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University of Portland
ME 403/503 – Engineering Design, Product Realization
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We have seen that the “design process” is often iterative. Typically, developing overall concept is the first phase. The University of Portland is currently in the conceptual phase of the Dundon-Berchtold Hall (how many offices, meeting halls, class rooms – and what size).

What might follow “concept development”? (rhetorical question)

Thermal Expansion

Last week, you were asked to design a structure to keep two points in space equally spaced as temperature changed from 20°F to 110°F. You probably skipped right over the concept phase and went straight into detailed design?!? Since the main criterion was vague (minimize the variation in spacing as much as possible), you are probably pretty confident you did as good a job as anyone could given the material restrictions. Now step back and look at this problem again. You may work on a team of 1-4 people. Start with concepts BEFORE doing any analysis. Brainstorm. The criteria remain the same, except I now challenge you by quantifying the main criterion. The change in length over the 30 inch span with the temperature ranging from 20°F to 110°F should be no more than 0.0005 inch. AFTER developing at least one novel concept, do detailed analysis to determine if the criterion of $\Delta L < 0.0005$ inch is achieved. So that we are all dealing with the same apples and oranges, use the following properties (assume expansion coefficient is constant over the design temperature range):

material	Thermal expansion coefficient ($10^{-6}/\text{deg F}$)
A36	6.5
SAE 4340	6.8
2024-T351	12.7
6061-T6	13.1
7075-T651	13.0
Ti-6-4	4.8
Al ₂ O ₃	4.5
plastics	Rejected due to lack of structural integrity (subject to creep)

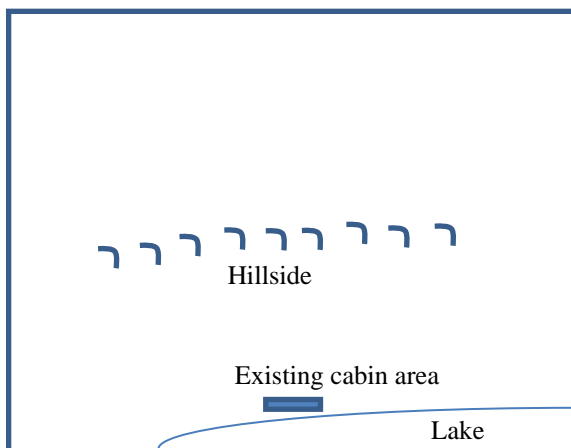
Lake-Side Resort Development

Situation: You have been asked by the new owner of a lake-side resort to design a plumbing system for the cabins (only the supply side, not the waste side). Facts:

- The owner just inherited this resort property from a long-lost aunt and uncle and is hoping to “upgrade” the facility over the next 5 to 10 years. The first phase of the upgrade is to add kitchenettes and bathrooms (including showers and the typically bathroom plumbing needs). Longer term upgrades will likely include adding 12-15 new cabins (also with kitchen/bathrooms).
- Total property is about 50 acres, including over 1000 feet of waterfront property and hiking trails up the hillside behind the cabins.

- The owner has had the lake water tested; the water is deemed potable.
- Other than the lake, the only water on site is a central well with a hand pump.
- There are six cabins and one “resort” house where the owner plans to live. The resort house also provides recreational space for those who have rented a cabin (meeting hall with card tables, large fire place, etc. – space for about 50 people with various chairs, sofas and tables).

Your task: you will be meeting with the client on Tuesday September 13 (in class, next Tuesday). You may work in teams of 1-4 students per team. Each team will present to the client (and class) their concept design – yes, powerpoint. Include enough slides to communicate your concept. You may assume everyone is familiar with what’s being asked, but it never hurts to summarize the main “given, find, assume” sort of stuff. This is a relative informal design review (“normal” student attire is acceptable) – present your idea for the project. The concept may include a very rough plan to discuss how you recommend proceeding (for example, do you recommend designing a pumping system to meet the demands of the long term expansion, or will the pumping system be done in phases – or maybe that would be decided after you get a bit more data....). At this point, you will have done no work to determine pump size, etc. During the design review, you may ask questions of the client trying to better understand the needs – but for now, all you can do is work with the information you are given.



Approximate layout of the existing 50 acre resort. NOT TO SCALE