

Operations Research: Science or Engineering?

Christopher Thomas Ryan, September 5, 2025
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Growing up, I was never much interested in what school called “science.” It felt dead, just a bunch of facts to memorize and dry problems to solve. The real excitement for me lay in the humanities—literature, history, philosophy—fields where meaning was made, not merely rehearsed. But was the “science” I disliked in school really science?

Trying to define science has consumed volumes,¹ but a few distinctions might be helpful—especially for understanding the roots, and perhaps the future, of operations research.

The high school textbook idea of science, which likely descends from Francis Bacon, is not a definition so much as a process. Something counts as science if it follows the “scientific method”:

- Observe phenomena
- Formulate a question
- Propose a hypothesis
- Test it by experiment
- Evaluate the results
- Communicate findings

This is an inductive, empirical method. Bacon’s vision was that theories emerge from sustained attention to reality—not from pure logic but from observation, variation, and revision. By this view, operations research began as a science. Charles Kittel, an early OR practitioner and advocate, said so explicitly in his influential 1947 article that introduced many to the OR field in (fittingly) the journal *Science*:

Operations research is a scientific method for providing executive departments with a quantitative basis for decisions.²

But there is another sense in which people speak of “science”—one tied not to experimentation so much as mathematical formalism. Consider two classic statements associated with this view:

Philosophy is written in this grand book—I mean the universe—which stands continually open to our gaze... It is written in the language of mathematics. — Galileo Galilei³

¹My favorite accessible introduction is Godfrey-Smith, Peter. “Theory and reality: An introduction to the philosophy of science.” *Theory and Reality*. University of Chicago Press, 2009. What I discuss here is grossly over-simplified compared to this rich tradition. Please forgive me Professor Godfrey-Smith!

²Kittel, Charles. “The nature and development of operations research.” *Science* 105.2719 (1947): 150–153. A similar definition graced the first page of the first textbook on operations research by Morse and Kimball, *Methods of Operations Research* (1951). MIT Press.

³Galilei, G. (1957) [1623]. “The Assayer”. In Drake, S. (ed.). *Discoveries and Opinions of Galileo*. Doubleday. Pages 237–238.



In any special doctrine of nature there can be only so much proper science as there is mathematics therein. — Immanuel Kant⁴

This view loomed large in my schooling, where physics felt like a second math class. We sat in a lab but never touched the equipment. If that was science, it was all deduction and no dirt.

So here we have two currents: one empirical and one mathematical. One inductive and one deductive. Of course, both views can intertwine—but which serves which?

Physics somewhat resolved this tension by splitting into two major subfields—theoretical physics and experimental physics. Each side, grudgingly or not, respects the other. Operations research, by contrast, appears to have never resolved this tension. Is OR a field of applied mathematics that gave us linear programming to win wars? Or is it an empirical science that tinkers with depth charges in the field? It's probably both, but why no “theoretical OR” and “experimental OR” and its grudging mutual respect?

To make matters even worse, the early OR community brought additional confusing concepts into the mix. In the early 1950s, a splinter group of the Operations Research Society of America (ORSA)—the newly formed academic society for operations research—created an ever newer association, the Institute for Management Science (TIMS). One reason for the split had something to do with membership rules at ORSA,⁵ but maybe a deeper reason reflects a tension among OR practitioners about a further distinction—between science and engineering.

A common definition of engineering is, briefly, “applied science”.⁶ It takes theories from fields like physics and chemistry and puts them to use—in bridges, engines, algorithms. As Mel Salvesson, one of the driving forces behind the inception of TIMS, put it:

The central requirement of everyone who studies to become an engineer is to master the “bodies of scientific knowledge” that underlie their field.⁷

Engineering must apply science. The founders of TIMS believed there could be such a thing as a science of management. Or more poetically, a *management science* (MS). Article II of the Constitution of TIMS stated its objective:

...to identify, extend, and unify scientific knowledge that contributes to the understanding and practice of management.⁸

As C. West Churchman, philosopher of science and founding editor of TIMS's flagship journal *Management Science*, later wrote:

⁴Kant, Immanuel. *Critique of Pure Reason*, translated and edited by Paul Guyer and Allen W. Wood, Cambridge University Press, 1998 [1781]. Page xiii of the Preface to the Second Edition.

⁵Churchman, C. W. “Systems profile-Discoveries in an exploration into systems thinking” *Systems Research* 4.2 (1987): 139-146.

⁶There is a recent and robust debate on just what exactly constitutes “engineering”. See, for instance, Michelfelder, Diane P., and Neelke Doorn, eds. *The Routledge Handbook of the Philosophy of Engineering*. Taylor & Francis, 2020.

⁷Salvesson, Melvin E. “The founding fathers of TIMS: historical re-examination of humanity inspired the development of the management sciences.” *OR/MS Today* 30.3 (2003): 48-54.

⁸“Constitution and by-laws of the Insitute of Management Sciences” *Management Science* 1.1 (Oct 1954): 97-102.

My hope was that MS would be quite different from OR, because MS, the journal, the meetings, and the research would be the attempt to create and design a science of management that lived up to the standards of good science, whereas OR would be the practical application of such a science.⁹

Essentially, operations research was to be a type of *engineering* that applied management *science*. Neat and clean, right?

