TBL Module Exemplar in Mechanical Design

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Context

- 3rd year undergraduate course on mechanical design with an emphasis on analysis tools used to design functioning components
- Meetings:
  - 2 x 50-minute class / week (1 section)
  - 1 x 2-hr tutorial (with TA) (3 sections)
- Students
  - 140
  - Teams of 5 (some 6), formed from like disciplines for scheduling but otherwise random
- Module topics
  - 0 Review (2 weeks)
  - 1 Fracture (2 weeks)
  - 2 Fatigue (2 weeks)
  - 3 Shafts (2 weeks)
  - 4 Welding (2 weeks)
  - 5 FEA computer modelling (2 weeks)
  - Course review (1 week)
- Tiered lecture theatre

Grade Distribution

- 15% RAP (7.5% iRAT and 7.5% tRAT*)
- Assignments (20% team*, 10% individual for peer assessment tasks on peerScholar)
- Midterm 20%
- Final exam 35%

*team items are multiplied by a peer evaluation score, based on 3 iPeer evaluation. Mean peer evaluation is 100 in a team – some are above, some are below.

Readings

Modules 1-5 each have assigned pre-readings from the course text. The text is large and information-dense. Each module topic above is a chapter of approximately 40-60 pages. Reading guides are used to focus on key elements and to make the readings more digestible and less daunting. Readings are divided into three categories:

- **Required**: the primary source of material for RAP quizzes (15-20 pages)
- **Beneficial**: additional materials to support the required readings (10-15 pages)
- **Supplementary**: nice-to-know material, not required for the course (balance of chapter)

The expected time commitment for the readings is approximately 1-hr every two weeks.

Example readings are provided.

Readiness Assurance Test

- 15 questions, A-E multiple choice
    - iRAT on scantron
    - tRAT on IF-AT
    - Test is protected (not revealed or available outside of RAP)
- Prepared in folders
    - Blue "Individual" folder pre-loaded with 6 scantrons and 6 question books (even for teams of 5)
    - Red "Team" folder pre-loaded with 1 IF-AT and 1 appeal form
- Support during test: 2 TAs

- Process:
    1. Announcement (e.g. put away books and phones)
        - Hint: speak about why no phones; project a "no cell phone" graphic
    2. Distribute Individual folders
    3. Individual test: ~1 minute per question + 3 minutes (18-20 minutes)
    4. Students return Scantrons to Individual folder (team holds onto all question booklets)
    5. Trade Individual folders for Team folders
    6. Team test: same timing as Individual; 1 TA invigilates, 1 TA scores scantrons, I assist with sorting scantron forms while keeping an eye on the class
    7. Review individual performance (scantron report) once scoring is done and teams are working
    8. Teams hand in folder with IF-AT, 6 question booklets, appeal form
    9. TA counts question booklets to ensure 6 per team (automatic 0 on iRAT and tRAT otherwise… teams are warned and this is written right on the test!);
        - hint: rip the corners of question booklets as they are counted
    10. TA separates any used appeals forms and puts a fresh blank one back in the folder
    11. Based on iRAT performance (summarized by scanner software) I address any areas of concern
- Tips:
    - iRAT scores are lower than tRAT scores because the team outperforms its strongest members; also, if you use IF-ATs with a 4-2-1-0 scoring scheme, there are multiple chances for marks on a tRAT. I normally see 70-80% iRAT average, and 90-95% tRAT average
    - Remind students that the purpose of the RAP process is to get them ready, including providing you and them feedback on areas of strength and weakness; not a "test"
    - If you want to reuse questions (I suggest you do), you need to be firm:
        - Explain why you are being strict
        - Make sure no exam booklets leave the room (count booklets returned by team, as described above)
        - Make sure no one has a phone out or takes notes (automatic 0 and loss of IF-AT)
    - Look at the summary statistics (if you use a scanner to score the iRATs)
        - Consider mean score for each question; I aim for some a mix of easy (quick confidence-builders) and challenging (good for team discussion)
        - Consider discrimination index (or point biserial). It measures whether students who did well overall did well on a question. Scrutinize and revise questions where this is near 0 (no correlation) or negative (weak students on the test performed better on that question)

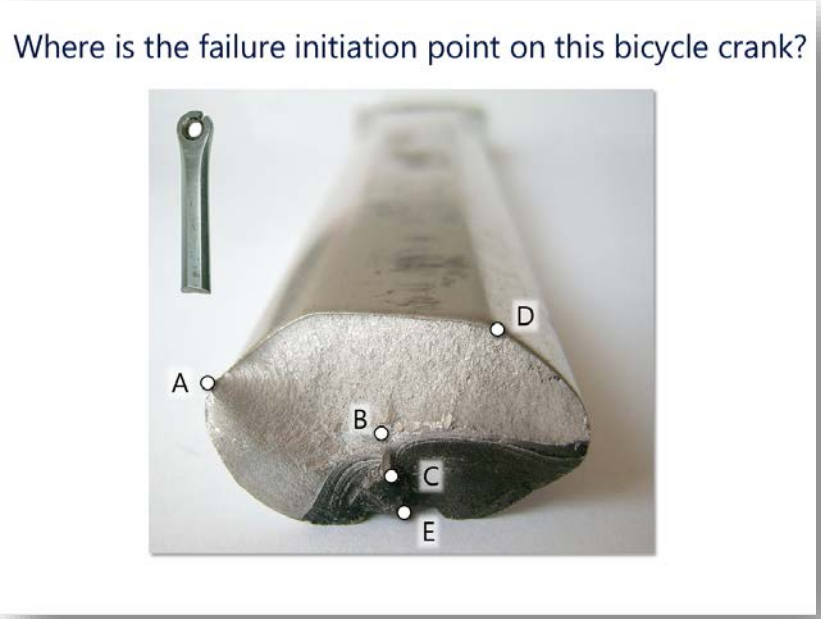
Examples questions are provided.

