Scour Risk Management

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Presented to:

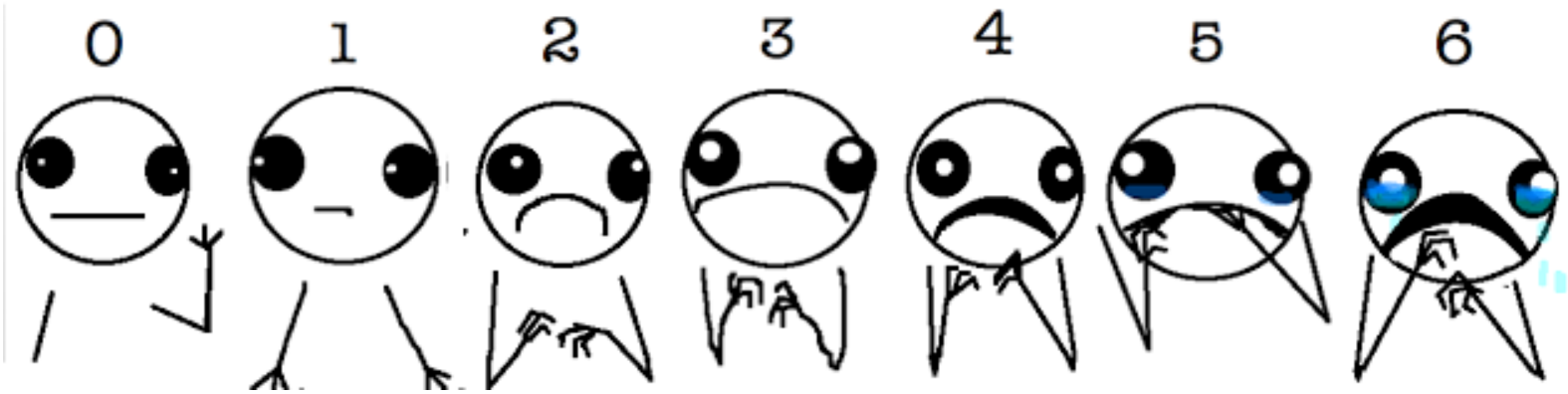
Michigan Department of Transportation
Bridge Scour Technology Transfer Workshop

October 5, 2017

Water Resources Solutions

UMKC
School of Computing & Engineering

Rate your level of project uncertainty



- Risk is related to uncertainty.
- Uncertainty is difficult to quantify.
- Every Computational process in the scour analysis has uncertainty.

How often are you still uncomfortable, even though you designed for a particular flood event and used the recommended procedures?

What did you do about it?

Pick a Design Flood of level of acceptable risk

- NCHRP project 12-48 & Report 489
  - Revised Design Flood Exceedance probabilities for NEW Bridge design. Table 2.3

Hydraulic design flood	Scour design Flood	Scour design Check Flood**
Q_{10}	Q_{25}	Q_{50}
Q_{25}	Q_{50}	Q_{100}
Q_{50}	Q_{100}	Q_{200}
Q_{100}	Q_{200}	Q_{500}

**or worst case (i.e. incipient overtopping)

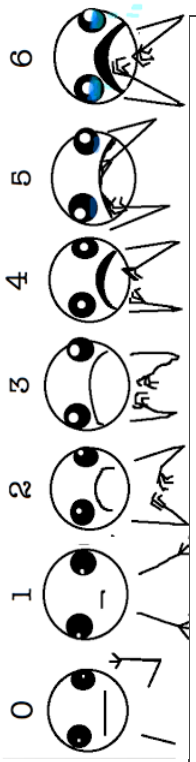
  - Uncertainty in estimating design flows is related to Quantity/Quality/Type of hydrologic study.

What is the real risk?

Flood Frequency	Probability of Exceedance in N Years (or Assumed Bridge Design Life)						
Years	N = 1	N = 5	N = 10	N = 25	N = 50	N = 75	N = 100
10	10.0%	41.0%	65.1%	92.8%	99.5%	100.0%	100.0%
25	4.0%	18.5%	33.5%	64.0%	87.0%	95.3%	98.3%
50	2.0%	9.6%	18.3%	39.7%	63.6%	78.0%	86.7%
100	1.0%	4.9%	9.6%	22.2%	39.5%	52.9%	63.4%
200	0.5%	2.5%	4.9%	11.8%	22.2%	31.3%	39.4%
500	0.2%	1.0%	2.0%	4.9%	9.5%	13.9%	18.1%

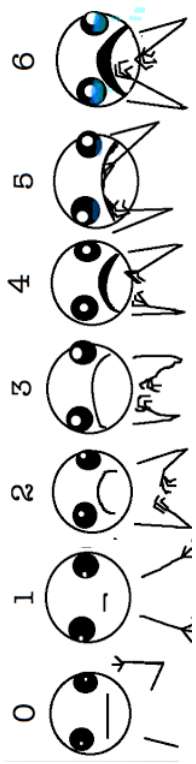
The good news is that these recent studies provide a quantifiable level of risk for design relating to the remaining life of the structure. But there is still uncertainty in the method to determine design flows.