Sadly, even with this attempt to splinter the field into two—“Operations Research” and “Management Science”—ambiguities persisted. Consider the following statement in a talk at only the second National Meeting of TIMS in October 1955:

...we of TIMS need not be especially concerned with the grand effort at *fostering basic science*—our main effort should be to *adapt existing scientific knowledge*, and the techniques of the scientist, for the solution of problems of management.¹⁰ [emphasis added]

Not concerned with “fostering basic science”? Wasn’t this exactly what was meant to distinguish TIMS from ORSA in the first place? Adapting “existing scientific knowledge ... for the solution of problems”, doesn’t that sound a lot like “applied science”, or more simply, “engineering”?

In muddy the waters even further, in the same talk, Flood shared his view of a major contribution to management *science*:

Many of us feel that von Neumann’s theory of two-person games, first published in 1928, represents a shattering advance in the science of decision making—especially so if we include linear programming theory and Wald’s statistical decision theory as natural offspring of game theory.¹¹

But one may ask: Is the theory of two-person games a “scientific” theory at all? Indeed, shortly after Flood’s speech, Churchman wrote:

In the management sciences, we have become used to talking about game *theory*, inventory *theory*, waitline *theory*. What we mean by “theory” in this context is that if certain assumptions are valid, then such-and-such conclusions follow. Thus inventory theory is not a set of statements that predict how inventories will behave, or even how they should behave in actual situations, but is rather a deductive system which becomes useful if the assumptions happen to hold.¹²

On the one hand, we have a *deductive* mathematical *theory* of inventory, and on the other, we have an *inductive* testable *theory* of how inventory behaves in the wild. We have returned full circle to the old competing views of what constitutes science, but now at the heart of the ongoing debate of what constitutes “Management Science” (and, by convoluted implication, “Operations Research”).

⁹Churchman, C. West. “Management science: Science of managing and managing of science.” *Interfaces* 24.4 (1994): 99-110.

¹⁰Flood, Merrill M. “The objectives of TIMS.” *Management Science* 2.2 (1956): 178-184.

¹¹*ibid.*

¹²Churchman, C. West. “Management Science—Fact or Theory?” *Management Science* 2.2 (1956): 185-185.

Flood makes his math-centric view even clearer by claiming later in his talk that “the best traditions of the natural sciences” “bring mathematical theories and observational data together”,¹³ seeming to downplay the non-mathematical contributions of someone as eminent as Charles Darwin. Somewhat unsurprisingly, Churchman, the concurrent editor of both the journal *The Philosophy of Science* and of *Management Science*, had a much more nuanced view. His aspiration for creating a “big tent” is captured in the opening letter of the first issue of *Management Science*:

Management Science is committed to the conviction that all these philosophies should be given expression in its pages ... mathematical models, measurement and control, broad viewpoints, specific cases ... no matter what the origin of the writer may be—mathematician, physicist, social scientist, biologist, engineer—manager and non-manager—philosopher.¹⁴

Sadly, by his own admission, Churchman viewed the “big tent” approach a failure.¹⁵ As for the concept of “management science”, it seems to have largely survived in name only, essentially synonymous with “operations research” but far less popular. Technically, my PhD is in “Management Science,” but I never heard anyone in my department describe themselves as a “management scientist”. I certainly don’t.



Where does this all leave operations research?

The early definitions—Kittel, Kimball, Morse—describe OR as a scientific *method*. Does that make it a science? Once “management science” was conceived and TIMS was formed, some imagined OR to be an application of that “science”—a “management engineering” if you will. But no one seemed able to agree on what that “science” was. To make matters even more confusing, some hold to the notion nowadays that operations-related work in the journal *Management Science* is a kind of “applied” operations research, a total inversion of its original intent.

You might say to yourself: Isn’t this all just an academic exercise of definitions? Names upon names. Who cares? Shouldn’t we all just get down to the business of *doing* operations research?

Or was that management science?

Decision science?

How about decision analysis?

¹³Flood, Merrill M. “The objectives of TIMS.” *Management Science* 2.2 (1956): 178-184.

¹⁴Churchman, C. West. “Management Science, the journal.” *Management Science* 1.2 (1955): 187-188.

¹⁵Churchman, C. West. “Management science: Science of managing and managing of science.” *Interfaces* 24.4 (1994): 99-110.

Are we doing analytics now?

If names don't matter, why can't we just stick with one?

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While I didn't resonate with the "science" I learned in high school, I realize now that I liked science all along.

For two decades, I've worked with math models that roughly fit under the name of "OR" (although not everyone of consequence to my career even agreed on this). All philosophical debate aside, my math research felt more to me like art than science—a kind of mathematical fiction. I dreamt up worlds from my desk, far from the field. There was no dirt nearby.

But when I became curious about OR's history, I couldn't turn to equations. It drew me to reality. So I observed, asked questions, checked historical documents, got confused with conflicting data and versions of events—something that ironically felt more like science to me than anything I had done before in my career. Maybe I had finally found the "science" that evaded me in high school.