UF Herbert Wertheim College of Engineering
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Comparing Engineering Students’ and Professionals’ Conceptions of Ambiguity

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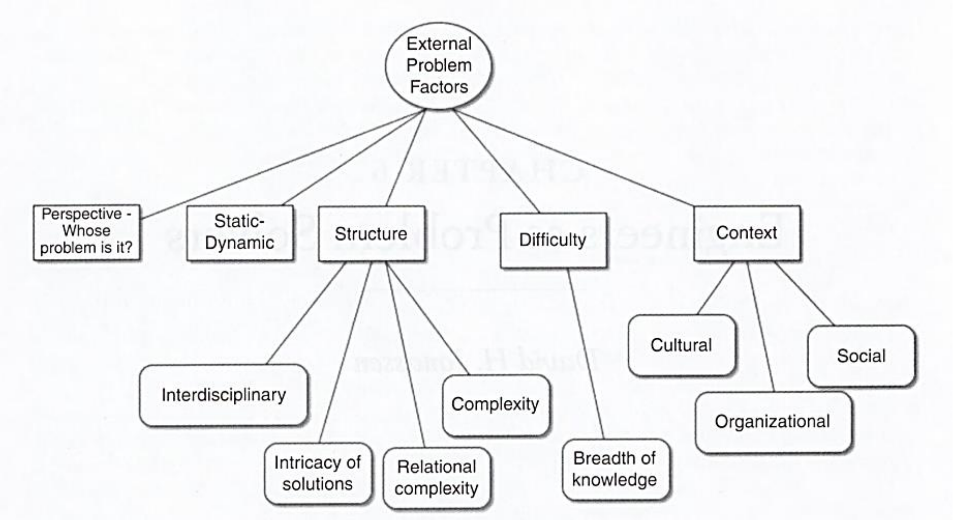
Engineering Problem Solving



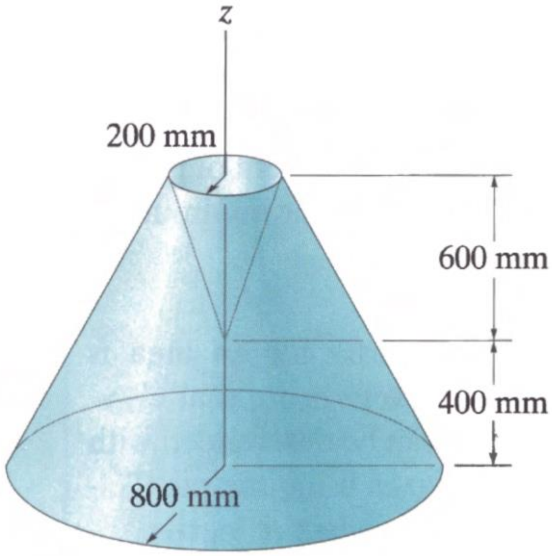
algorithmic problems

dilemmas

most academic problems

most workplace problems

Algorithmic Problem

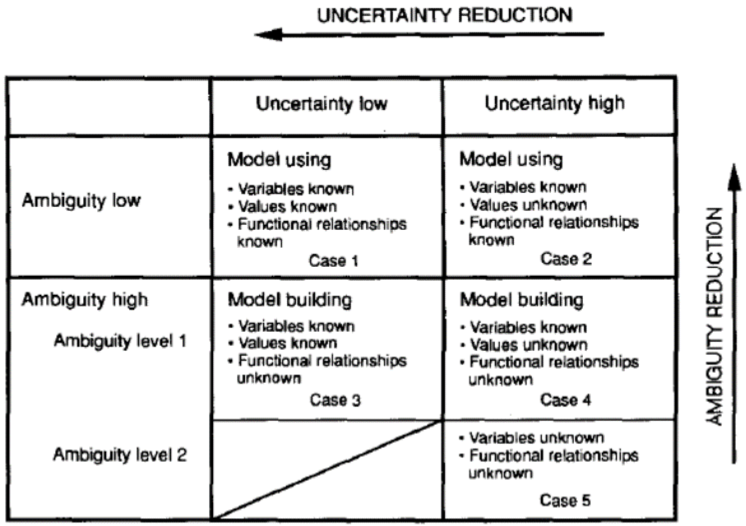


Determine the moment of inertia I_z of the frustrum of the cone which has a conical depression. The material has a density of 200 kg/m^3.

Design Problem

A rail guideway system is being built as a precast segmental box girder structure where each span is supported by steel tendons running the length of the span. These tendons are prestressed and then grouted in place. As the engineering firm is nearing the end of construction, they discover three tendons that had strands that snapped prior to the tendon being grouted. They replaced those they tendons but do not know how to deal with the hundreds of other tendons which have already been grouted and now have questionable structural integrity. Propose a mitigation plan that takes into account both technical and financial aspects.

Ambiguity in Problem Solving



Schrader, S., Riggs, W. M., & Smith, R. P. (1993). Choice over uncertainty and ambiguity in technical problem solving. Journal of Engineering and Technology Management, 10(1-2), 73-99.

