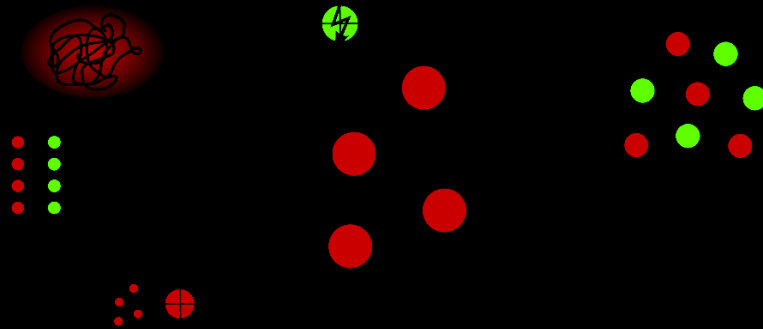


WICKED PROBLEMS IN ENGINEERING EDUCATION



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OUTLINE

- What are wicked problems (WPs)?
- What do engineering students need to learn to be able to address WPs?
- How can we assess that learning?
 - Constructive alignment
 - Learning outcomes
 - Assessment rubric
 - What for?

STORY PROBLEMS

"In our educational program, (...) the problems you get to work with there have a solution. And that's the one [solution] that is correct, and there aren't a lot of issues to discuss. Because it [the solution] just is the way it is and there isn't really anything else to think about."

undergraduate engineering student, 2012

"But that's not really how it is, it doesn't work that way [in real life]. Because [t]here you might solve a problem in one country, and then you come to the next [country]. Or you might solve a problem in one country, but that might not turn out so well, so you have to continue. And that is what —, that's how it's going to be in real life. It's not like I'm just going to calculate this formula and then we have everything, then you'll all get water."

undergraduate engineering student, 2012

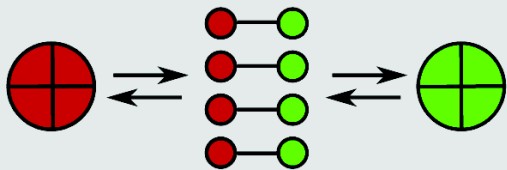
WICKED PROBLEMS

1. There are no definitive formulations of wicked problems.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not true-or-false, but good-or-bad.
4. There is no immediate and no ultimate test of a solution to a wicked problem.
5. There are no exhaustible sets of solutions or methods from which to choose the most appropriate one.
6. Every solution to a wicked problem is a 'one-shot operation'.
7. Every wicked problem is essentially unique.
8. Every wicked problem can be considered to be a symptom of another problem.
9. Descriptions of wicked problems, and preferences for how they should be addressed, are strongly influenced by questions related to norms and values.
10. The planner has no right to be wrong.

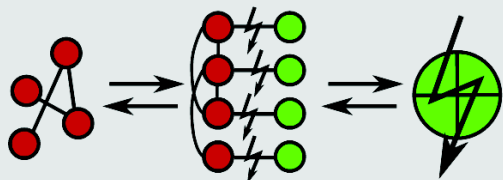
(Adapted from Rittel & Webber, 1973)



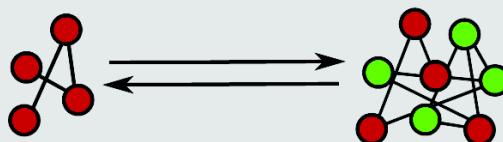
A: Simplify & Avoid



B: Divide & Control



C: Isolate & Succumb



D: Integrate & Balance

SIMPLIFY & AVOID

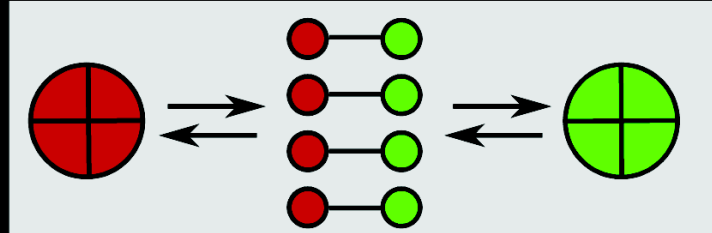


S: "Long-term solutions are usually good, aren't they? The best would be if they could do both long-term and short-term things, which don't inhibit each other, at the same time. So that they [the people in Jordan] can get water both now and in the future."

