

What is Automation?

"What is quality?" asked the narrator in Robert Pirsig's classic *Zen and the Art of Motorcycle Maintenance*.

In a similar spirit, we might ask: "What is Automation?" The question is especially relevant to members of the IEEE Robotics and Automation Society considering where to submit their next journal paper. Should it go to the Transactions on Robotics (T-RO) or to the Transactions on Automation Science and Engineering (T-ASE)?

In 1984, a group of visionary researchers arranged the marriage of two subfields to form the IEEE Robotics and Automation Society. Twenty years later the Society bifurcated its journal into two publications. T-ASE was astutely guided during its first five years by EiC Peter Luh and the next five by EiC N Vishu Viswanadham. As we approach the Society's thirty-year anniversary, we might step back to consider the respective roles and characteristics of Robotics and Automation.

Let's admit: Robotics is sexier, more esoteric, more alluring. Automation has always been viewed as the workhorse, focused on manufacturing, less glamorous, but with a larger impact on the world economy. One reason the term "Science" was added to T-ASE was to emphasize the rigorous and theoretical aspects of Automation. Despite their differences, the marriage has succeeded, and over time like most married couples, the partners have acquired many mutual interests.

Automation has expanded beyond its roots in Manufacturing to include applications in Healthcare, Security, Transportation, Agriculture, Construction, Energy, and many other areas. Both Robotics and Automation explore the frontiers of automated and semi-automated machines. Both fields are increasingly concerned with the role of humans and human interfaces, and with the potential of the Internet and Cloud Computing.

So what's the difference between Robotics and Automation?

There are many possible distinctions. Here's the summary from our Society's Field of Interest Statement:

"...Robotics focuses on systems incorporating sensors and actuators that operate autonomously or semi-autonomously in cooperation with humans. Robotics research emphasizes intelligence and adaptability to cope with unstructured environments. Automation research emphasizes efficiency, productivity, quality, and reliability, focusing on systems that operate autonomously, often in structured environments over extended periods, and on the explicit structuring of such environments."

This statement emphasizes how Automation emphasizes structured vs. unstructured environments, reliability vs. adaptability, and efficiency vs. exploratory operations. These are valuable distinctions and I'd like to propose another one.

In my view, research in Robotics emphasizes Feasibility. Feasibility focuses on proof-of-concept, demonstrating how a new functionality can be achieved. Robotics papers usually demonstrate a new ability of a robot, for example demonstrating how a robot can walk, drive, fly, or perform a surgical subtask.

On the other hand, research in Automation emphasizes Quality. I use the upper-case to indicate Quality in the technical sense, as in Quality Control, which includes efficiency, productivity, and reliability as stated in our Field of Interest statement. Quality can be improved with new techniques, analysis, models, and results on robustness, stability, productivity, efficiency, completeness, optimality, convergence, performance guarantees, time complexity, sensitivity, verification, and reliability. Of course an Automation paper may present a feasibility study for an entirely novel mechanism, model, or theory for applications that involve repetitive operations, for example in manufacturing or healthcare. But an Automation paper could also focus on making robots walk, drive, fly, or perform a surgical subtask more efficiently, more reliably, or more cost effectively.

Let's dispel the myth of the excluded middle: Robotics and Automation are not disjoint. Feasibility and Quality are closely related. Many papers include aspects of both subfields, but emphasize one or the other. Viewed this way, many researchers study both Robotics and Automation.

I should clarify the distinction between upper-case Quality and lower-case quality. Lower-case quality is related to value and as Pirsig noted, is a subtle characteristic related to rigor and originality. A paper that emphasizes Feasibility can be high-quality and a paper emphasizing Quality can be of low quality.

Almost all papers include elements of both Feasibility and Quality: the distinction will never be binary; it's a matter of degree. Both publications emphasize "research" over "development". In my view, a paper with significant results that primarily emphasize Feasibility (i.e., the focus is on proof of concept) should be submitted to T-RO. And a paper with significant results that primarily emphasize Quality (i.e., the focus is on performance) should be submitted to T-ASE. Of course there will be many exceptions.

The IEEE Robotics and Automation Society is a successful marriage that has grown stronger over time. I believe it's vital for the RAS community to take a fresh look at T-ASE and expand our definition of Automation while also welcoming a new community of researchers who focus on Automation. As I have argued here, an important part of this self-reflection is to expand and clarify our definition of Automation.

It is also important to consider other changes. For example, reproducibility is a hallmark of Science. Everyone benefits when researchers compare their new results alongside data or reproduced experiments from previously published methods. To facilitate this, T-ASE encourages authors to publish data, code, CAD models, and other media with their papers, as well as details on experimental methods, so that others can repeat and extend published results. To increase access and impact, we also encourage authors to include presentation materials and illustrative videos. See Info for Authors, Submission of Multimedia Material, at our website. I'll write more about this issue in a future Editorial.

I'm looking forward to the next chapter of T-ASE. Please visit our website for updates, links to the latest issues, and information about past and upcoming Special Issues (for example

on Green Manufacturing), new Editors and Associate Editors, and our newly revised list of keywords and topic areas.

I'm convinced the RAS community will grow, thrive, and increase our global impact by advancing both Robotics and Automation. Maybe someone will even figure out a way for robots to maintain motorcycles.

Ken Goldberg, Editor-in-Chief
IEEE Transactions on Automation Science and Engineering
<http://iee-ras.org/tase>

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