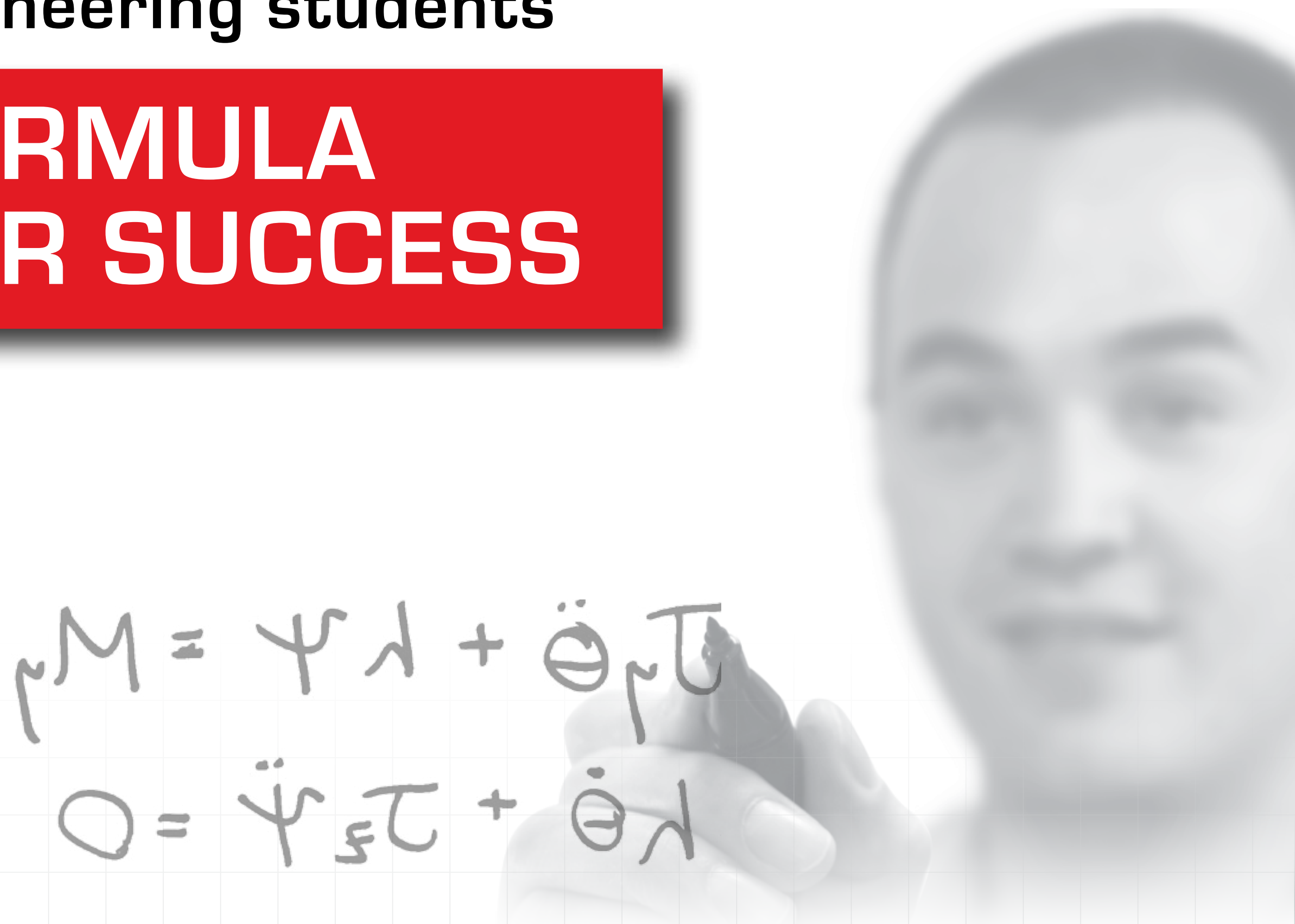
QUANSER

INNOVATE. EDUCATE.

Attract and retain
engineering students

FORMULA FOR SUCCESS



FORMULA FOR A SUPERIOR REPUTATION, FINER GRADUATES AND VAST SAVINGS:

ADVANTAGES OF MULTI-DISCIPLINARY CONTROL LABORATORIES

DR. APKARIAN began his career teaching Electrical Engineering at the University of British Columbia. Before launching Quanser, in 1990 to enhance and advance control theory education, he held various positions where he contributed to the development of several key projects, including control systems for the Canada Space Arm and components of the Space Station.

