

FUNDAMENTALS OF AI-AUGMENTED ENGINEERING: A CONVERSATIONAL APPROACH

Taner Onsay, Ph.D. & Sebnem Onsay
Authors
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The engineering workflow you will use throughout this book
by Taner & Sebnem Onsay,

CHAPTER - 3

PART 1 · ≈ 30 MIN

The Disagreement — What Does “Wrong” Mean?

The search said 20.0. Algebra said 20.37. Both came from the same model — and a vehicle is waiting on the answer.

Problem



Model



Compute



Analyze



Validate



Improve



CONTENTS OF CHAPTER 3:

Chapter 2 asked: how do we express engineering thinking precisely enough that a computer can execute it? **Chapter 3 asks:** how much should we trust the number the computer hands back?

1

The disagreement — what does “wrong” mean?

Approximation vs. reference value · the gap has a size · how accurate is accurate enough?



2

Measuring error

Absolute · relative · percent — by hand, on your own search · which digits would you sign?



3

Step size, resolution & the cost of accuracy

One knob in your Chapter 2 code · Excel makes it visible · Python sweeps it · the price of a decimal



4

Convergence, tolerance & knowing when to stop

The answers settle · tolerance is a specification · a convergence claim that lies



5

Accurate enough? Validate & decide

Numerical error vs. real uncertainty · BREAK THE AI · the engineering decision



Prediction before computation is used throughout — as always. Nothing in this chapter is new to you; today it gets named.



A promise made at the end of Chapter 2

THE SEARCH YOU BUILT

```
while stopping_distance(v+step, t_r, a) <= d_avail:
```

Discovered by hand, made visible in Excel, automated in Python — yours, line by line.

THE DISAGREEMENT

20.0 m/s vs 20.37 m/s

Same model, same inputs. The search and the algebra do not agree.

WHAT YOU WATCHED HAPPEN

step 0.5 → 20.0 · 0.1 → 20.3 · 0.01 → 20.36

Smaller steps pulled the answer toward 20.37. You saw it settle before you had a word for it.

RUNS ≠ CORRECT

Chapter 2 · Principle No. 2

The program ran perfectly every time. That was never the question.

“Something interesting happened here. We will return to it.” This chapter is that return — you have already seen everything today's vocabulary describes. Rule of engagement, unchanged: **AI assists. Human verifies. Engineer decides.**

Problem



Model



Compute



Analyze



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Improve



DISCUSS



**A vehicle. A hazard. 50 m of road.
The search says 20.0 — algebra says 20.37.
Which number do you report?**

And is your program wrong? Argue it as an engineer — 2 minutes with a neighbor.

Say your reasoning out loud. Words like “off by” and “close enough” are about to get precise meanings.

Problem ›

Model ›

Compute ›

Analyze ›

Validate ›

Improve



An approximation — and a reference to judge it by

THE SEARCH'S 20.0 — AN APPROXIMATION

$$v_{\max} \approx 20.0 \text{ m/s}$$

The normal, honest product of a numerical procedure. The search answered exactly what it was asked, to the resolution it was given. An approximation is not a failure.

THE ALGEBRA'S 20.37 — A REFERENCE VALUE

$$v_{\text{ref}} \approx 20.37 \text{ m/s}$$

An independent answer we trust enough to judge against — here the analytical solution: the quadratic from Chapter 2, provided, not derived.

WHY WE WILL NOT SAY “EXACT”

Real engineering problems rarely possess a knowable exact answer — t_r is measured, a is estimated, the model is idealized. A reference may come from an analytical solution, an experiment, an independent numerical method, or a trusted benchmark. **We say reference value — and stay honest about where it came from.**

“Wrong” is not a yes/no question. The gap between an approximation and its reference has a size — and a size can be measured. Measuring it is Part 2.

Problem



Model



Compute



Analyze



Validate



Improve



How accurate is accurate enough?

CHAPTER 3 · PRINCIPLE No. 1

A NUMERICAL ANSWER IS INCOMPLETE UNTIL YOU KNOW ITS ACCURACY.



Every part returns to the same 50 m of road. No new physics enters this chapter — only new questions about the number.

