method	MODIFIED_NEWTON
Mixed Equations Method	RK45_NEWTON
Absolute Accuracy	1.0E-5
Time Accuracy	1.0E-5
Relative Accuracy	1.0E-5
Fixed Time Step	0.0010

## Agent Type: Main

Name	Value
General	

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# Incremental Delivery



# Best Advice: Start Simple!

- It is easy to get lost in these models
- Focus on building up the models incrementally, as insights arise
- Innovate off of simple examples
- Avoid the temptation of the “big bang” project

# Some Benefits of Incremental Delivery

- Morale: Get products soon
- Discover problems sooner
- Flexibility to change direction in way that reflects new knowledge & understanding
- Easier to estimate time required for next deliverable
- Can better handle slower progress or unexpected schedule limits: At least get some value from dev.
- Get more insight about what to do by tangibly working with a produced artifact
- Can avoid “gilding the lily” by heading off unnecessary development

# Continuous Integration

# Continuous Integration

- Continuous integration involves ongoing integration of different people's contributions to an underlying artifact
  - This is in contrast to the traditional “big bang” approach of integrating all elements at once
- Continuous integration is conceptually different from but helps support incremental delivery

# Continuous Integration: Advantages

- Cooperation: Greatly reduces integration headaches
  - Reduced likelihood of merge conflicts
  - Easier, less wasteful to fix if conflict occurs
  - Allows bigger teams to function nimbly
- Quicker identification of problematic modifications & bugs
- Helps identify state of project via smoke tests, availability of executable
- Improved estimation, flexibility for shipping
- Feedback: Reduces need for status reports, polling
  - Automated build validation test (BVT) scripts
- Improves team morale
- Helps force fixing bugs before continuing

# Managing Process Complexity

# Process Complexity: A Barrier to Quality ABM Modeling

- Medium+ scale ABM projects generate a large # & diversity & versions of related artefacts
- Careful coordination of these artefacts is important for ensuring quality insights
- Efficient coordination is important for productivity
- Existing tools offer limited support for such coordination
- Difficulties limit what can be accomplished

# Common Elements of the MP

- Creation of a modeling project
- Successive model versions are created for that project
- Each version is evaluated wrt a scenario set
  - Each scenario is motivated by some intention
  - This frequently includes a baseline and alternative scenarios
  - Frequently the set of scenarios exhibits some systematic structure
  - Results are analyzed (often in external docs)
- There is a frequent need to share access to these artifacts



# Important Gaps in Software Support

- Model version control
  - Rollback
  - Comparison with earlier versions
- Ability to collaborate on shared artifacts
  - Communication of artifacts across machine/institutional boundaries
- Reification of structured scenario collections
- Lack of explicit links & referential integrity b/t
  - Versions & scenarios
  - Conceptually linked versions
  - Metadata & data
    - Motivation for creating scenario collection & scenario outputs
    - Artifacts & docs on intentions for producing them
    - Definition of scenario & output
    - Output & analysis documents
- Distributed evaluation of large scenario sets

# Why the Gaps Matter

- Process transparency
- Risk of modeling errors
- Client confidence
- Speed of learning
- Modeling efficiency
- Practical limits on project scope

# Risk-Driven Testing

# Testing: Not Just “Finding Bugs”

- Identifying other quality problems
  - Design departures from requirements
  - Usability problems (particular power users)
- Should focus on *important bugs*
- Give immediate feedback on rough quality
  - Broad look at entire system
- Identify usability issues early thru test design
- Using different bug identifications than skills than developers
- Effective reporting critical

# JUnit Tie-ins

- Tools like JUnit can be used to do some testing against AnyLogic models
- Broad AnyLogic testing is made more challenging by need to create appropriate test harnesses for testing extensions of AnyLogic classes
- Suggestion:
  - Create alternative experiments for focused testing
  - Create alternative startup logic in Main that calls testing-specific methods

# Prototypes

# Some suggestions on Prototypes

- Try adding in detail in experimental (throw-away) prototypes before commit to it
- Prototype two ways of approaching something
  - This takes time, but may save more time

# Prototypes – Not Just for the UI!

- Engineering mockups critical in other domains (e.g. construction)
- Identify relationships between components
- Identify risks
- Identify potential engineering savings from design changes
- Understanding interfaces between components
- Understanding testing priorities