"We know the countries that out-teach us today will out-compete us tomorrow." – President Obama[1]

Simply replace the word 'countries' with 'colleges' in Obama's quotation and you have a presidential dilemma that any engineering Dean can appreciate. Deans can gauge how well their college is teaching by whether their engineering graduates are innovating and competing internationally. But teaching today's engineering students requires innovation itself, because they learn differently. Change is needed to teach them better but budgets are tight and tightening. Yet there is a spirit of co-operation afoot that could spell success for engineering colleges and their Deans, helping them 'out-compete tomorrow'.

THE DEANS' DILEMMA:

How to graduate better engineers, thereby enhancing the college's reputation, with dwindling funds for control laboratories? "Resources for educational laboratories have always been constrained at most universities. The problem is, of course, much worse now with decreasing state support for public institutions and decreasing endowments at private institutions," says Dean, Mark Spong of the University of Texas.

THE DEPARTMENTS' SOLUTION:

Pool several engineering departments' resources to create fewer but far better, more adaptable laboratories and students with wider experiences. According to Associate Dean, Andrew Alleyne of the University of Illinois, this approach creates, "higher quality and lower cost. You get more out of your lab activity with a reduced amount of overhead to building, running, and maintaining a lab."

VAST SAVINGS

At Quanser, we estimate that five departments would spend $100k each for a lab, plus $50 to$100k each annually for lab technicians. But what if you install a couple of new multi-purpose control labs and hire just two technicians? Then the college instantly saves around 60 per cent. Sean P. Meyn is the Director of the Decision and Control Lab at the University of Illinois where they did this. He had no trouble selling the idea because his Dean "could see the duplication of effort. It really didn't cost any money because there was a duplication of labs." At the very least, such savings are worthy of investigation. But there are other factors to consider. First, let's examine the Dean's dilemma. Being somewhat broad, it breaks down further into several sub-dilemmas. A summary from an article in IEEE Control Systems Magazine which appeared four years ago (an eon in technological time) includes them all: "The existing U.S. paradigm of individual departmental laboratories is increasingly difficult to justify due to the interdisciplinary nature of modern control engineering, the high cost and rapid obsolescence of technology, and the demands on faculty time."[2] Remember, too, that 2005 was a very different time, economically.

COMPOUNDING BUILT-IN OBSOLESCENCE

It's almost cliché to say, technology is changing so fast that much equipment is irrelevant before it's off the shelf. Yet many engineering schools compound the problem. How often have you seen a laboratory jury-rigged by a graduate student? Then after spending hundreds of hours and tens of thousands of college dollars, the student moves on a couple of years later, leaving no one with the knowledge, expertise or inclination to maintain that equipment with its unique configuration. The result? It sits gathering dust. The short-term advantage of having a grad student invent equipment in-house creates expensive long-term problems.

DEMANDS ON FACULTY TIME

In a recent interview, Kelly Cohen PhD of the University of Cincinnati's Aerospace Engineering and Engineering Mechanics Department said: "My time is quite valuable. I don't get credit for putting hardware together." Professors are hired to think, not rig labs. So rather than commissioning their leading professors or even transient grad students to run labs, many engineering departments hire lab technicians. But even these workers' time would be better spent helping students and fostering co-operation between engineering departments and disciplines, instead of just trouble-shooting technology.

GETTING BEYOND THE 'COOL' FACTOR

Many professors agree that today's generation of engineer students learn differently. Growing up in an age of instantaneous communications, they tend to be less patient with extended theoretical lectures, preferring the practical, and hands-on experiments on new gear. New technology captures the imagination of younger students. The result? Mark Spong, the Dean of Engineering at the University of Texas noticed: "Better equipment certainly results in better educational opportunities and experience… It can change the nature of research problems that control engineers are faced with and can result in better designs, easier implementations, and better performance. "But it's about more than just novelty. Using the latest technology also helps students get more done. Last year, Kevin Wise of Boeing made this observation during an open-panel discussion at the American Control Conference in Seattle, Washington. Whereas students once could complete two experiments in a semester by writing their own algorithms, Wise noted, with modern technology and software, they can now complete up to ten. Clearly state-of-the-art equipment is more than something 'cool' for young engineers. It helps colleges out-teach their competitors. So their students go on to better employment, ultimately enhancing the good name of the college.

MODERN CONTROL ENGINEERING

The future of engineering lies in cross-disciplinary problem solving. Systems have simply become too complex for engineers to work in silos, or for students to study a single subject without wider context. Consider research recently conducted by Collaborative Product Development Associates, LLC on the state of the industry: "Design decisions require tight coordination between multi-disciplinary design and engineering activities in order to ensure that complex functions of the product deliver on all requirements and meet all constraints. … disciplines involved in mechatronics development must understand how they depend on each other for information, for decisions, and for the joint requirements. Those dependencies mandate collaboration."[3]

They're not unique in this point of view. We've always known this at Quanser. But the National Academy of Engineering's comprehensive report, The Engineer of 2020, concludes that in ten years engineers: "will be working with diverse teams of engineers and non-engineers to formulate solutions to yet unknown problems. They will increasingly need to address large-scale systems problems."[4] In short, teamwork.