4S Application Tasks

Application tasks range from simple in-class multiple choice questions to large, complex out-of-class assignments.

Simple, in-class question 1.

This would be a short (5-minute) in-class activity. While coloured cards could be used here, I would often go for something like clickers or a particular pose or gesture (i.e. point in a specific direction for each letter) just to keep things moving quickly.



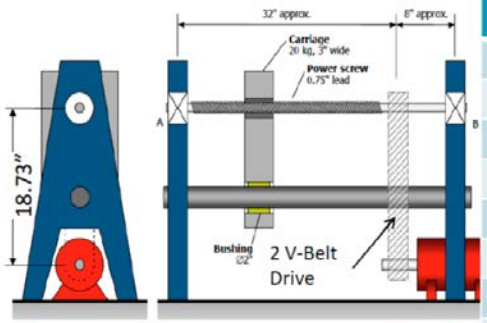
Simple in-class question 2.

Here's an example that builds off of the last. There are some subtleties for students where the thinking from the previous question does not apply here.

Hint: if you show of hands, coloured cards, or some other voting method, look for the team that reports their answer last or changes their answer and call on them first in the discussion.

Next page: an assignment example from a related course used with a gallery walk. It takes students several weeks to complete. By identifying a performance metric (in this case, cost), it is possible for teams to compare their project merit (after several weeks of work) with someone else's project. The reporting can also be done online (e.g. Google form), or low tech (see sticky note continuum example on next page), and then teams with the best design "on the hot seat" can show their solution on the doc cam for scrutiny with the goal for the class to identify the best design that meets all requirements.

Mech 325 Assignment 2 – Team B4

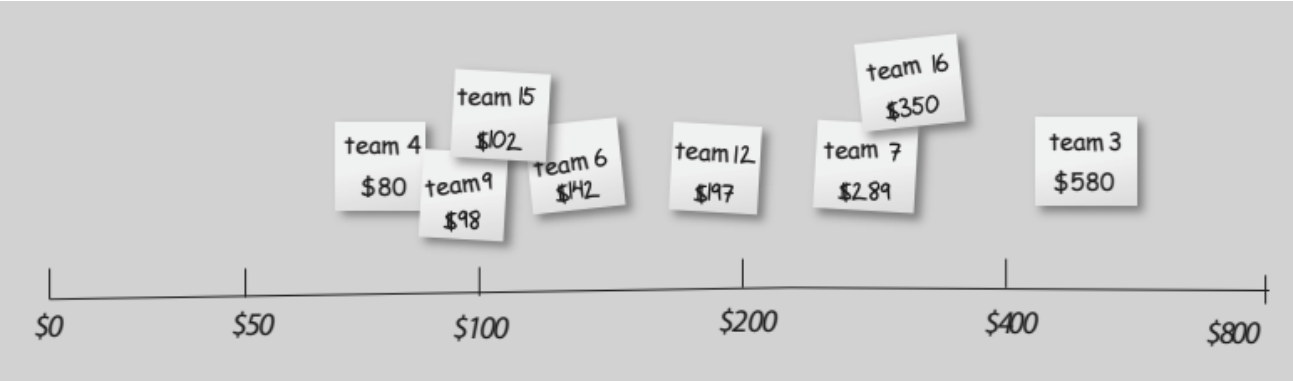


Component	Cost ($)
V-belt	$18.16
Pulleys	$33.50
Bearings (A and B)	$8.70
2" Dia. Bushing	$102.58

Assumptions
Coefficient of Friction for Belt = 0.51
Xo=0.02, a=3, b=1.483, θ=4.459

Component or Parameter	Value
Drive Train	e = 0.52
Drive Type	2 A50 V-belts, 6186K151
Drive Pulley (McMaster)	3" PD, 6245K32
Driven Pulley (McMaster)	5.75"PD, 6245K511
Center-to-center distance	18.73"
Expected Belt Life	201,790hr
Bearings A and B (Reid)	SKF-05 Deep Groove, Ball
I.D. / O.D. / Width	20mm / 47mm / 14mm
Dynamic Basic Load Rating	2860lb
Static Basic Load Rating	1470lb
Expected Bearing Life	8.75x10^11 revs
Bushing (McMaster)	PTFE-Fiberglass, Sleeve
I.D. / O.D. / Length	2" / 2.25" / 3"
Bushing Life	7861h (replace once)

Performance Metric = $162.94



Another Assignment Example

Included is an extended team assignment (on the redesign of an amusement park ride) that was peer assessed on peerScholar. It is a messy and ill-defined problem that forces students to make (and defend) many assumptions. The purpose here was less about the 4 Ss and in class discussion, but more about developing the skill of reviewing someone else's work and giving constructive feedback. It hit the S's of significant problem, same problem, and specific choice). In peerScholar, the assignment took place in three stages:

1. Teams worked together to interpret the problem and propose a solution. Each individual uploaded their team's solution to peerScholar.
2. In peerScholar, each individual was randomly assigned two other team's assignments to assess. They did this using 4 different criteria related to the appropriateness of the assumptions and analysis and the quality of the final design proposed.
3. In peerScholar, each individual was responsible for reviewing the feedback they received, discussing it with their team, and assessing the quality of the assessment they received.