The First Joint Conference on Foundations of Computer-Aided Process Operations (FOCAPO) and Chemical Process Control (CPC): (FOCAPO/CPC 2012)

FINAL REPORT to CACHE
18 September 2012

General Chair:	B. Wayne Bequette
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Planning Facilitator:	Robin Craven

Schedule: January 8 (Sunday) – January 13 (Friday), 2012
FCOPO: Sunday evening – Wednesday evening
CPC: Tuesday evening – Friday evening
Joint Sessions: Tuesday night and Wednesday with a Wednesday evening banquet

Site: Westin Savannah Harbor, GA

URL: http://www.focapo.org
http://www.cpcmeeting.org

Executive Summary

The first joint conference on FOCAPO and CPC was held in Savannah, Georgia during the second week of January, 2012. The conferences were held sequentially, with FOCAPO beginning on Sunday evening and ending on Wednesday evening. CPC began on Tuesday evening and ended on Friday evening. Joint, single-track sessions were held on Tuesday evening, and Wednesday, with a joint conference dinner on Wednesday evening. Financial support was used to cover the registration expenses for 40 young researchers (12 young faculty members and 28 graduate students and postdocs) to participate in the conferences.

A total of 182 participants registered for the two conferences, with 76 people attending both conferences; 52 participants were students or postdocs. FOCAPO had 139 and CPC had 119 registrants, thus the number of people only registering for FOCAPO was 63, while the CPC-only registration was 43. The large joint conference attendance played a major role in the financial success of the conferences; it is likely that either conference, on its own, would not have had enough participants to cover a reasonable budget.

1. Background and Motivation

1.1 Foundations of Computer-Aided Process Operations (FOCAPO)

FOCAPO has been the premier conference in the area of chemical process operations since 1988. Previous FOCAPO conferences were organized as follows:

- 1988 – Park City, UT: G.V. Reklaitis and H.D. Spriggs
  Definition of Process Operations – Data management
- 1993 – Crested Butte, CO: D.W.T. Rippin and J. Hale
  Planning and Scheduling, Safety
- 1998 – Snowbird, UT: J. Pekny and G. Blau
  Plant Wide Optimization, Quality, Planning and Scheduling
- 2003 – Coral Springs, FL: I.E. Grossmann and C.M. McDonald
  Integration of R&D, Manufacturing, and Supply Chain
- 2008 – Cambridge, MA: M. Ierapetritou, M. Bassett and S. Pistikopoulos
  Multi-Scale Integration of R&D, Manufacturing, and Optimization for Enterprise-Wide Operations

With increased globalization and reduced profit margins, there is a significant industrial interest in all aspects of supply chain management and its integration with planning, scheduling, and control. Furthermore, process operations has traditionally been a very active area for academics and has given rise to many challenging problems for academic study. These problems have necessitated the study and development of enabling techniques in the area of optimization, which has remained a strong focus of the process engineering community over the past three decades. As a result, FOCAPO has consistently attracted between 100 and 150 attendees, with nearly one third of them from industry and approximately 40% of the participants coming from outside the U.S. Given the strong interest in this area by industry as well as academia, it is now time to continue the series.

1.2 Chemical Process Control (CPC)

The goal of the CPC conference series has been to bring together academic researchers, industrial practitioners and control vendors in order to assess progress in the field of process control, identify industry needs and future research directions, and stimulate wider implementation of advanced control in practice thus narrowing the gap between theory and practice. The first seven conferences in the CPC series were organized as follows

- 1976 – Asilomar, CA: Alan Foss and Morton Denn
- 1981 – Sea Island, GA: Thomas Edgar and Dale Seborg
- 1986 – Asilomar, CA: Manfred Morari and Thomas McAvoy
- 1991 – South Padre Island, TX: Yaman Arkun and W. Harmon Ray
- 1996 – Lake Tahoe, CA: Jeffrey Kantor and Carlos Garcia
- 2001 – Tucson, AZ: James Rawlings and Babatunde Ogunnaike
- 2006 – Lake Louise, Canada: Michael Henson and Thomas Badgwell