“Ambiguity refers to the extent to which a precise and predictable formula for generating a product can be defined. Risk refers to the stringency of the evaluation criteria and the likelihood that these criteria can be met on a given occasion” (p. 131, italics in original).

Doyle, W., & Carter, K. (1984). Academic tasks in classrooms. Curriculum Inquiry, 14(2), 129-149.

What are the qualitatively different ways that practicing engineers (and engineering students) experience ambiguity during problem solving?

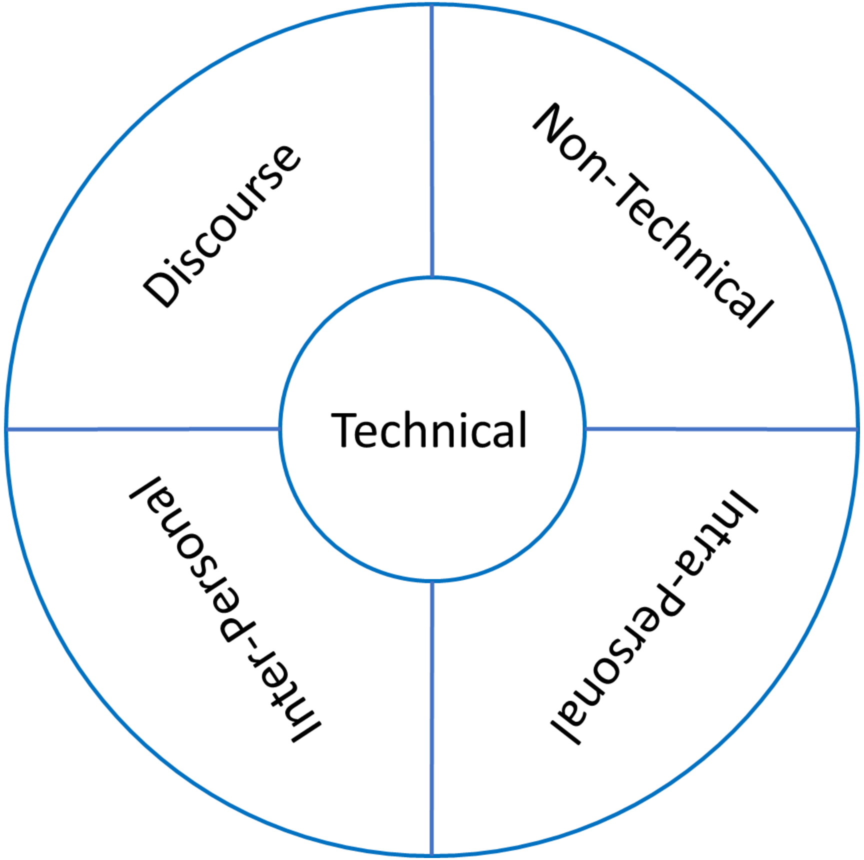
Methodology

- 16 professionals in civil/environmental engineering
- Artifact elicitation interviews
- Success levels of coding and constant comparison to create a grounded theory

Participant Demographics - Professionals

Gender	9 male, 7 female
Race	7 White, 6 Black, 2 Asian, 1 Native American
Ethnicity	12 non-Hispanic, 4 Hispanic
Age	Range from 32 to 60
Highest degree	7 BS, 7 MS, 1 PhD, 1 MBA
Employment type	6 public, 9 consulting, 1 large corporation

Grounded Theory - Professionals



Themes and Subthemes

Technical	Discourse
Unclear or changing scope	Lack of clarity in contracts
Missing information	Communication
Unknown path to solution	Legal issues
Multiple possible solutions	
New information impacts possible solutions	
Human error in calculations	

Themes and Subthemes

Inter-Personal

- People who influence the project
- Way expectations are handled
- Different interpretations
- People's reactions to engineering projects

Intra-Personal

- Experience impacts ambiguity
- Ambiguity changes based on role
- Affective responses

Themes and Subthemes

Non-Technical

- Politics
- Financial elements
- Ethics

Participant Demographics - Students

Gender	6 male, 8 female
Race	12 White, 2 Black
Ethnicity	10 non-Hispanic, 4 Hispanic
Age	Range from 20 to 23

Comparison of Students and Professionals

Professionals	Students
Unclear scope	Unclear scope
Missing information - Knew where to find it	Missing information - Expected to be taught it
Having multiple solution paths is not ambiguous	Having multiple solution paths is ambiguous
Classroom problems generally not ambiguous	Classroom problems generally are ambiguous

Comparison of Students and Professionals

Professionals	Students
Ambiguity is natural element of engineering problems	Ambiguity is obstacle to be overcome
Little discussion of emotional response	Considerable discussion of emotional response - Mostly negative: stress, anxiety, “self-loathing” - Some positive: enjoying the challenge

Conclusions

- Professionals and students have very different views of ambiguity
  - Professionals: natural component of engineering problems
  - Students: obstacle to be overcome
- Education teaches students that engineering problems can be solved algorithmically to get a single correct answer
- We are finalizing the grounded theory for the students to compare the results more directly

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