That teamwork is led by control engineers says Dean Spong: "The availability of low-cost sensing and computation means that 'intelligence, which really means 'control' can be embedded in virtually any system and any application. Most of the critical problems facing society today, in sustain-able energy, healthcare, the environment, security, and others, will rely on control engineering for solutions. For example, smart grid technology will greatly improve the efficiency of electric power generation and transmission. Smart homes will utilize energy more efficiently. Increased energy efficiency through intelligent control will mean that fewer power plants will need to be built, which will mean less impact on the environment and reduced dependence on oil imports. Wearable and implantable sensors for healthcare monitoring, assistive technologies foraging populations, and robotic surgery, will transform healthcare. Large-scale sensor networks for environmental monitoring will allow monitoring and control of pollution, track and help endangered species, and secure our borders. The list of examples and applications of control engineering is nearly endless… The 21st century will be known as the age of automatic control. In short? An argument for engineering departments to work together in control labs.

Quanser creates, installs and services multi-disciplinary labs for several engineering departments to share, with curriculum and technical support. So students learn from theory to experiment to application. Our concept is sup-ported by the co-authors of IEEE Control Systems Magazine's article who boldly "advocate a shift from departmental labs to college labs for pedagogical as well as financial, reasons."[1] Sharing space and equipment fosters teamwork. The cross-pollination of disciplines or, more simply, teamwork is healthy for creative thinking. Not incidentally, 'creativity' is also a crucial element of the makeup of The National Academy's Engineer of 2020.[5] The engineering departments at the University of Illinois have worked as a unit, sharing multi-disciplinary labs for years. Engineering Dean Spong of the University to Texas was there when they established it. He notes: " if recurring funds can be secured as a result, either from the central administration, or by pooling depart-mental funds, then the benefits are enormous."

EFFICIENT USE OF MATERIALS

So, by sharing space and resources, we ultimately share ideas. A control innovator for decades, Dr. Karl Åström of Sweden's Lund University, believes "many control labs are not used 100 per cent… So I think from the Dean's perspective, if you do it right, you are getting more efficient use of space. Which means that you can free space somewhere else." The team from U of Illinois makes a related, but more blunt, point: "it is difficult for a single department to establish and maintain state-of-the-art labs."[2]

The Integrated Learning Center (ILC) at Queen's University in Kingston, Canada, is an example of efficient lab integration. "The ILC belongs to a collection of departments in the university and mostly depart-ments within applied science," explains Professor Keyvan Hashtrudi-Zaad. The exact same equipment, "is used for first year projects by the chemical engineering department; fourth-year controls courses in the EC department; for the third-year controls course in the engineering mathematics department; and it's used for fourth-year robotics courses in the EC department. Plus there's some discussion as to how mechanical engineering can also share the equipment for their courses. So as you see the Integrated Learning Centre not only integrates topics but entire departments under the same roof. "From what Åström, Hashtrudi-Zaad and Deans Spong and Alleyne say, it follows that simple scheduling could help improve departmental efficiency and the quality of graduates – lightening the Dean's dilemma. It starts at the top Åström knows that buy-in has to come from the Dean. Asking assorted departments to relinquish their own labs, then share less with others may not come easily – even if the new equipment is superior. "You need some enthusiast to drive this, and then you need to sign in the Dean of Engineering, otherwise it's not going to happen…then of, course you need buy-in from different departments." Still, considering the immediacy of results and the long-term gain to the reputation of the Dean's college, that buy-in would be worth pushing for.

By Dr. Jacob Apkarian, Quanser Founder

Footnotes:

1. Address to Joint Session of Congress, February 24th, 2009
2. An Interdisciplinary, Interdepartmental Control Systems Laboratory; IEEE Control Systems Magazine, February 2005. By Andrew G. Alleyne, Daniel J. Block, Sean P Meyn, William R. Perkins and Mark W. Spong
3. Transforming Mechatronics: A Scorecard for Driving Collaborative Efforts Across Mechanical, Electrical, and Software Development Teams. By Vasco Drecun, Research Associate
4. THE ENGINEER OF 2020: VISIONS OF ENGINEERING IN THE NEW CENTURY, Pg 43
5. THE ENGINEER OF 2020: VISIONS OF ENGINEERING IN THE NEW CENTURY, Pg 55

NB: All other quotations are from first-source interviews with subjects. Sources available upon request.