Project Management

- **Typically, engineering and computer science involve coordinated work to develop something – a new product or process, a manufacturing method, a maintenance procedure, or a special one-of-a-kind prototype to prove (or disprove) some theory.**
- **We can therefore characterize a <u>project</u> as a quantity of work that is not ongoing, but is <u>specific to some task</u>.**
- <u>As such, a project will be of a specified length, have one or more well-defined goals, a set of things to accomplish to achieve the goal(s), a team of coordinated workers to attack the project, and a designated end point.</u>

Project Management (2)

- Clearly, <u>**project management**</u> is the act of managing a project.
- <u>**Project management**</u> is simple to understand conceptually, but <u>**quite hard to actually do**</u>.
- As evidence of this, there have been <u>**thousands of books written about project management**</u>. Management journals constantly have articles on project management.
- You can even earn a <u>**master's degree**</u> in project management!

Project Management (3)

- Since a project is a set, limited amount of work, what would a project look like? How is it different from other types of work?
- Project example: <u>Designing and building a new, modern electrical generation plant</u>, possibly using solar or wind or other non-traditional electrical generation.
- "Regular" work: <u>The ongoing operations at an electrical plant</u>, which do not have a stopping or end point, and which can continue indefinitely (at least until the generators wear out).

Project Management (4)

- **Obviously, one 75-minute lecture will not make you an experience project manager.**
- **However, we do have time to explore the <u>characteristics of a project</u>, <u>how it may be managed</u>, and some of the <u>management tools</u> that are used by professionals to manage projects.**
- **Let's start with a summary of the elements of a typical technology project.**

Characteristics of a Project

- As a specific, measured task, a project will have a number of standard characteristics:
  - A stated goal, e.g., development of a product/process.
  - A specified beginning and end or conclusion (due date) which define a project timeline.
  - A set of well-defined tasks required to accomplish the goal.
  - A team of participants, often with specific tasks assigned to each (sometimes tasks assigned to sub-teams).
  - A budget that specifies the overall funding (perhaps with a set percent of permissible overrun).
  - A set of reporting requirements and/or communication events.

Project Elements: Goal

- **Every project has a <u>goal</u>.**
- **In general, this <u>goal</u> is very specific, and may include a specification which describes very clearly what the end objective is:**
  - **Example: The goal of this project is to design a new clocking element for a digital sampler that will operate at __ MHz, with __ % stability and __ % reliability.**
- **Clearly defining the <u>goal</u> assures that project team members understand exactly what success involves.**
  - **"If we don't know what the exact goal is, how will we know when we're done?"**
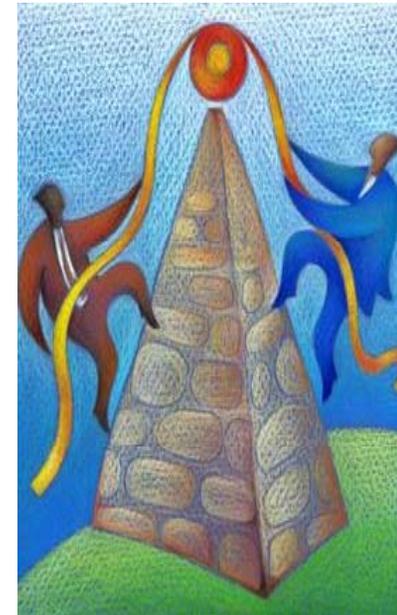
Project Timeline

- **Most projects are defined in terms of a goal to be met by a specific date.**

- **Frequently this goal is completion of a product or process design (covered in Lecture #9).**

- **The forecast date for the achievement of the goal defines a timeline that stretches from project start ("now") to project conclusion.**

  - **Typically, this timeline defined by the completion date may have a series of objectives with dates ("milestones").**

  - **Timelines** **are usually defined on a chart or graph (covered in project tools, below).**

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Project Objectives or Tasks

- **Normally, a project will have a set of objectives or carefully-defined <u>tasks</u> that must be accomplished to achieve the project goal.**
- **These <u>tasks</u> are a way of dividing the project workload among team members (next slide) so that the project effort may be accomplished in the required time:**
  - **Each task has an associated milestone (time to complete date).**
  - **This date is <u>very important</u>, as it is normal for <u>later</u> project tasks to depend on completion of <u>earlier</u> tasks.**
  - **Thus a "sliding" task (task not complete by its deadline) can <u>affect the whole project schedule</u>.**