# Prototypes

- Minimal mockups to test (grouped) ideas
  - Examine key issues w/o assumption that using this approach
- Risk analysis e.g.
  - Prototype most challenging or highest priority questions
  - Pick best idea from each affinity group for prototyping
  - Prototype each affinity group
- Should be for throw-away use – do not to use code
- Later use should be driven by open issues & decision making needs

# Peer Reviews & Inspections

# Reviews: Why?

- More cost-effective than testing
  - IBM found 3.5 hours/error for inspection removal vs. 15-25 hours/error for testing
- Easily pay for themselves (“Quality is Free”)
- More flexible than testing
  - **Need not wait for executable code**
    - Can perform at all stages of software engineering process
    - Can be done early in the development of a component
  - Can assess communications issues (clarity, style, commenting, etc.)

# Importance of Early Reviews

- Requirements
- Early artifacts have disproportionate impact on development process
- Marketing documents
- UI design
- Design
- Unit implementation
- Unit testing

# Other Benefits of Peer Reviews To...

- Person reviewing the artifact (Clarify understanding, learn coding tricks, stylistic ideas)
- Person whose artifact is being reviewed
  - Improving technique, learn
- Broader culture
  - Spread of knowledge about code base
  - Spread of knowledge of standards, coding styles
  - Code written with other people in mind



# Guidelines for reviews

- Keep impersonal: Focus on artifact, not people
- Keep review team small (3-7 participants)
- Try to identify -- **but not solve** -- problems during review
- Limit meeting to no more than 2 hours
- Require advanced preparation for **formal** reviews
- Be sensitive to cultural and human components
- Prioritize focus for more major issues

# Inspection: Best Practices (Wiegers)

- Plan inspections to address project & inspection objectives
- Inspect upstream documents first
- Begin inspect documents early in their lives
- Check against source and related documents
- Prepare & inspect at your organization's optimum rates
- Focus on major defects
- Measure your benefits from inspections
- Emphasize defect prevention and process improvement
- Use serious, quantitative entry and exit conditions



# Stages: Planning

- Participants review material on own before meeting
- Moderator assigned at this point
- Author contributes objectives for inspection
- Based on historic data moderator estimates # of meetings required to do reviews of desired scope
- Moderator
  - Invites participants
  - Helps author prepare package of materials for inspections
  - Distributes package to participants several days ahead of time

# Stages: Overview

- Often a separate meeting
- Author more informally describes perspective on product
- Sometimes the inspection package is distributed during this meeting
- Sometimes skip if
  - Participants already familiar with product
  - Overview can be described in package

# Stages: Preparation

- Most preparation centers around inspection package
  - The deliverable to be inspected
  - Standards/Requirements/Specifications
  - Typo list/individual issue log
  - Work aids to help identify defects
    - (e.g. Common defects for this sort of deliverable)
  - Test documentation to verify this deliverable

# Stages: Meeting 1

## ■ Deliverables

- "inspection summary report" (moderator)
  - Work product appraisal
  - Information to communicate to mgmt, etc.
- "issues log"
- Indication of what changes are needed to complete inspection process
- May stop inspection if identified errors are too serious to make it worth it to continue

# Meeting Participant Roles

- Author (shares perspective)
- Moderator: leads process
- Reader: presents pieces of code (and perspectives on) to inspectors
  - Can help catalyze shared understanding by inspectors
- Inspectors: (any participant, including those assigned to other roles)
  - Can critique code
  - Can identify possible issues where errors
- Recorder: Documents issues
- Typically 3-4 participants

# Stages: Rework

- Author addresses most items in issues log
- Sometimes issue log items get assigned to others
- Sometimes just log defects in defect control system to be followed up later
- Result
  - Updated work product
  - Annotated issue log indicating resolution for each item

# Stages: Followup

- Often with moderator as "verifier" (moderator decides when process is over)
- Verifier confirms that changes have been successfully made
- Baselining of changed deliverable into SCCS

# Stages: Causal analysis

- This basically uses inspection process to improve
  - The development process
  - The inspection process
- Focus on process improvement and not on people
- Try to identify root cause of defects
  - E.g. Ambiguous explanations in requirements, design specs, inconsistent naming conventions