A Survey on Industry Impact and Challenges Thereof

At its 2014 World Congress, the International Federation of Automatic Control (IFAC) launched a "pilot" industry committee with the objective of increasing industry participation in, and impact from, IFAC activities. The chair of this committee is Tariq Samad, with support from Roger Goodall (Loughborough University, United Kingdom) and Serge Boverie (Continental, France) as cochairs. This committee was established as an outcome of an industry task force led by Roger Goodall in the last IFAC triennium (2011–2014).

In 2015, the committee surveyed its members to get their views on the impact of advanced control and challenges associated with enhancing the impact. The survey had two questions, and 23 of the 27 committee members (excluding the chair) responded. The majority of the committee is either currently with, or has prior affiliation with, industry; all others have had substantial industry involvement. To be more exact, 12 of the respondents were affiliated with industry, ten with academia, and one with government. The committee's experience base covers many of the industry sectors that have benefited from control science and engineering, including aerospace, automotive, refining, petrochemicals, chemicals, metals, mining, biomedical, finance, and beer brewing. The geographic distribution is also broad, with representatives from 21 countries and all continents except Antarctica. Most of the members were nominated by IFAC national member organizations and technical committees.

Although limited in many ways, the survey responses should still be of interest to the control community and any feedback is always welcome, so please send comments to samad@ieee.org. Note that an earlier version of this column is published on the IFAC blog site http://blog.ifac-control.org/.

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SURVEY QUESTION 1: IMPACT OF SPECIFIC ADVANCED CONTROL TECHNOLOGIES

First, members were asked about their perceptions of the industry success (or lack thereof) of a dozen advanced control technologies. Proportional-integral-derivative (PID) control was also included in the list for calibration purposes. A glossary was included with the survey, listing topics covered under each technology. Members were asked to assess the impact of each of these technologies by selecting one of the following:

- High multi-industry impact: Substantial benefits in each of several industry sectors; adoption by many companies in different sectors; standard practice in industry.
- High single-industry impact: Substantial benefits in one industry sector; adoption by many companies in the sector; standard practice in the industry.
- Medium impact: Significant benefits in one or more industry sectors; adoption by one or two companies; not standard practice.
- Low impact: A few successful applications in one or more companies/industries.
- No impact: Not aware of any successful deployed real-world application.

The results are provided in Table 1.

On the face of it, these results are disappointing. No advanced control technology is unanimously acknowledged by industry-aware control experts as having had high industry impact—90 years after its invention (or discovery), we still have nothing that compares with PID! It's also concerning that the "crown jewels" of control theory appear near the bottom of the list. However, the fact that all the technologies had at least some positive assessments suggests that the

TABLE 1 A list of the survey results in order of industry impact as perceived by the committee members.

Rank and Technology	High-Impact Ratings	Low- or No-Impact Ratings
PID control	100%	0%
Model predictive control	78%	9%
System identification	61%	9%
Process data analytics	61%	17%
Soft sensing	52%	22%
Fault detection and identification	50%	18%
Decentralized and/or coordinated control	48%	30%
Intelligent control	35%	30%
Discrete-event systems	23%	32%
Nonlinear control	22%	35%
Adaptive control	17%	43%
Robust control	13%	43%
Hybrid dynamical systems	13%	43%

TABLE 2 Level of agreement.

Statement	Agreement	Disagreement	Academia/Industry Differentiation
Industry lacks staff with the technical competency in advanced control that is required for high-impact applications.	83%	4%	
Control researchers are much poorer than researchers in other fields at communicating their ideas and results to industry management.	26%	30%	
The maturity or readiness level of results of advanced control research is too low for attracting industry interest.	57%	22%	42% of industry respondents, but no academic respondent, disagreed with the statement.
Advanced control has limited relevance to problems facing industries and their customers.	4%	65%	
The conflict between industry deadlines and academic research time lines is worse in control than in related engineering fields.	30%	35%	
Control researchers place too much emphasis on applied mathematics or advanced algorithms whereas successful industry applications require deep domain knowledge.	83%	13%	
Control researchers place too little emphasis on plant/process modeling and model-development methodologies.	57%	17%	No one from industry disagrees, 30% of academics disagree.
Students in control (undergraduate and graduate) are not sufficiently exposed to problems in industry.	70%	13%	No one from industry disagrees, 30% of academics disagree.
The academic control community is not seriously interested in collaboration with industry.	26%	39%	33% of industry respondents, but only 11% of academic respondents, agree.
There is no problem—advanced control is successful and appreciated in relevant industries.	13%	83%	

impact could well be higher than indicated. Many control scientists and engineers are likely not aware of the impact of control technologies outside the application domains of their experience. Thus, the problem may be as much perception as reality.

Academic and industry respondents were generally in good agreement on these assessments; notable exceptions were for intelligent control (25% high-impact from industry, 50% from academia) and fault detection and identification (58% high-impact industry, 40% academia). It's also worth noting that model predictive control is broadly acknowledged for having gained currency in industry.

SURVEY QUESTION 2: ISSUES AND CHALLENGES WITH INDUSTRY IMPACT

The second question listed several statements and asked respondents to indicate their level of agreement with each. Agreement could be indicated as strongly agree, agree, neutral, disagree, or strongly disagree.

The statements and the levels of agreement are provided in Table 2. In those cases in which the differences of opinion between the industry and academic members of the committee were significant, separate numbers for the two categories are also given.

A clear message is that domain understanding/modeling is crucially important but not adequately pursued and taught. Neither expertise nor experience in advanced control per se is sufficient to realize industry impact.

CONCLUSIONS

This survey wasn't, and nor was it intended to be, scientific or comprehensive, but the committee members have found the results to be thought and discussion provoking. We are continuing to explore the challenging problem of industry impact from control research. Among other outputs, we expect to recommend specific enhancements to IFAC events, publications, and volunteer groups. Your feedback is welcome and will be appreciated!

The IEEE Control Systems Society (CSS) is also devoting organizational attention to industry participation. Recently, Sandra Hirche (who is also a member of the IFAC committee) chaired a task force on this topic and in July 2016 CSS formed a new Standing Committee on Industry Activities. The chair of this committee is Kingsley Fregene. The control research community is putting a much needed and overdue focus on industry impact and relevance.

Tariq Samad