HYPOTHESIS TESTING AS A FRAMEWORK FOR RESTORATION DESIGN

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Part II
Short Course

Day 1: August 9th, 2010
OBJECTIVES

LESSON:
• Share a design technique to help augment your own design approaches
• Explore concept of design hypothesis testing

REST OF WEEK:
• Highlight some available tools for testing design hypotheses in:
  – Design
  – Monitoring
1. Review of Design
2. Contrasting Channel Design Approaches
3. Concept of a Design Hypothesis
4. Formulating Design Hypotheses
5. Preview of Week
Balance between a **creative** design development process and an **objective** design selection process to arrive at a final design.

**Problem**

- Design Development

**Solution**

- Design Selection

**DESIGN PROCESS**

Should design process be implicit or explicit?
Is the design transparent or is it a blackbox?

- Expectation Management
- Missed Learning Opportunities (Adaptive Management)
- Increased Liability
SOME GOALS THIS WEEK

**DESIGN PROCESS**

- We don’t want to take your **creativity** out of design development process
- Provide you with more tools for developing different design scenarios
- We don’t question your **objectivity** in the design selection process
- Provide you with some additional tools for testing your designs
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MANY APPROACHES TO DESIGN

• Found in:
  - In practice
  - Your own experience
  - Restoration short-courses (e.g. ICRRR, Rosgen, Portland State)
  - Restoration literature

• Is design process implicit or explicit?

• What is the ‘right’ way to design?
Phase 1: Preliminary Planning
Phase 2: Pre Project Characterization
Phase 3: Design Development
Phase 4: Final Design Selection
Phase 5: Construction
Phase 6: Post Project Assessment
Phase 7: Long-term Monitoring & Adaptive Management

MODE KEY:

- DCM: Conceptualization Mode
- CM: Scientific Exploration Mode
- SEM: Data Collection Mode
- MM: Modeling Mode

MOST APPROACHES FOLLOW SEQUENCE

Sequence dictated by how projects unfold...

(Wheaton et al. 2004a &b): or see: http://shira.lawr.ucdavis.edu/
POPULAR BUT VAGUE LABELS FOR RESTORATION APPROACHES

• Holistic
• Science-based
• Integrated
• Multi-Disciplinary
• Ecosystem Restoration

Redmon Washington Bridge & Restoration
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MORE MEANINGFUL, DISCRIMINATING LABELS

1. Spatial Scale: Catchment-scale versus Reach-scale
2. Passive versus Active
3. Form vs. Process
TO WAIT... OR NOT TO WAIT?

Active vs. Passive Approaches to Restoration and Recovery

We pursue **active** approaches to restoration when:

• We are not willing or able to wait for natural recovery

• Recovery needs a ‘kick start’ or resetting of the boundary conditions

We pursue **passive** approaches to restoration when:

• System is sufficiently dynamic that fluvial processes will allow it to ‘restore’ itself
IN THIS COURSE -> CHANNEL DESIGN

- Focus is on designing channels…

(i.e. modifying an existing channel’s geometry, occupying a former channel alignment, constructing a new channel)
CONTRASTING APPROACHES TO DESIGN

• Lots of different ways to design
  – What are strengths and weakness of each?
  – Each actually provides a reasonable starting point (or counter-point) for design
  – By themselves not as useful (in conjunction more powerful)
  – Premise -> You can get more out of all of these approaches using design hypotheses
OUTLINE

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WHAT IS A DESIGN HYPOTHESIS?

• An educated guess or prediction that articulates how specific design features are supposed to result in specific outcomes, functions and/or processes

From Wheaton, Pasternack and Merz (2004)
‘A supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation’

‘A proposition made as a basis for reasoning, without any assumption of its truth’
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HOW DO I DESIGN A CHANNEL?

• Given a blank-slate, where would you start?
• Look at something else for ideas (analogues)?
  • Reference reach
  • Empirical formulas
  • Concepts
  • Theory

Come up with the design, then articulate your predicted responses as design hypotheses…
How do you translate a design idea or feature to a design hypothesis?