JL: "If different solutions do cause different problems, how should one choose which of these problems are [considered] worse than others?"

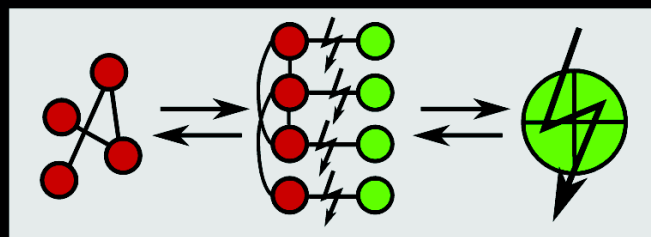
S: "Well, those-; you'd have to check-; I mean, if the negative consequences exceed the positive, then it's not a good alternative."

DIVIDE & CONTROL



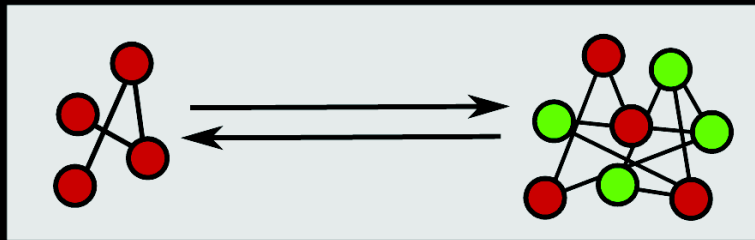
S: "[If we use desalination,] we will at least have water. And then there will be other problems, like how we're going to get the energy. But that's kind of a problem that people work with somewhere else."

ISOLATE & SUCCUMB



S: "There is no obvious solution. (...) Whatever you [do], you always have to take water from somewhere and to somewhere else. (...) The best would maybe be if they could reduce their water consumption without causing anything to suffer (...) But that's also wishful thinking."

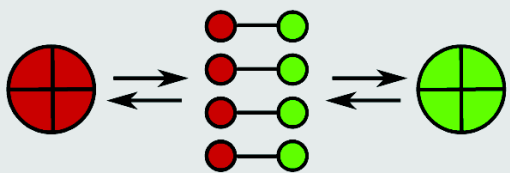
INTEGRATE & BALANCE



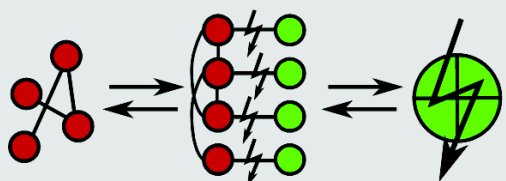
S: "Maybe one could combine, nationalize this [the water obtained from desalination] as well; so that it has to be included in the allocation plan; so that it's not a freestanding private sector that distributes water to those who pay the most."



