Models of Math Use in Non-academic Workplace Settings

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Introduction

- Previous research on frameworks that describe math within physics has focused on either mathematical modeling or math use for problem solving at the undergraduate level[1, 2]
- Typical problems encountered by researchers and engineers are more diverse than undergraduate physics problems[4].
- **Goal: Analyze typical tasks involving math performed by employees at various optics and photonics companies and articulate a tentative frameworks to describe the role of math within those tasks.**

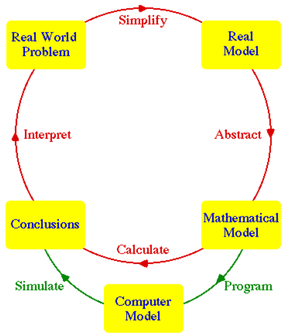

Figure 1: Typical example of a mathematical modeling cycle[3].

Methods

Conduct interviews with employees at Rochester, NY optics and photonics companies

Include math-specific questions in the interviews (Figure 2)

Mark all instances of math being discussed in the interviews (487 instances)

Apply emergent scheme in Table 2 to any instances labeled "Math" to classify by math type or tool

Perform inter-rater reliability with a second researcher to check for consistency

Apply second round of emergent coding to describe how the math or tool was used

Focus on frequently occurring and important uses of workplace mathematics

Role in Sample	Count
Engineers	14
Technicians	6
HR managers	2

Table 1: Number of participants by occupation

- **What math tasks do employees take part in daily or weekly?**
- **What tools do these tasks involve?**
- **What math skills are employees expected to use on the job?**

Figure 2: Selected questions related to math from the interview protocol

Label	Definition
Algebra	Solving equations, plug and chug, using formulas, interpreting graphs
Arithmetic	Addition, subtraction, multiplication, division, percent, counting
Calculus	Single or multivariable calculus, differential equations
Excel	Specific mention of using Excel or using a spreadsheet
Finite Element Analysis	Any mention of a finite element analysis program such as Zemax, COMSOL, Code V, LS-DYNA
Geometry and Trigonometry	Angles, shapes for design, trigonometric functions, surfaces
MATLAB	Specific mention of using MATLAB
Pencil and Paper	Any mention of doing math by hand rather than by computer or calculator

Table 2: Top-level scheme applied to every instance of math in each interview

Results

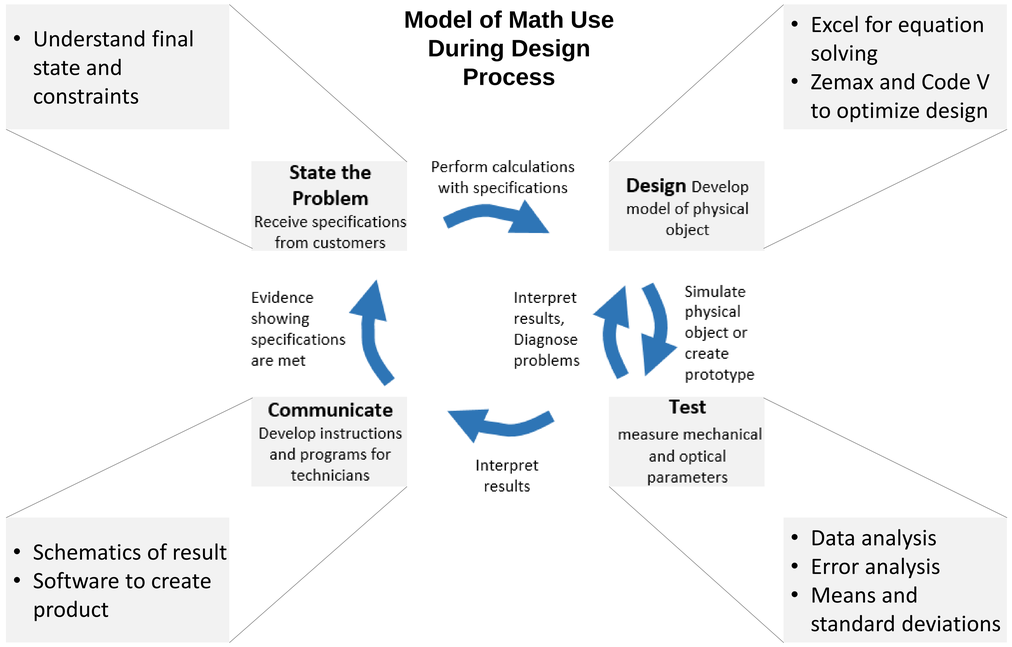

Figure 3: A visual representation of the typical process an engineer would use to design an optical device such as a lens system

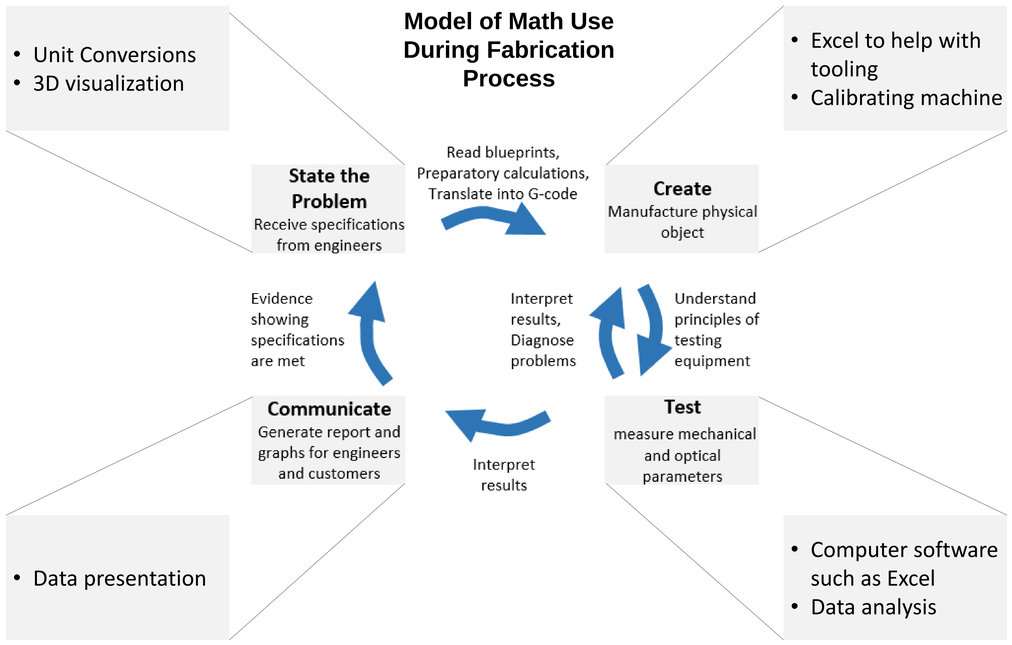

Figure 4: A visual representation of the typical process a technician would use to manufacture an optical device such as a lens system.

Conclusions

- Common workplace situations are similar to the engineering design cycle[5].
- Interplay between real-world and abstract mathematical representations as in mathematical modeling but are much more diverse.
- Final step of evaluating the result is done physically in the workplace but done abstractly in the mathematical frameworks.

Future Research

- Increase number of participants to better capture math in typical workplace tasks.
- Expand our analysis to include graduate students and PhD advisors.

Educational Implications

- A greater emphasis should be placed on using software to aid in mathematical calculations.
- Design problems should be incorporated in physics courses to expand math problem solving in a way relevant to a student's future career.

References

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