1. Identify concept or analogue that is guiding use of a specific design feature
2. Succinctly describe exactly what the design feature is
3. Clearly articulate what the intended function or expected result of that feature is
4. Try to rephrase in a way that focuses on how that design hypothesis could be tested
ADVANTAGES OF DESIGN HYPOTHESES

• Improve any design by formulating design hypotheses because:
  - Forces a clear articulation of design intent
  - Highlights what is testable and what is not
  - Testable design hypotheses can help avoid costly mistakes
  - Emphasizes iterative nature of design
  - Establishes a level of design transparency that makes it easier for reviewers to give more constructive feedback
  - Provides a clear link between design and monitoring within an adaptive management framework
  - Expectation management...
HOW MANY DESIGN HYPOTHESES FOR A SINGLE DESIGN SCENARIO?

• Many (>5-10)

• Every individual design feature should have a design hypothesis associated with it (if it was important enough to include in the design, include a design hypothesis for it)
HOW MANY DESIGN SCENARIOS FOR A SINGLE RESTORATION PROBLEM?

• At least 2… the more the better
• Use design scenarios with contradictory design hypotheses to test competing ideas
• Not sure what you like best… try them all (cheaper to do in design then build on ground)
• As many as your budget will allow
WHY AREN'T DESIGN HYPOTHESES USED MORE?

• In traditional engineering, problems are better constrained and well understood -> Expectation is we know how to solve them
• With rivers we don’t!
• Adaptive management is also a good idea… but its rarely used correctly either
• Design hypotheses help with expectation management!
HOW DO WE TEST HYPOTHESES?

• As scientists, we set up an experiment to support or disprove hypothesis

SO, HOW SHOULD WE TEST OUR DESIGN HYPOTHESES?

• Could treat restoration projects as experiments and build and monitor (i.e. adaptive management)
• But I want to test this before I build it to avoid costly mistakes!
IDEA OF DESIGN HYPOTHESIS TESTING...

Balance between a **creative** Design Development Process and an **objective** Design Testing Process to arrive at a final design.

**DESIGN PROCESS**

- **Problem**
  - Design Hypothesis Testing
  - Design Development
  - Design Selection

**DESIGN HYPOTHESIS TESTING**

- **RANGE OF POSSIBLE DESIGN HYPOTHESES**
- INCORPORATE DESIGN HYPOTHESES INTO DESIGN SCENARIOS
- TEST DESIGN HYPOTHESES (If Possible)

*(From SHIRA: Wheaton, Pasternack & Merz, 2004)*
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AS THE WEEK UNFOLDS...

• Ask yourself how the tools you’re learning can be used in design
• Are they tools that are helpful in planning and developing designs?
• Are they tools that are helpful in testing design hypotheses?
General Principles of Channel Design; Estimating Watershed Sediment Supply; 1D Modeling

- PRW – General Concepts of Sediment Transport & 1D Modeling
- PB – Assessment of Sediment Supply at Watershed Scale
- Field Exercise – Data for 1D Modeling
- TMA – 1D Modeling w/ HEC-RAS
TUESDAY

Channel Form & Sediment Transport: Measurement & Estimation

- JMW – Field Measurements of Channel Form
- PRW – Estimating Sediment Transport

Morning

- Field Exercise – Topographic Surveying/Measuring Sediment Transport
- SOE – Working with sediment Transport Measurements
Sediment Transport & Modeling Tools in Channel Design

• PRW – Sediment Transport Analysis

• JCS – Estimating Design Discharge / Geomorphic Concepts in Design

Afternoon

• JMW – Modeling & Design Hypothesis Testing

• RBM/NK – 1D/2D Models for Floodplain Design

• SOE/JMW – 2D Models for in-channel Design
THURSDAY

Channel Design Problem

• PRW – Sediment Transport in Channel Design (Part II)

• JCS – Geomorphic Concepts in Channel Design (Part II)

• TMA – Intro to Provo River Channel Design Problem

• Provo River Design Activity
FRI DAY

Design, Construction, & Maintenance of Alluvial Channels

- Student Presentations of Design Exercises
- TMA – Construction, Planning & Maintenance Issues in Stream Restoration
- TMA – Provo River Restoration Project Fieldtrip
SUMMARY

1. Review of Design
   - Design process has creative design development phase and objective design testing phase... not always explicit

2. Contrasting Channel Design Approaches
   - Many approaches, most reasonable...

3. Concept of a Design Hypothesis
   - Making design process explicit

4. Formulating Design Hypotheses
   - Articulating your predictions

5. Preview of Week
   - Testing design hypotheses... Learning the tools
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