Project Team

- **Projects such as the Intel Hex-core CPU's now on the market, the Microsoft Windows™ OS, or the Apollo moon-landing are good examples of large-team projects.**

- **Such massive projects take enormous effort by many people.**

- **Industry or government projects like these are usually the work of the many professions required to complete the project.**

- **Consider a (somewhat) smaller project team assigned to develop a new automobile radio/GPS/CD/MP3 audio system.**

Audio System Project Team

- **The team will have many specialists, for example:**
  - **A radio designer (EE)**
  - **An amplifier designer (EE)**
  - **A microprocessor expert/interface specialist (CE)**
  - **A lead software developer (CS/SE expert)**
  - **A power supply designer (EE)**
  - **A chassis designer/packaging expert (ME)**
  - **An automotive interior designer (probably a styling specialist)**
  - **A test engineer for internal test development (EE, CE, CS)**
  - **A product engineer to design the production process (ME)**
  - **A marketing specialist to assure customer satisfaction**
  - **(Occasionally) One or more subcontractor representatives, if subcontracting vendors will also be involved.**

Project Budget

- **The project budget may be a many-sheet chart with funding totals for both manpower and parts and/or equipment, depending on the size of the specific project and the overall project timeline.**
- **Budgets can be charted versus time, to show investment by week or month.**
- **Funding may also include such categories as rent (for facilities or equipment), transportation, and vender services.**

Reporting Requirements

- **Most projects will have specified a set of reporting requirements associated with the effort. These include specific, formal reports as well as regular, much more frequent updates of project status.**

- **We will cover reporting in another section below. Typical requirements for project reporting are:**

  – **A formal proposal**

  – **A preliminary design report (prior to conditional go-ahead)**

  – **A critical design report (prior to full go-ahead)**

  – **A final project report**

  – **Brief updates on some regular schedule, perhaps weekly or monthly (depending on project importance)**
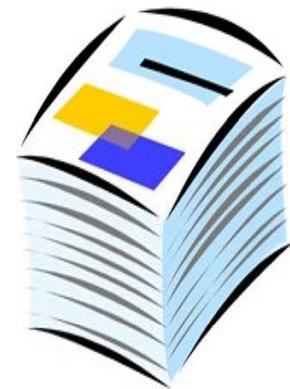
Project Tools

- **Project tools are items which aid the project manager in managing a project.** **They are generally graphs, charts, and/or descriptive elements having specific information about work yet to be done.**

- **There are many project tools, most of which today are computer-based and/or generated.**

- **In this case, we will consider manual (paper) versions of some tools, which can be just as useful, although possibly a little harder to change or update.**
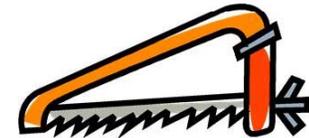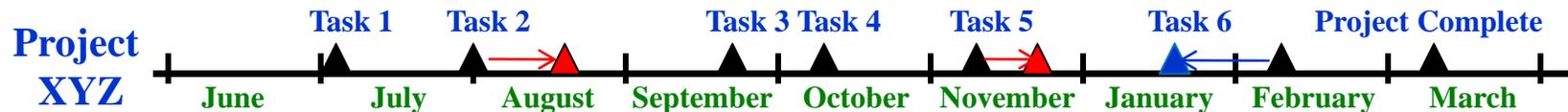
Project Tool List

1. **A statement of work (SOW), giving (excruciating) detail on the exact goal of the project.**

2. **Schedule chart, typically with key milestones.**

3. **Task chart, typically done as a schedule chart ("Gantt chart"), often with personnel assignments.**

4. **(Often) A manpower allocation chart, showing the forecast manpower required for each task.**

5. **A budget. The budget may be displayed in two ways:**
   – **A summary of expenditures by category (manpower, parts, etc.).**
   – **An expenditure schedule, as shown on an upcoming slide.**

SOW (From Previous Audio System Example)

   "The goal of the Auto Media Center Project is to complete the design and productization of a new stereo/radio/CD/MP3 player system for the (auto company) (model and year), which will include full GPS navigation capability. Key features:

1. Full audio range, 15-15K Hz
2. Subwoofer
3. MP3 Audio dock
4. Minimum 400 watt audio output, front/rear channels
5. AM/FM/HD radio with satellite radio option
6. Full speech input control
7. Maximum cost no more than $275."

