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A Mathematician in Industry

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I will divide this talk into three sections

- How do industry, laboratories and academia differ,
- What does a mathematician do in industry and laboratories, and
- What does it take to be successful?

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You will have to “filter” everything I say.

What is the filter?

Every organization/company has a mission, vision and metrics of success

- University – teach and do research
- Industry – make products and make money
- Laboratories – accomplish a mission

In reality, the lines between these blur.

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One difference is that industry accounts for everything in terms of $.

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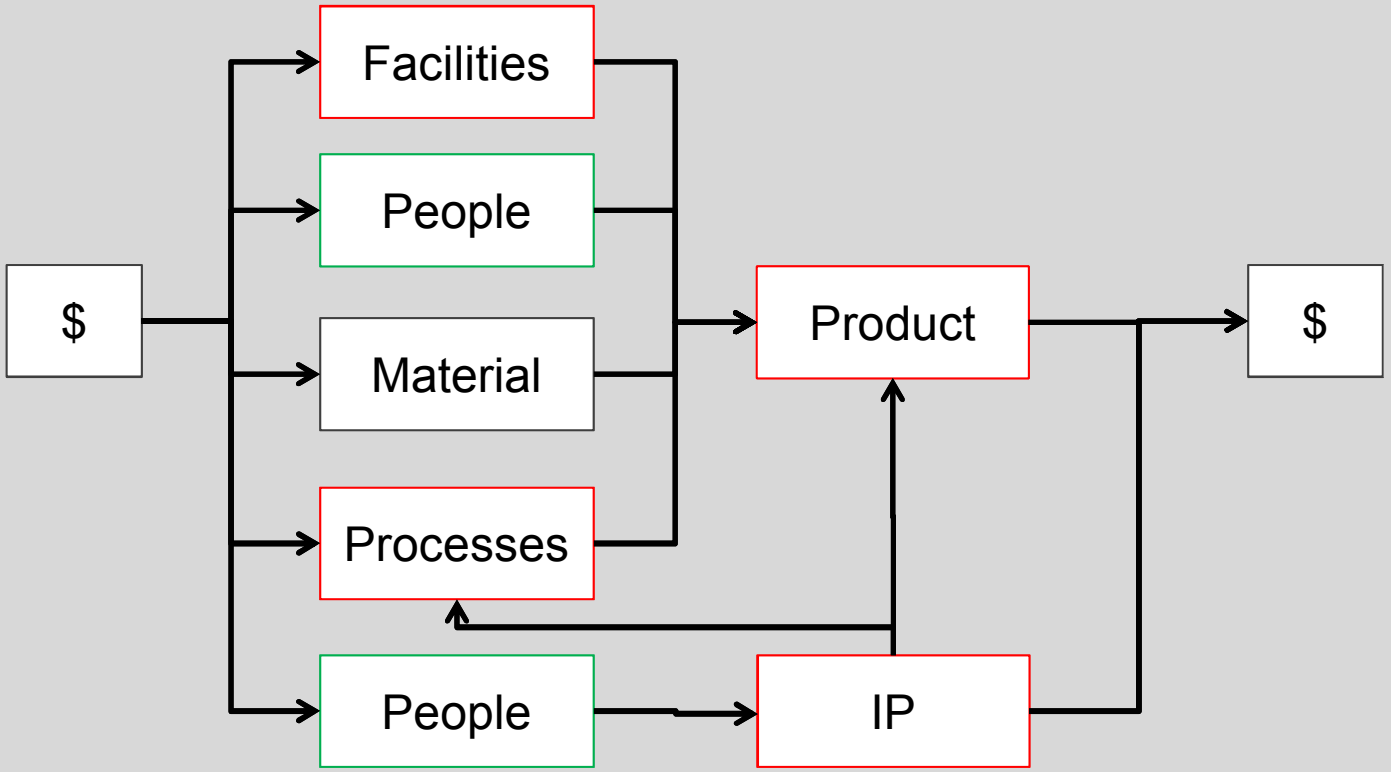
An very simplistic flow diagram:



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If the currency of business is $, we have to measure the value of mathematics and computer science to that business in $.

How do you do that?

Another difference is that industry has strong top-down management. In general, management will set overall corporate objectives, strategy, metrics and business practices.

Everyone has their own personal objectives and metrics of success. If your objectives do not agree with the company's, your options are relatively limited.

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Yet another difference is that industry handles intellectual property significantly differently from either universities or laboratories.

Industry also tends to protect its brand more aggressively than either universities or laboratories.

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Remember the green boxes? A good company will invest in its staff.

And a good staff member will invest in himself or herself.

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One more difference is that staff in industry tend to work in interdisciplinary teams.

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What is the role of Mathematics or Computer Science in industry? What does a mathematician actually do?

I am not aware of a company whose product is “Mathematics” or “Computer Science.” To paraphrase the BASF advertisement, mathematics doesn’t make the product, it makes it better.

In other words, a mathematician does everything and nothing.

There are several very different phases in an industrial career

Let’s look at some typical job assignments.

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Phase 1.

Welcome to your new job. Here is an office, desk, and computer. You'll be working on our interdisciplinary computational simulation team. Your first job will be to help the team deploy a structural analysis capability for wind turbine blades. This is William, who will be your technical lead and meet with you daily.

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Phase 2.

You've been doing fairly well lately. Would you put together a small proposal to management for some independent work with the goal of improving the efficiency of the gear box in our turbines?

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Phase 3.

We're seeing an increasing number of failures in our wind turbines. Would you lead a project team to identify the cause of the failures and suggest possible solutions? We can probably make 5-10 staff available and will need a report within 6 months.

Would you consider becoming a manager?

---------- Or ----------

Phase 4.

We'd like to name you as a company fellow. Would you lead the technical project to put a conceptual design for our next turbine. Or would you serve as our representative on the national board to develop wind turbine regulations?

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A few more examples of how mathematicians have contributed.

How should you prepare for that career?

The ability to communicate is perhaps the single most important skill you can develop

The obvious
- Proposals
- Reports

The less obvious
- Everything you do or say

Learn to speak the language of the “customer”

What do you think of the following writing?

“New techniques to perform small-scale simulations conditioned on the large-scale state will be formulated. To avoid the curse of dimensionality, informational entropy theory will be brought to bear to identify the most important large-scale quantities. Identifying emergent phenomena is a major challenge we will undertake and solve using model selection theory to assess which averaging length scales result in minimum model error and computational cost. Each aspect represents a scientific advance, but synthesis of these algorithms will create an entirely new computational framework in which significant mesoscales are discovered dynamically to provide next-generation fidelity for material models.”

The next most important thing is “learning agility.”

Mathematicians in industry need to focus on breadth rather than depth and avoid getting isolated.

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And the third is to work with others.

Remember interdisciplinary teams. We live in a complex world with complex products. You can accomplish very little alone.

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And finally, learn to think outside the technical box.

- Business
- National security
- Art and literature
- Philosophy
- Athletics

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One final thought. Ethics is not a difference or a skill, but it is fundamental.

To keep it simple, ethics is the ability to distinguish right from wrong.

Ethics and rules are not the same thing

At some point in your career (industry or academic) you will face an ethical dilemma

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Is an industrial career right for you?