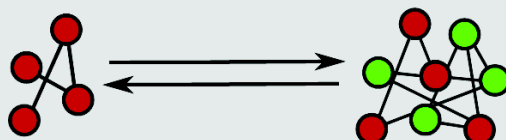
A: Simplify & Avoid



B: Divide & Control

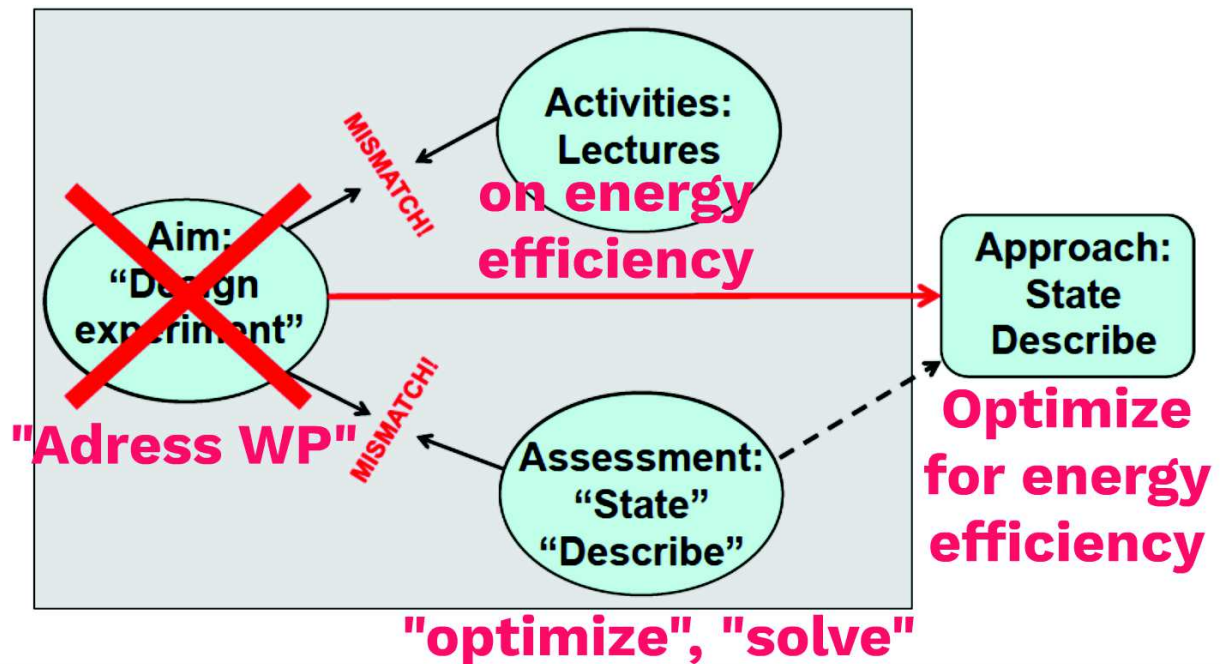


C: Isolate & Succumb

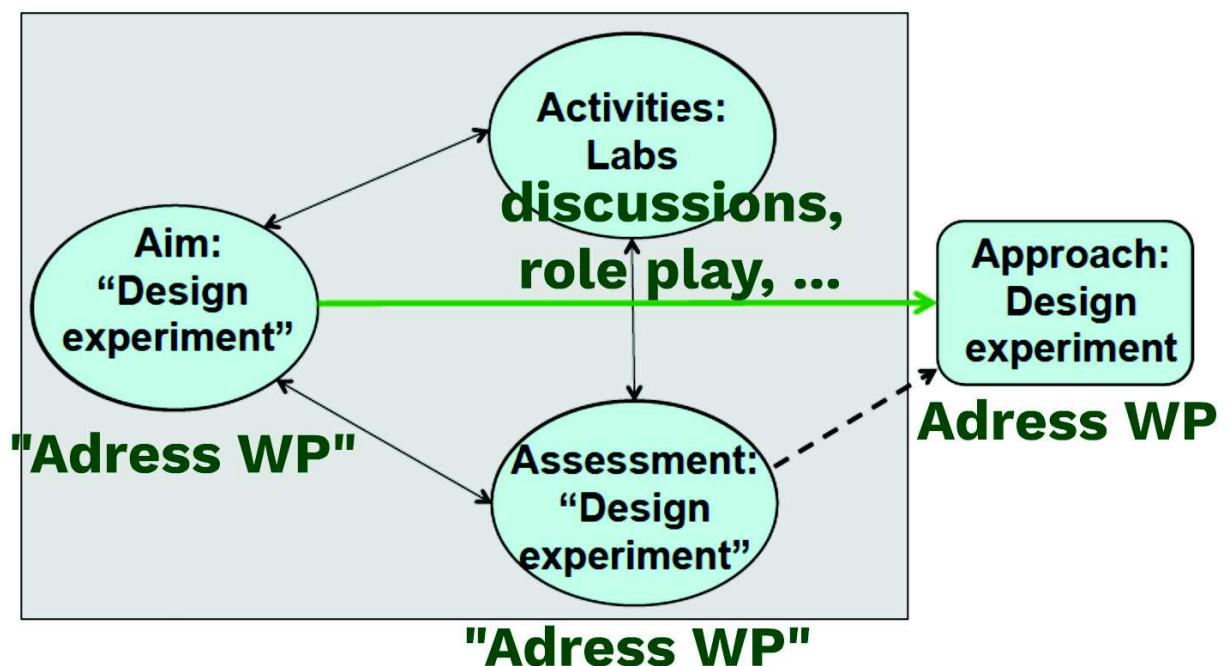


D: Integrate & Balance

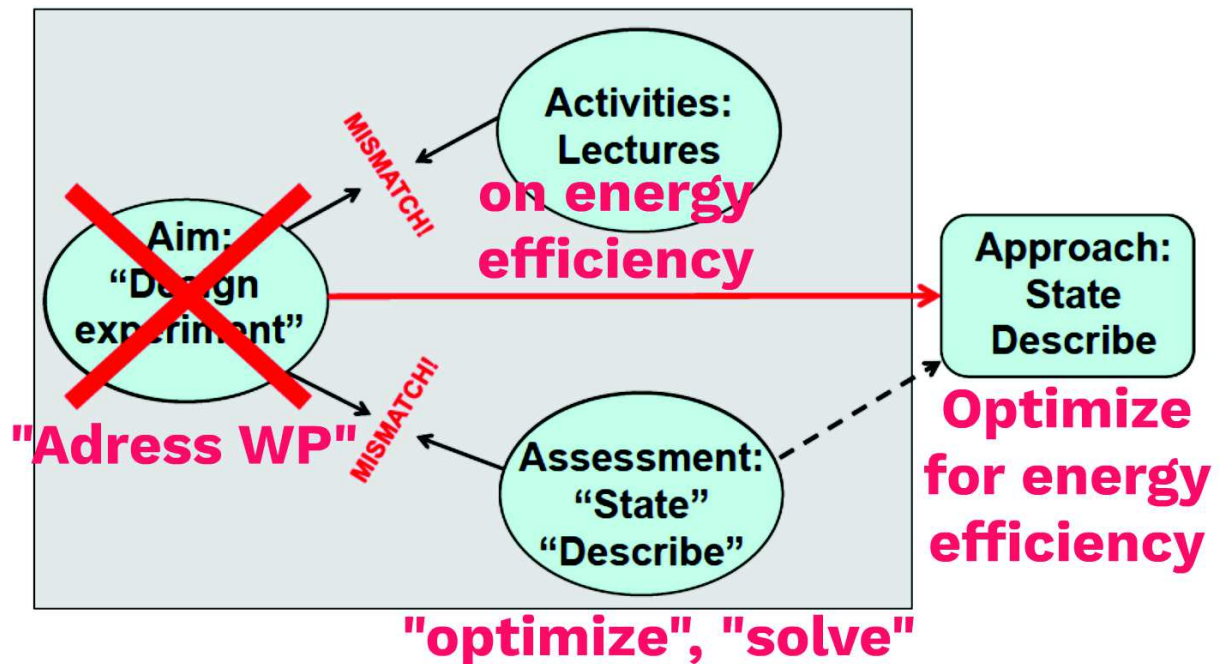
Constructive Alignment



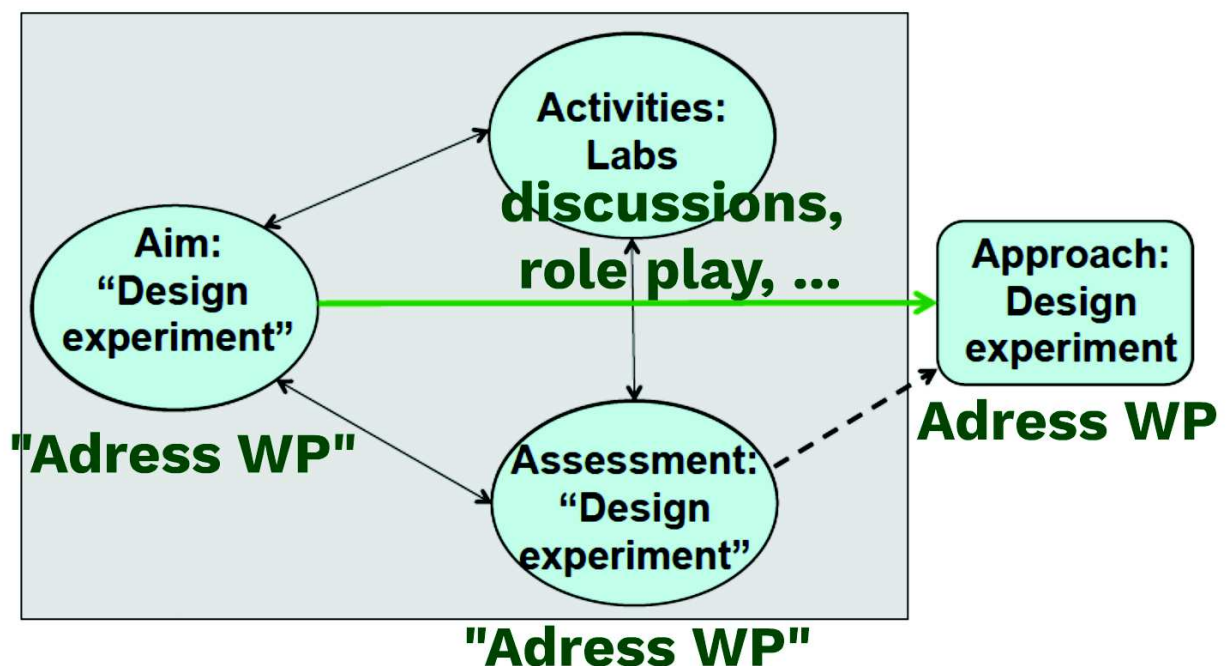
Constructive Alignment



Constructive Alignment



Constructive Alignment



TAMING STRATEGIES

1. locking down the problem definition rather than allowing iterative redefinition,
2. asserting that the problem is solved when it clearly is not from all perspectives,
3. specifying objective parameters by which to measure the solution's success,
4. casting the problem as 'just like' a previous problem that has already been solved,
5. giving up on trying to get a good solution to the problem,
6. declaring that there are just a few possible solutions, and that one just needs to choose to "best" one among those.

Conklin, J. 2005. Wicked Problems & Social Complexity. In J. Conklin, *Dialogue Mapping: Building Shared Understanding of Wicked Problems*. Wiley.

EXAMPLES OF LEARNING OUTCOMES

Describe the general characteristics of WPs, particularly in contrast with tame problems.

Independently identify a WP in the context of one's future profession (here: one's discipline) and describe why it is a WP.



Switch partners for peer assessment:
describe your problem to your partner and
argue for why it should be seen as a WP.