Timeline Schedule

Project XYZ

Task 1   Task 2   Task 3   Task 4   Task 5   Task 6   **Project Complete**

June   July   August   September   October   November   January   February   March

- **A schedule can be as shown above, a single timeline, with key milestones clearly laid out.**
- **As noted below, the project tools can change as project knowledge grows. Thus milestones may be slipped (red) or accelerated (blue).**

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"Gantt" Chart

- **A <u>Gantt Chart</u> is a method of showing the timeline of project tasks on a single document.**
- **Henry Laurence Gantt was a management consultant and engineer, who devised the Gantt chart in the 1910's.   At that time, Gantt Charts were quite innovative. Construction projects like Hoover Dam and the Interstate Highway System necessitated a tool such as the Gantt diagram.**

Henry Laurence Gantt

- Now a staple project management tool in modern project administration, <u>Gantt Charts</u> are routinely deployed by PM's, planners, and system developers.*
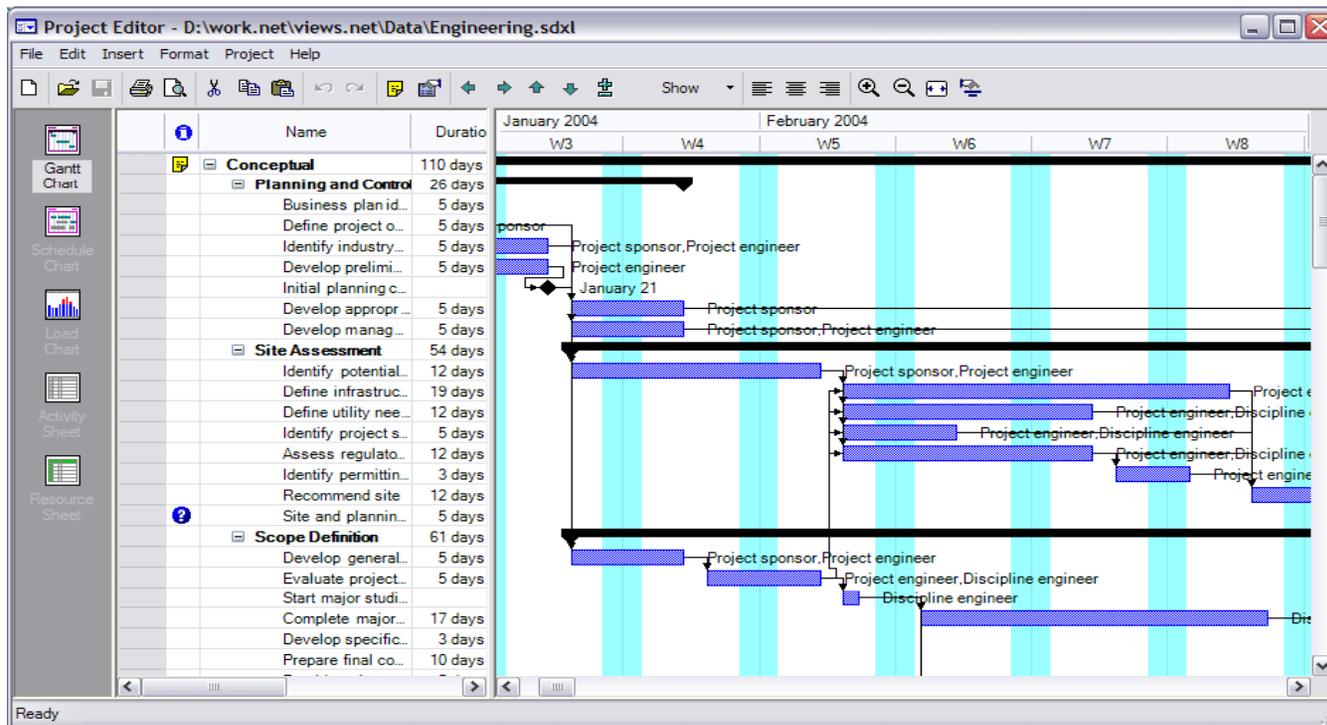
*This information and the chart on the following page from "Gantt Charts for everyone."