Contraction Scour Uncertainty



• 1-D HEC-RAS • 2-D Steady Flow • 2-D Unsteady Flow • 3-D Unsteady • Physical Modeling (with 2 or 3-d model)	• 1-D HEC-RAS • 2-D Steady Flow • 2-D Unsteady Flow • 3-D Unsteady • Physical Modeling
Study conduced by Trained Personnel	Study conduced by Qualified Expert

Uncertainty-Scour Analysis Piers



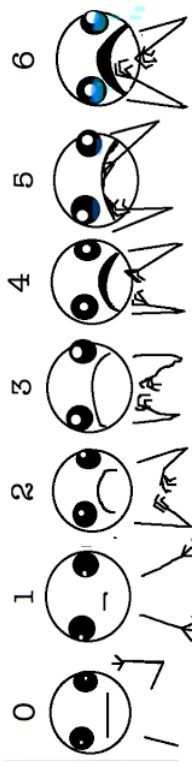
- Complex piers (HEC-RAS)
- Complex piers (2-D)
- Simple Pier Walls (HEC-RAS)
- Simple Pier Walls (2-D)
- Circular Piers

Note:
Uncertainty strongly influenced by angle of attack

Predicting pier scour in soils other than sand increase uncertainty

Deviation from ideal lab conditions increase uncertainty

Uncertainty-Scour Analysis-Abutments



- Froehlich
- HIRE
- NCHRP 24-20 1-D
- NCHRP 24-20 2-D

(abutments near channel)

- Froehlich
- HIRE
- NCHRP 24-20 1-D
- NCHRP 24-20 2-D

(abutments Set Back from channel)

NCHRP Report 761 (project 24-34) Reference Guide for Applying Risk and Reliability-based Approaches for Bridge Scour Prediction

- Risk and reliability-based methodology linking scour depth estimates to a probability consistent with load and resistance factor design (LRFD)

- Assessment of variability of scour estimates from Monte-Carlo simulation considering the variability of individual hydraulic and scour computations.

- Uncertainties associated with bridge scour prediction—
  - Simple bridge-conditional probability of exceedance
  - Complex Channel/Pier step-by-step procedure for scour factors

Strategies for reducing uncertainty risk

Option 1 Increase level of conservativism

- "When in doubt-he** for stout"
- Relatively modest Engineering costs $
- Relatively large structure and construction cost $$$$

Option 2 Find an "expert" to invoke "Engineering Judgment"

- Shifts risk to someone else ? (maybe)
- Low Cost Alternative? (if all goes right)

Strategy 3
Risk Based Approach

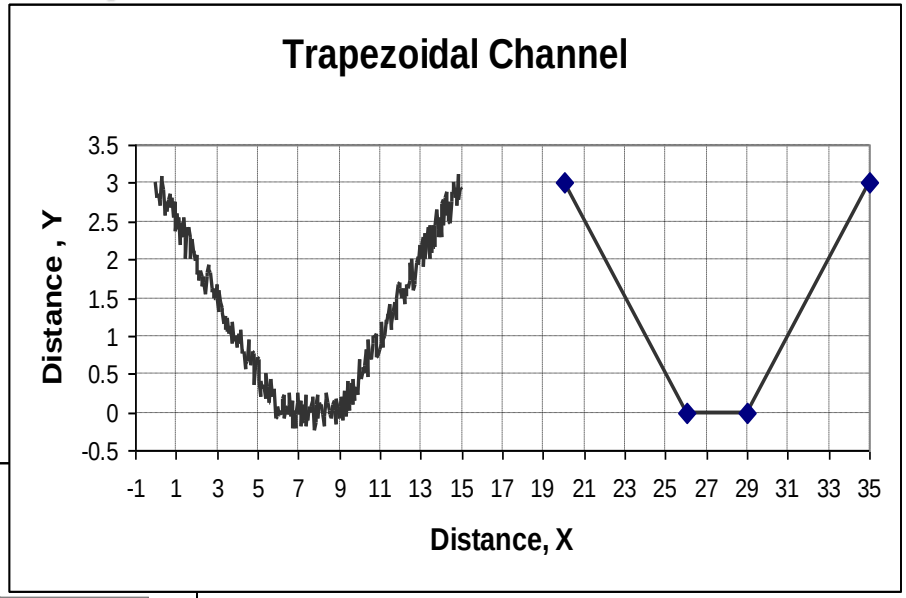
- NCHRP 761 approach
- Multi-parameter analysis
- More consistent scour analysis from a broad population of analysists of varying expertise.

