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Learning to Learn: The Art of Doing Science and Engineering, Session 5:

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Learning to Learn

The Art of Doing Science and Engineering

Session 5: History of Computer Applications

Addressing Large Groups

A function of a scientist is to communicate

Master these 3 communication methods:

- Written books & articles
- Formal Talks
- Informal Talks

It is your obligation as a scientist to do this

Informal Talks

Avoid becoming a back-room scientist

- Issuing position papers, after attending a group activity where the real decision was made, simply doesn’t help
- Speak promptly, to the point, and carry conviction

Formal Talks

You cannot become a great scientist if you cannot communicate well.

How to get invited back:

- Don't necessarily talk about things that you are very interested in, or that you are an expert in
- Instead, focus on subject your audience wants to hear:
  - *Look towards addressing issues (like the future of computing) so that the talk stimulates both you and the audience.*
  - *Reduce concepts down to something the audience can understand*
  - *Use talk research to keep yourself up-to-date on latest innovations*

Computer Applications: Simple Logic to Simply Idle

Computing began as simple arithmetic.

- Raymond Lulle (circa 1300) – build a logic machine

1940s-50s were spent “number-crunching”

- Limited applications due to expense of computers

Machines are now idle most of the time

- Similar to telephones and restrooms – must have, but don’t need to be used constantly to be useful

Sizing Up the Opposition

Common to work very difficult problems on primitive machines and evolve to working simple jobs with advanced equipment.

- Large impedance exists in getting new ideas into organizations, which forces demonstrating that the concept can work first under the most difficult conditions. Once installed, the bulk of the machine's time will then be spent on simpler problems.

Sometimes it's best to abandon the effort and go do something else.

Mass Production of a Variable Product

Working all of next year's proposed problems

- Example: 1 man-year (4 months) to get a software system going and able to accomplish several year's worth of effort within the year, but... ...hardware/software became obsolete in 2.5 years

Thus, if you do build a custom system, get the savings out of it early (1-1.5 years). Software tools and technologies change rapidly, rendering custom tools obsolete more quickly.

Time vs. log Ops Curve

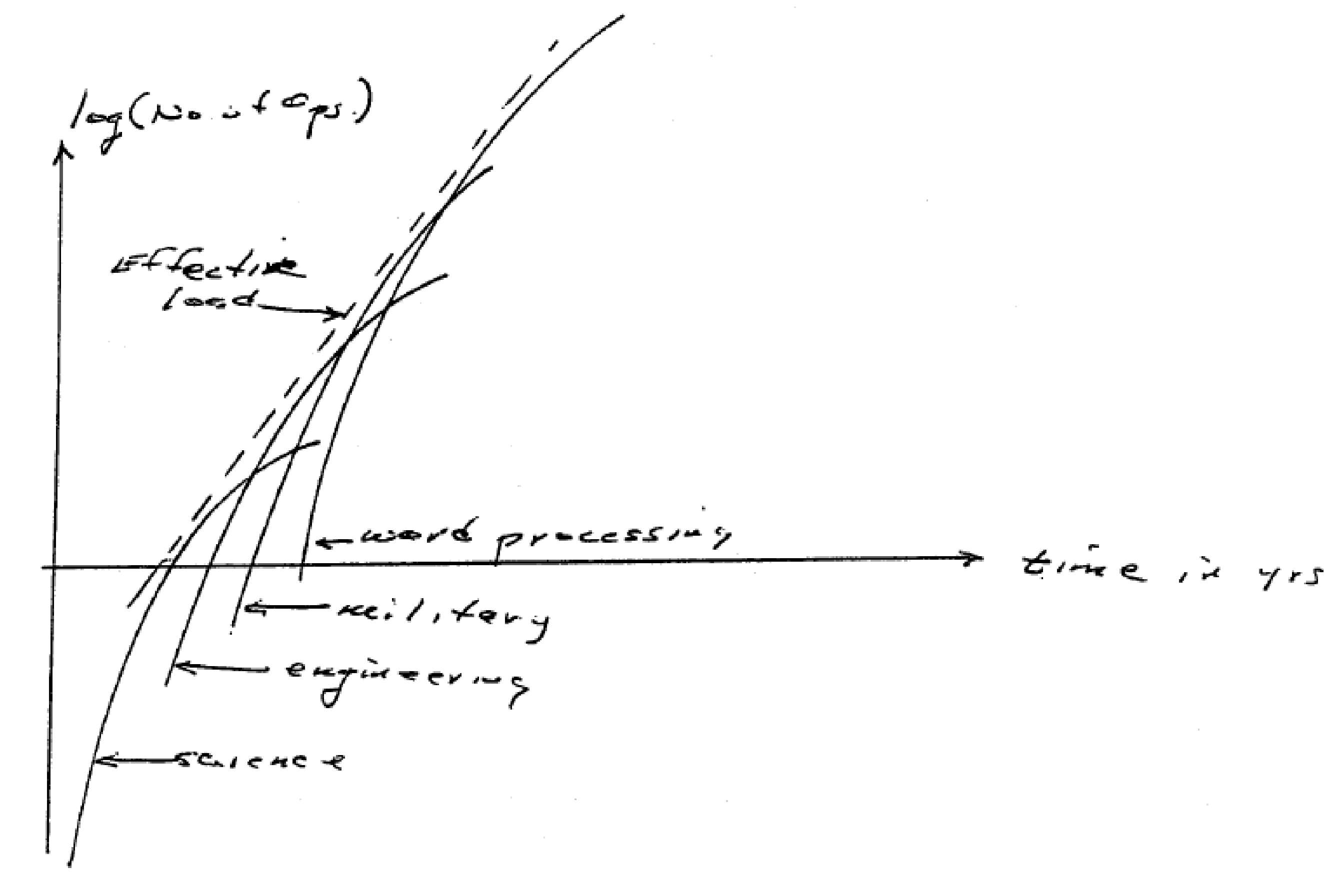

Figure 5-1

Use of Computing Resources

Saturation Point (curve bent over)

- Given 1000 research scientists, just how many problems can they ask per day?
- Engineering helps the curve (more work placed on machine)
- Military best at utilizing computing resources (maxing them out)
- Future large consumers: pattern recognition, virtual reality (VR) and artificial intelligence (AI)

Saturation leads to need for parallel processing

Early Interactive Computing

- **Jack Kane idea: connect computer to cyclotron to reduce data on the fly**
  - Doubled effective production of cyclotron
  - Gathered, reduced, and displayed data during test, allowing problematic runs to be aborted early
- **Small computers used at Bell Labs**
  - Similar to above, but also acted as experiment drivers
  - Allowed for interactive experimentation
- **Computer redefined nature of experiment**

Temporal Nature of Databases

Boeing aircraft design teams

- Used static copies of databases for design and then reintegrated changes back into common database

Rapidly changing databases should not be used to make analytical decisions

- Examples: managerial reports, optimization studies, etc.
- It is always tempting to use “latest numbers,” but spikes and fluctuations can overshadow overall trends

Custom Systems

Use general purpose device for specific purposes. Much easier to accomplish than vice-versa.

- Economies of scale, larger user base, better support, easier to obtain, potential upgrades, more adaptable
- Special-purpose chips are often ego-driven

Parting Shots…

Note application successes & failures.

Understand root causes & situations which produce success vs. those that guarantee failure.

Realize that machines don't do the same job, they do an equivalent one (and with flexibility, one that can be expanded).

Never forget about field maintenance!