Example Gantt Chart

- **An example Gantt Chart is shown above. Gantt charts can also show personnel assignments on specific tasks.**

Schedule-Form Budget

Forecast Funding, XYZ Project (Note that total budget = $825K)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.
Engineering Expenditures	$17 K	$22K	$38K	$42K	$42K	$42K	$37K	$25K	$15K
Software Expenditures	$10K	$14K	$21K	$22K	$21K	$21K	$14K	$10K	$8K
Parts Expenditures			$12K	$25K	$50K	$37K	$7K	$5K	$5K
Computer Services	$50K	$36	$22K	$15K	$10K				
Transportation Rental				$9K	$10K				
Non-Exempt Hourly	$5K	$5K	$10K	$20K	$33K	$33K	$18K	$15K	$12K
Total by Month	$82 K	$77K	$103K	$133K	$166K	$133K	$72K	$55K	$40K
		Proposal Comp.	Team Ready	PDR	Simulation Comp.	CDR			Final Demo.

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Notes on Tools

- **Project tools are forms of paperwork (or computer documentation) that <u>aid in project management</u>.**
- **These are "living" documents. <u>They are not static</u>, that is, generated once and then forgotten.**
- **As a project continues, the project manager gains <u>additional knowledge</u> about the technical approach, the project goal, and this ability of his team.**
- **With this increasing knowledge comes a clearer view of project tasks, manpower, and expenditures.**
- **As a consequence, the project tasks, budget, timeline, and even the goal can change to fit this new knowledge.**

Project Reporting

- **Project reporting means <u>written reports</u> that are generated by the project manager or team to communicate with the sponsoring entity or customer :**

  - **Project proposal – Document that describes proposed effort, goal, resources required, and project deadline. Contains most of the project tools described above.**

  - **Work statement ("Statement of Work") – Fairly terse statement (often only a page or two) that spells out the project goal. Note: The SoW is a <u>project tool</u> as well as a report.**

  - **Preliminary design report (PDR) – Updated overview of the project with corrections or changes from the proposal. A last opportunity for project cancelation or modification due to SOW, schedule, or budget changes.**

Reporting (2)

- – **Critical design report – A report, typically 30% or so through the project schedule, that presents status, budget, schedule, and so forth. A "go" signal here means full commitment of management or the customer to the project.**

- **The proposal, PDR, and CDR have the same sections:**
  - – **Introduction/overview (goal)**
  - – **Work statement**
  - – **Major tasks and assignments**
  - – **Schedule with key milestones**
  - – **Budget (chart or timeline graph, $$$ by month)**
  - – **Personnel/task schedule (Gantt chart, optional)**
  - – **Summary with key objectives (milestones) and project goal**
  - – **Key difference: Each report deeper into the project will have more accurate budget, manpower, and schedule information.**

Reports (3)

– **Weekly/monthly reports – Engineering/computer science projects normally have regular communications to update stakeholders on project status.** **These are typically <u>skeletal updates</u> – only status changes or milestones accomplished since the last update.**

– **Normally do not contain copies of the various tools and charts. Can be weekly or perhaps monthly, depending on importance of the project (I had one that was DAILY!).**

– **Project summary report – Final project report, one that documents the project success (or lack thereof), final schedule and budget, and outcome. Some companies or organizations also include a "lessons learned" (particularly of unsuccessful projects) to help other project manager on a similar projects.**

Project Communications

- **By "communications" we mean the normal oral communications during the project, exclusive of the reporting. The key oral reports include:**
  - **Proposal – Like the report, a presentation seeking approval of the goal, budget, and schedule.**
  - **Preliminary design review (PDR) – Oral report that requests conditional project go-ahead based on early project work.**
  - **Critical design review (CDR) – Oral report that requests full project go-ahead based on 20-30% of project work.**
  - **Periodic updates (typically at key milestones) – Updates that presents status and any changes since last presentation.**

Project Communications (2)