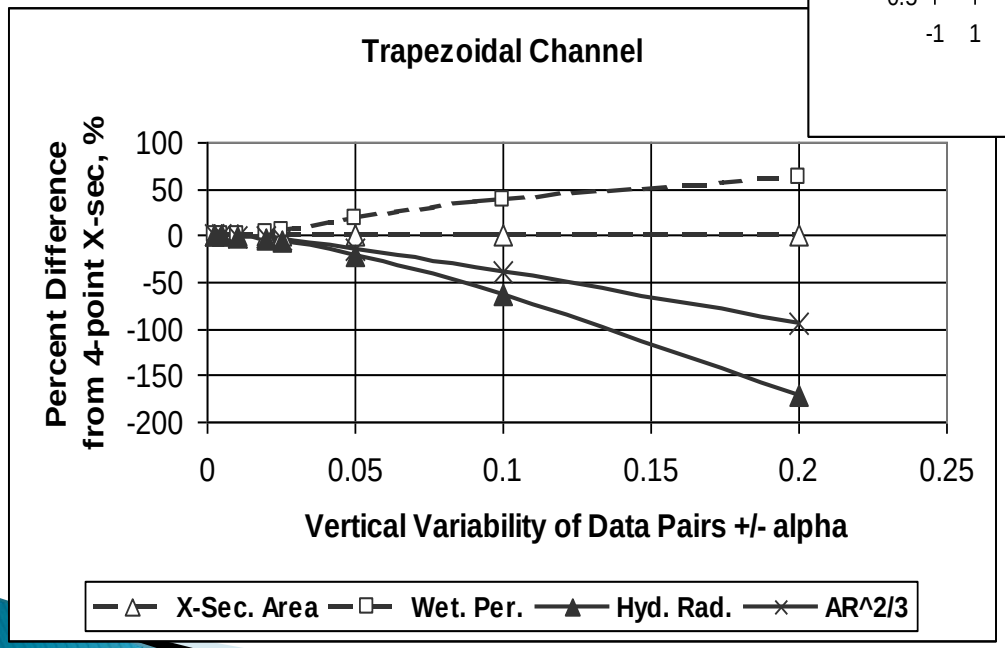
Strategy 4
Utilize experts using more level 3 tools

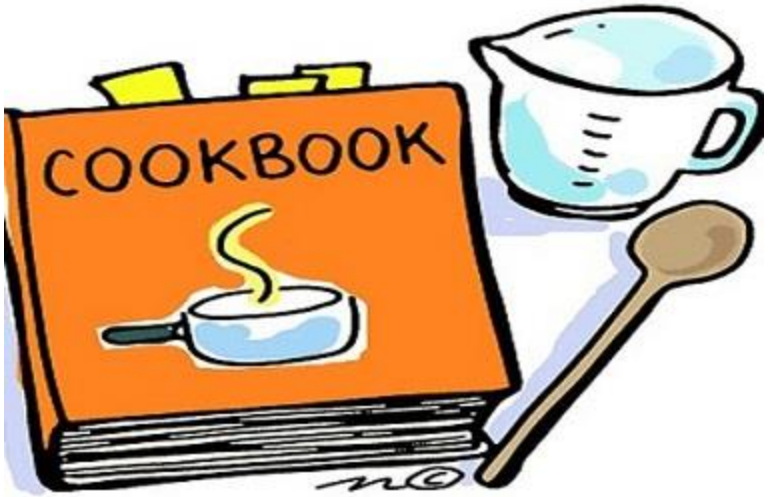
- Significantly narrows the uncertainties within each process.
- Larger Engineering costs $
- Design and CM targeted to specific scour issues
- Reduced structure and construction cost $$.

Risk is related to Uncertainty

- However, more data does not always reduce uncertainty
- Techniques that were developed for sparse data often deteriorate when high density data is used







OR

Allowing skilled experts to apply advanced tools and knowledge will.

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