Early CPC conferences had as their primary focus the development of constrained multivariable control technology for chemical processes, robustness considerations, model predictive control (MPC) developments, adaptive and nonlinear control, and actual industrial applications of advanced control. CPC-6 (2001) focused on modeling, identification, monitoring, control theory and hybrid systems, as well as problems in life sciences, reactors-separators and product distributions. CPC-7 (2006) combined an assessment of core technologies from control theory, modeling and estimation, with a discussion of emerging applications in micro-chemical systems, multi-scale systems, information systems and systems biology.

Despite significant progress over the last few decades (e.g. in the development and application of MPC technology), the gap between theoretical developments in control and industrial practice is still wide. Furthermore, the process industries currently operate in a global environment with frequent and significant fluctuations in market demands and prices, which make a tighter integration of process operations (planning, scheduling, optimization) and control essential. Also, the scalability of advanced control methods is becoming a key problem, as plant designs become more complex and integrated to improve efficiency. Continued growth in advanced materials manufacturing leads to new opportunities for application of estimation and control methods in non-traditional industries. At the same time, new processes are emerging, such as those for the production of energy, fuels and chemicals from renewable resources, clean coal technologies, hydrogen and fuel cell systems and others. Control concepts are also finding new applications in fields like finance and medicine. These developments point to numerous new challenges and opportunities, and an exciting future agenda for the process control community. CPC-8, organized jointly with FOCAPO, provided an ideal forum for reviewing recent progress, assessing needs and emerging opportunities, and tracing major directions for research and technology development in the next decade.

2. Rationale for a Joint FOCAPO/CPC

FOCAPO and CPC have individually been the premier conferences in their respective areas of computer-aided process operations and chemical process control. Recognizing that, particularly from an industrial manufacturing perspective, these areas have a tremendous overlap, a goal of this proposed joint conference was to increase participation in each individual conference. Thus, the motivation for a joint conference was two-fold: (i) technical overlap that may spark interesting interactions and collaborations, and (ii) increased registrations for less financial risk compared to two individual conferences. Both goals appear to have been met. The post-conference survey was overwhelmingly supportive of the joint conference format (see Appendix B for a summary). Of the 182 people registering for the conferences, 76 registered for both – a substantial number. FOCAPO had 139 and CPC had 119 registrants, thus the number of people only registering for FOCAPO was 63, while the CPC-only registration was 43.

3. Meeting Scope and Format

The joint conference had a sequential conference format, with FOCAPO at the beginning of the week, CPC at the end, and one evening and day of joint programming; see Appendix A for the session schedule.

Four themes were developed for the conferences:

- Integration of control, optimization, planning and scheduling in a scalable way. The overall goal is target regulation, but directly realizing the importance of the different levels and time scales.

- Process monitoring and fault detection. The main issue here is that there are many academic papers on the subjects, but the theory is not in wide use.

- Forecasting. Project market conditions, such as demand and prices for products, or changes in operating conditions further into the future.

- Nontraditional applications of optimization to business problems. This includes real-time cash flow optimization, Sales force effectiveness, and their impact on supply chain design and management.

4. Target Audience and Participants

The 182 participants were a mix of academics and industrial practitioners, with 96 from academia (53%), 48 from industry (26%), and 38 students (21%).

The previous FOCAPO (Cambridge, MA, 2008) had 132 total participants, involving

- 59 academic (45%), 37 industrial (28%), 36 students (27%)
- 72 U.S. (55%), 33 Europe (25%), 17 Asia (13%), 10 other (7%)

The previous CPC in Lake Louise (CPC-VII, 2006) had 113 participants, with the following distribution:

- 55 academic (49%), 43 industrial (38%), 15 students (13%)
- 71 U.S. (63%), 20 Europe (18%), 16 Canada (14%), 6 other (5%)

One of our objectives in seeking NSF support was to encourage graduate students to participate in both conferences, thus providing them with a broader perspective on process operations and control.