- **Note that most of the oral communications vehicles have a written counterpart.**
- **In your instructor's experience, normally weekly and monthly reports are written.**
- **The project proposal, PDR, and CDR are generally live, with an accompanying report.**
- **The only other oral presentations after the CDR might be after <u>major milestones</u>.**
- **The project summary is generally a written report only.**

Estimating

- **A very important part of project proposals and also the preliminary design review are the forecast manpower required, the cost of parts and equipment, and the overall time to complete.**

- **In general, the project manager does not <u>know</u> these exact figures; they are in fact <u>unknowable</u> early on.**

- **The project manager must therefore be <u>very skilled in estimating</u> the various costs involved, the manpower required, and the overall time frame.**

- **In general, this is <u>not</u> easy!**

Estimating (2)

- **How does one become a good project estimator?**
- **With practice!**
  - As you become increasingly experienced in projects, you learn to estimate key parameters with increasing accuracy.
  - At first, this will be <u>hard</u>. You will be basing your estimates on limited personal experience (projects accomplished) to help in understanding the new challenges, perhaps with some inputs from colleagues.
  - Generally you will be going from smaller to larger projects, which makes the estimating that much harder.
  - However, with experience, it does get easier!
  - You can use your UTD project experiences (beginning with ECS 1200) to begin to hone your estimating skills.
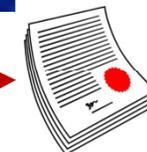
Starting a Project

- **How does a project get started?**
- **In industry or government, upper management, perhaps working with some outside agent (marketing, a customer, a government agency) determines that a scope of work ("project") must be accomplished.**
- **An organization is chosen to do the work (in industry, normally the engineering or product development group).**
- **The organization chooses a project manager (more experienced for bigger projects) and the project manager chooses or designates one or more lead technologists to be the key project leads.**

Starting a Project (2)

- **The project manager (PM) meets with the customer or benefiting organization (and perhaps his upper management also) and discusses the project goal.**

- **A statement of work (SOW) results from this discussion.**

- **All concerned parties sign off on the SOW.**

- **Based on the SOW, the PM generates estimates for the amount of work required, types of expertise, parts and equipment budgets, and an estimated timeline, working with his tech leads and using the tools described above.**

- **From this preliminary work, a proposal is generated and presented to management and/or the customer.**

Starting a Project (3)

- **When the proposal is approved (and this may require give-and-take [negotiation] between parties), the project scope of work, schedule, and budget are approved.**

- **The actual project effort begins:**
  - **Team members are assigned.**
  - **Design of the product or process starts, and task assignments, budget, and the schedule are fleshed out.**
  - **The PDR occurs general at the 10%-20% mark on the schedule, giving all concerned a second go/no-go opportunity.**
  - **The CDR is generally ~30% or so into the project. By this time, most project unknowns have been well defined. Assuming a go-ahead at the CDR, the project proceeds to its conclusion.**

Project Management: A Key Discipline

- To sum up, project management is a key discipline for all technologists.
- **Virtually all hardware and software development in industry, academia, and governmental organizations is done within the project framework.**
- **You, the young technologist (especially engineers, but also computer science students to a good extent) must master the discipline of project organization, management, and control.**
- You will have a project management opportunity **soon**!

A Real Project Story

- **Setting the stage:**
  - **It is the early 1980's. Vint Cerf and his associates on the west coast have already invented the Internet (although they still call it the "Arpanet"). The IBM PC is flourishing. Computers are beginning to talk to each other over wire lines ("local area networks" – LAN's), but there is no standard communication protocol. IBM decides on a new communication protocol called a "token-ring" protocol, and charters Texas Instruments to design and produce a single chip that will allow any device to connect to this LAN.**
  - **Problem: It will take two years to complete the chip. IBM also has to produce LOTS of software, and it needs to being testing it in _about a year_.**

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The Project

- **The TI LAN chip will not be ready soon enough to test the software that will run on it.**

- **What to do?**

- **Solution: Build several special purpose computers that emulate the chip and on which IBM can test its SW.**
  - **With heavy manpower and funding commitments, TI management believes this can be done in a year.**
  - **Properly constructed, these special digital systems will allow the IBM software to be tested and perfected for nearly a year before the chips are available, assuring that software and hardware will be available to IBM customers when required.**