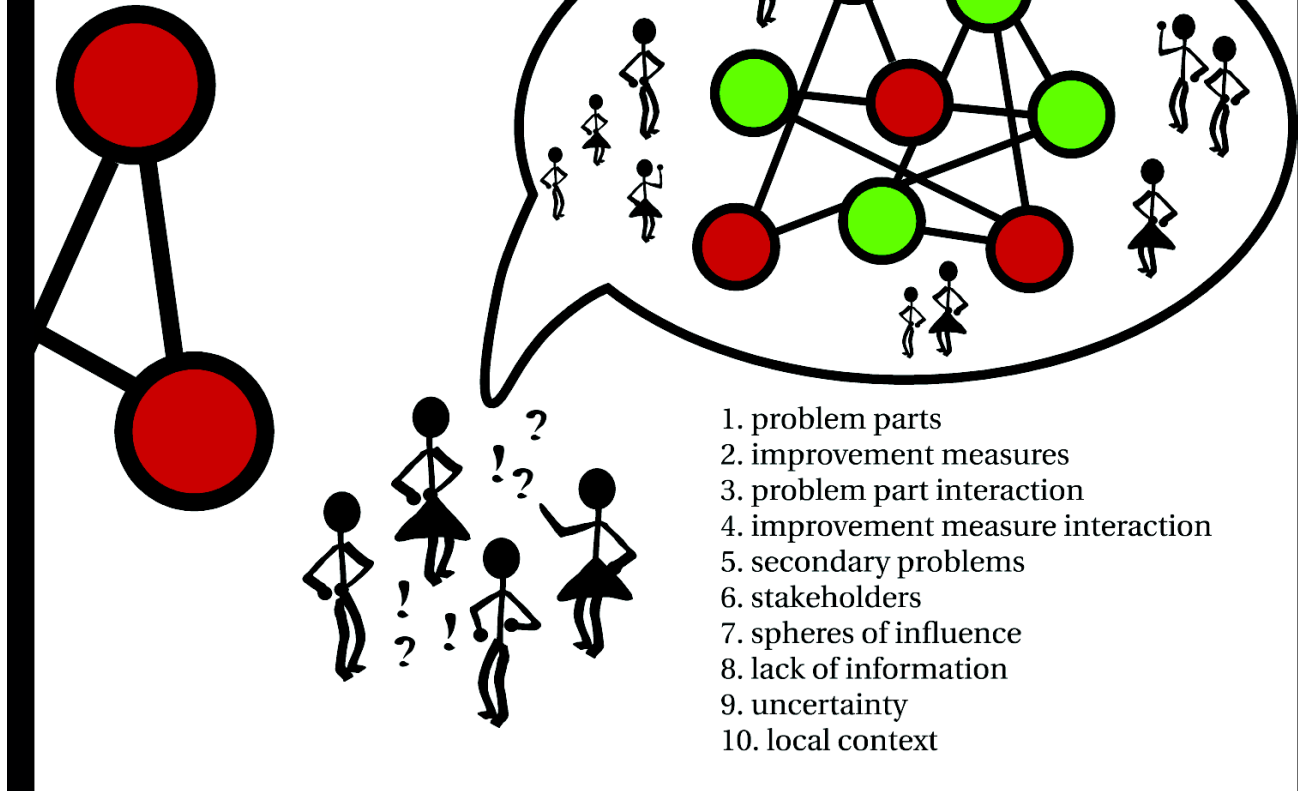
ABSTRACT VS CONCRETE TERMS

- | | |
|------------------|------------------|
| • sustainability | • dam |
| • love | • water |
| • freedom | • rice |
| • equality | • death |
| • problem | • carbon dioxide |
| • responsibility | • money |
| • sacrifice | • tree |

What is the difference between the terms on the left and right side?

"Sustainability is
wishy-washy. It's just
a lot of empty words."