5. Proceedings

Preprints for both conferences were available on USB memory sticks distributed at the conference. These papers underwent a peer-review, using members of the conference organizing committees. Two special issues of Computers and Chemical Engineering, were organized. Most of the invited conference papers were asked to submit a paper to the special issues, which underwent the usual journal peer review process. Selected contributed poster papers were also invited for submission to the special issues. The special issues are expected to appear by December, 2012.

6. Governance and Organization

FOCAPO and CPC was organized under the auspices of the CACHE (Computer Aids for Chemical Engineering) corporation. CACHE is a non-profit organization whose purpose is to promote cooperation among universities, industry, and government in the development and distribution of computer related and/or technology-based educational aids for the chemical engineering profession. During the 1960s the rapid growth of computer technology challenged educators to develop new methods of integrating computers into chemical engineering education. Despite many significant contributions to program development, the transferability of computer codes, even those written in FORTRAN, was minimal. Because of the disorganized state of university-developed codes for chemical engineering, 14 chemical engineering educators met in 1969 to form the CACHE Committee. Initially the CACHE committee was a task force appointed by the Commission on Education of the National Academy of Engineering and funded by the National Science Foundation. In 1975, after several successful projects had been completed, CACHE was incorporated as a not-for-profit corporation in Massachusetts to serve as the administrative umbrella for the consortium activities. All CACHE projects are staffed by volunteers, including educators and industrial members, and coordinated by a Board of Trustees through various Task Forces. CACHE actively solicits the participation of interested individuals in the work of its on-going projects. Information on CACHE activities is regularly disseminated through CACHE newsletters and its website (http://www.che.utexas.edu/cache/). CACHE has been involved in the organization of many other technical meetings including all five FOCAPO and the last five CPC conferences. Thomas F. Edgar (CACHE Executive Director) and Jeffrey J. Siirola (CACHE Industrial Trustee and chair of the CACHE Conference Committee) were directly involved with the organization of this first joint conference on FOCAPO and CPC. A list of technical committee members that provided detailed advice, and much of the peer review, is shown in Appendix C.

7. Venue

The conference was held at the Westin Savannah Harbor in Savannah, Georgia.

8. Conference Financial Support

In addition to $40,425 in support from the National Science Foundation, $33,492 was raised from corporate sponsors to support the travel and registration costs of some of the invited speakers, particularly those that were outside the process operations and control communities. A registration fee was charged to all participants, to support breaks, facilities fees, production of the conference program (all papers were on CD, with a short paper version containing the conference schedule), staff costs, and the joint conference banquet.

The National Science Foundation were used to support 40 young researchers (12 young faculty members, and 28 graduate students and postdocs). Most of the graduate students and postdocs that attended were involved as co-authors in the contributed papers sessions. There was significant participation by women and minority graduate students; U.S. faculty who are active in the area of process operations and control were contacted and encouraged to have their more advanced students attend this conference.

National Science Foundation Funds

NSF support was used to cover the travel and lodging expenses for 40 young researchers and difference between the actual cost and the reduced rate registration fees, for 15 graduate students.

Lodging and travel for 40 young researchers	$34,425
Student registration, 15 students @ $400 each	$ 6,000
Total	$40,425

Appendix A. Conference Schedule

Schedule

Sunday, Jan 8 — **FOCAPO (Sun, Mon, Tue)**
- 7:30 - 7:45 pm — **Welcome Address,** *Wayne Bequette*
- 7:45 - 9:00 pm — **Keynote Address,** *Andy Boyd*
- 9:00 - 11:00 pm — Hospitality *(Harbor Ballroom B)*