The Project (2)

- **Although the TI Semiconductor Group (TISC, the chip seller) is expert in chips, they do not build <u>systems</u>.**
- **TISC approaches TI's Digital Systems (computer) group to design and build the emulator systems.**
- **This project is assigned to the Digital Systems Dallas Engineering Group, managed by Yours Truly.**
- **After meetings with TIDSG management, the engineering group agrees that with sufficient resources, funding, and emphasis, the systems can be built.**
- **One quibble: The Dallas digital systems group believes that it will take <u>longer than a year</u>.**

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The Project (3)

- **A project plan is drafted that forecasts 50 of the chip-emulators being built, at a cost of several $million (only about 30 will be built before IBM decides that it has enough systems to complete software testing).**

- **IBM participates in the funding, and TI also provides development $$$. The forecast profit from the LAN chips over several years is substantial.**

- **A schedule is proposed and approved, based on a one-year timeline, with reservations expressed by the Dallas group in writing. Funding is obtained, and the project proceeds at breakneck speed.**

The Team

- **A large project team is assembled:**
  - **A project manager (normally the manager of an entire group, who reports to the engineering systems manager [YT]).**
  - **A lead design engineer and several engineering specialists.**
  - **A lead programmer and his team (IBM will develop the LAN software, but the team has to have test software to assure that the emulator is fully functional).**
  - **A group of technicians to build circuit boards and the full systems.**
  - **A mechanical engineer to design packaging.**

The Team (2)

- **Because the systems are being used to test and checkout communication software for key IBM customers, we decide early-on that <u>reliability</u> is a key concern and requirement.**

- **In order to assure system reliability, a highly-regarded test engineer from TI's Defense Systems Group is brought in to ensure that the final system product is highly reliable.**

- **This engineer quickly adds major reliability and test efforts and hardware development to the project task list which make the overall schedule <u>very aggressive</u>.**

Reliability Considerations

- **The reliability engineer brings many new concerns and demands that are difficult and time-consuming but that will ultimately help to ensure project success:**
  - EVERY subsystem will have software developed specifically to test its full functionality. Hardware design will be very conservative to assure reliability.
  - When completely assembled, each system will be tested for several **days** prior to shipping.
  - Further, to assure full reliability, refrigerator/oven test cells are brought in so that systems are temperature-cycled during testing from below freezing to above 150°F. Systems ready for shipping will truly have been fully **burned in**!

Design Considerations

- **The circuit design is no problem – the chip group has designed it already.**

- **The problem is to duplicate it using <u>standard logic circuits.</u>**

- **However, there are other considerations:**
  - **Several printed circuit boards will be needed for the system.**
  - **Printed circuit boards take a good deal of time to lay out, proof, and manufacture.**
  - **If prototype circuits are made with wire wrapped boards, the general practice of the day, the delay will be excessive.**
  - **The decision is made to do <u>massive simulation </u>of circuit operation after the design is complete, then <u>go directly to PCB</u>.**

Schedule Problems

- **The design is completed on the accelerated schedule.**
- **Simulation starts at the same time as PCB layouts.**
- **As simulation finds "bugs," the PCB layouts are changed to match the bug fixes.**
- **Parts orders go out daily as circuit subsystems are verified.**
- **The project is now mid-year in duration, and although from the group manager's point of view (YT) and that of the project manager, things are going about as well as could be expected, the project is behind the one-year schedule imposed by TI Semiconductor Group.**

"Communication"

- **The executive VP of TISG, as well as the division VP responsible for the chip product decide that the situation is serious, and "request" oral reports – <u>daily</u>.**
- **The TISG are finally convinced – after several weeks of daily meetings – that things are going as well as they can given the current work week, <u>but they want more</u>.**
- **The engineering manager (YT) reminds the VP's that personnel are working 9-10 hours/day, 6 days/week. He says that is all he will request from his people, considering that engineers to not get overtime pay.**