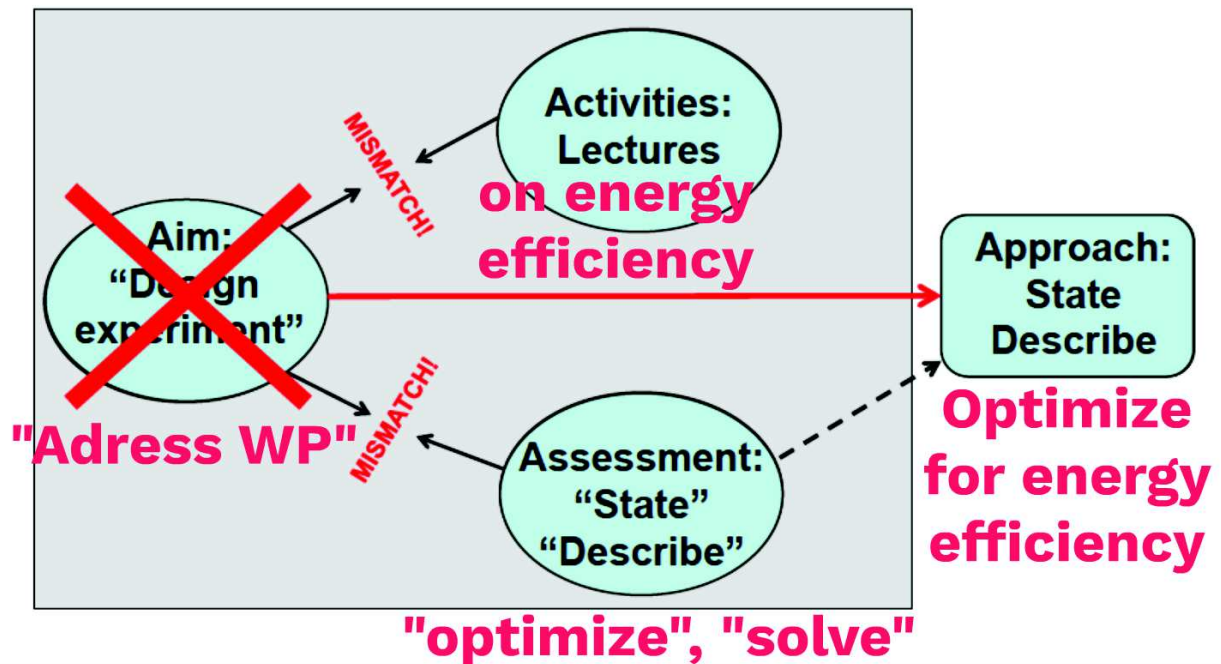
Lönngren, J. (2017). *Wicked Problems in Engineering Education: Preparing Future Engineers to Work for Sustainability*. Chalmers University of Technology. Gothenburg: Chalmers.



Identify at least two relevant stakeholders, and describe, in concrete terms, their interests in relation to the problem and/or possible improvement measures.

In concrete terms, describe at least one example of secondary problems that may be caused by a specific improvement measure.

Constructive Alignment



ACTION COMPETENCE FOR ADRESSING WPS

Demonstrate initiative, perseverance, and a sense of responsibility for addressing a WP, despite high levels of uncertainty, lack of information and knowledge about the situation, the ambiguous and contested nature of the SD concept, and the need to work across e.g. disciplinary and national borders.

"CULTURE OF DISENGAGEMENT IN ENGINEERING EDUCATION"

Students
interested in
contributing to
social welfare



ENGINEERING
EDUCATION



Students LESS
interested in
contributing to
social welfare

Measured through students' self-expressed interest in e.g.:

- helping others in need
- improving society
- understanding consequences of technology
- professional & ethical responsibility (Cech, 2014)

"CULTURE OF DISENGAGEMENT IN ENGINEERING EDUCATION"

"Engineering education fosters a **culture of disengagement** that defines public welfare concerns as tangential to what it means to practice engineering."

Engineering is characterized by an "**ideology of depoliticization**", i.e. "the belief that engineering work can and should be disconnected from 'social' and 'political' concerns because such considerations may bias otherwise 'pure' engineering practice."

(Cech, E.A. (2014). Culture of Disengagement in Engineering Education? *Science, Technology, & Human Values*, 39 (1), pp. 42-72.)

What is sustainable? What is unsustainable?

Give one concrete example for
each question!

Describe different perspectives on
what could be seen as SD and what a
sustainable society could be.

Critically examine and assess alternative descriptions of what
could be seen as SD and what a sustainable society could be.



"The Grand Challenges endeavor reinforces the values and norms most important to engineering culture. The report clearly emphasizes efficiency, economy, and large-scale and complex solutions over simpler "low-tech" solutions, and purely "technical" problem-solving over access and engagement with "social" or "political" elements (...) The beliefs and norms hidden between the lines of specific challenges and their solutions serve as reminders to engineers of what is valued most in past, present and future engineering work." (Cech, 2012)

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DESIGN PRINCIPLES FOR WICKED PROBLEM DESCRIPTIONS

1. Ensure that the problem can be understood and discussed from many different perspectives.
2. Ensure that conflicting values and interests cannot be ignored
3. Define an achievable "result" that does not allow definite answers or solutions to the problem.
4. Ensure that students can make a connection between the problem and their educational program.
5. Design problem-specific support for students (cognitive and emotional!)