Monday, Jan 9
- 8:00 - 12:00 pm — **ENTERPRISE-WIDE OPTIMIZATION,** *C. Pantelides (Chair)*
- 12:00 - 2:30 pm — **Poster Session A** *(Grand Ballroom B), D. Varvarezos, F. You (Chairs)*
- 2:30 - 6:30 pm — **OPTIMIZATION OF MULTISCALE SYSTEMS,** *L. Biegler (Chair)*
- 9:00 - 11:00 pm — Hospitality *(Harbor Ballroom B)*

Tuesday, Jan 10
- 8:00 - 12:00 pm — **SUSTAINABLE ENTERPRISE MANAGEMENT,** *D. Miller (Chair)*
- 12:00 - 2:30 pm — **Poster Session B** *(Grand Ballroom B), D. Varvarezs, F. You (Chairs)*
- 2:30 - 6:30 pm — **RISK MANAGEMENT**, *V. Venkatasubramanian (Chair)*
- 9:00 - 10:00 pm — Reception *(Harbor Ballroom)*, Hospitality *(10-11 pm, Harbor Ballroom)*

Wednesday, Jan 11 — **FOCAPO 2012 / CPC VIII Joint Session**
- 8:00 - 12:00 pm — **INTEGRATION OF OPERATIONS AND CONTROL,** *S. Pistikopoulos (Chair)*
- 12:15 - 2:30 pm — **Education Panel Discussion Session** *(lunch included), B.W. Bequette (Chair)*
- 2:30 - 5:00 pm — **NEW DOMAINS FOR OPERATIONS AND CONTROL RESEARCH,** *J. Lee (Chair)*
- 7:30 - 10:00 pm — **Reception and Banquet** *(Harbor Ballroom)*, **Keynote Address:** M. Morari

Thursday, Jan 12 — **CPC VIII (Thu, Fri)**
- 8:00 - 12:00 pm — **LARGE SCALE AND NETWORKED PROCESS SYSTEMS,** *D. Bartusiak (Chair)*
- 12:00 - 2:30 pm — **Poster Session C** *(Grand Ballroom B), A. Armaou, T. Soderstrom (Chairs)*
- 2:30 - 6:30 pm — **RENEWABLE ENERGY SYSTEMS AND SUSTAINABLE PROCESSES**, *S. Skogestad*
- 9:00 - 11:00 pm — Hospitality *(Harbor Ballroom B)*

Friday, Jan 13
- 8:00 - 12:00 pm — **METHODS AND ENABLING TECHNOLOGIES,** *D. Dochain (Chair)*
- 12:00 - 12:30 — **AWARDS**, *T. Edgar, D. Seborg (Chairs)*
- 2:00 - 5:30 pm — **NON-TRADITIONAL APPLICATION DOMAINS,** *J. Kantor (Chair)*

Post-Conference Survey (79/182)

YES or NO on whether the conferences should be held jointly again

1. Attending Both Conferences (42 total): YES = 36, NO = 1, Indifferent = 5
 Same Structure = 28 (+1 suggesting 2-day overlap)
 Fully Integrated = 12 (includes 1 suggesting a single 3 "Full-Day" conference)
 Indifferent = 1

2. Attending FOCAPO Only (10 total): YES = 9, NO = 0, Indifferent = 1
 Same Structure = 8   Fully Integrated = 2   Indifferent = 0

3. Attending CPC Only (24 total): YES = 14, NO = 2, Indifferent = 8
 Same Structure = 15   Fully Integrated = 6   Indifferent = 3

4. No Designation (3): YES = 3, NO = 0, Indifferent = 0
 Same Structure = 3   Fully Integrated = 0   Indifferent = 0

YES = 62, NO = 3, Indifferent = 14
Same Structure = 54 (+1 suggesting 2-day overlap)
Fully Integrated = 20 (includes 1 for a 3 "Full-Day" conf.)
Indifferent = 4

ORGANIZING COMMITTEE

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Nick Sahinidis   Carnegie Mellon University

CPC Co-Chairs
Prodromos Daoutidis   University of Minnesota
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