Going the Extra Mile

- **The VP's want "more effort" – i.e., 7 days/week.**
- **The project manager suggests the following:**
  - Go to 12 hours/day, 6 ½ days per week (65 hours/week).
  - Pay all engineers except senior engineers straight-time overtime up to 65 hours (hourly employees will get time and ½ over 40 hours, and double time over ~55 hours).
  - Cater breakfast and lunch each day for all project personnel, plus snacks at break time (free to all project personnel). That way, workers do not have to leave their workstations.
  - This will about double the labor budget, and the food cost will be stratospheric.
- **The VP's don't even blink. The project goes into really high gear.**

First Prototypes

- **All parts arrive and the first PCB's are in. Assembly goes rapidly and a first system is fired up.**
- **It doesn't work.**
- **…Which is not that surprising. With the good simulation that was done, the engineers know where to look for problems, and the first system is quickly debugged and running, with minimal wires on the PCB.**
- **System #1 goes into the burn-in refrigerator/oven, and quickly fails, but more problems are quickly found and the first system is fully operational and "burned in" by the one-year point on the schedule.**

"Production"

- **Fabrication of 50 systems is <u>very limited</u> production, but a technician line is set up and as PC boards arrive, systems are built and go into burn-in.**
- **The customer is frantic to get these systems, and some are soon sent to the IBM software development facility, along with the project manager, engineers, technicians, and software experts.**
- **The systems are quickly set up, and although IBM initially complains about a good deal of "hardware" problems, it is quickly discovered in every case that the problems are with <u>their software</u>.**

"You Did a Pretty Good Job!"

- **Complaints continue for about two weeks concerning the system hardware performance, but the problems are traced in every case to the customer's new (and untried) software.**

- **After two weeks, the IBM project manager of software development calls YT and says, "I'm sending your guys home – there's no use spending money to keep them here since your systems don't break."**
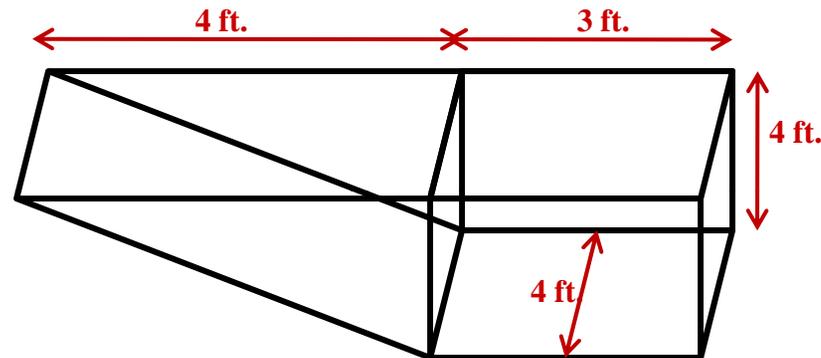
"You know, you guys did a pretty good job."

Project Exercise

- **How about a quick project exercise?**
- **You are trying to earn $$$ for <u>next semester</u> during the summer doing odd jobs, such as mowing lawns, repairing or cleaning up computers, running errands for older neighbors, etc. A neighbor want a hole dug in a corner of his backyard for a mulch bed. He wants it four feet deep, four feet wide, and seven feet long, with one end of the seven-foot side a four-foot ramp into the deeper area.**
- **He offers to pay you <u>one of two ways.</u>**

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Pit Specifications

4 ft.   3 ft.

4 ft.

4 ft

- He will pay you a flat fee of $400 to dig the hole (he will use the dirt in other places in his yard; you don't have to haul it off).
- He will also pay you $15/hour until you are done, even if it is more than $400, if you think the project will take longer.
- The area is too restricted between trees to use a backhoe.
- You have two shovels and a friend, Joe, who is willing to help for $100.
- What is your proposal?

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Comments on the Project

- **This is your homework assignment, <u>due next class</u>.**
- **Write a proposal for your "customer," showing:**
  - **Project timeline (how long will it take?).**
  - **Proposed budget.**
  - **Task allocation (for your "team," i.e., you and Joe).**
- **Clearly you need to know, to complete your proposal:**
  - **Volume of dirt (cubic feet) in the hole.**
  - **Volume (cubic feet) in one shovel full of dirt.**
  - **Shovels of dirt you and Joe can average an hour.**
- **Two pages, max.; use engineering paper or do in Word™. Paper proposal due at <u>beginning of class</u>.**
- **<u>Which deal do you take</u>?**

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