PURDUE PROCESS SAFETY AND ASSURANCE CENTER (P2SAC): *WELCOME, INTRODUCTION, AND STATUS UPDATE*

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HISTORY AND STATUS OF P2SAC

- Origin of and idea for P2SAC was born out of a presentation by Basaran to ChE faculty at a faculty retreat in May 2013
- Conception and birth of center: extensive telecons between Basaran and industry stakeholders in December 2013
- Inaugural conference/P2SAC's launch: Monday, October 13, 2014
- History of industry membership in P2SAC:
  - Spring 2014: Honeywell, BP, ExxonMobil (3 members)
  - Summer/Fall 2014: Honeywell, BP, ExxonMobil, and Eli Lilly (4 members)
  - Spring/Fall 2015: Honeywell, BP, ExxonMobil, Eli Lilly, and Shell (5 members)
  - Fall 2016: Honeywell, BP, ExxonMobil, Eli Lilly, Shell, and Chevron (6 members)
  - Spring 2017: Honeywell, BP, ExxonMobil, Eli Lilly, Shell, Chevron, Dow, P66, and Kenexis (9 members)

REMEMBERING THE P2SAC INAUGURAL CONFERENCE

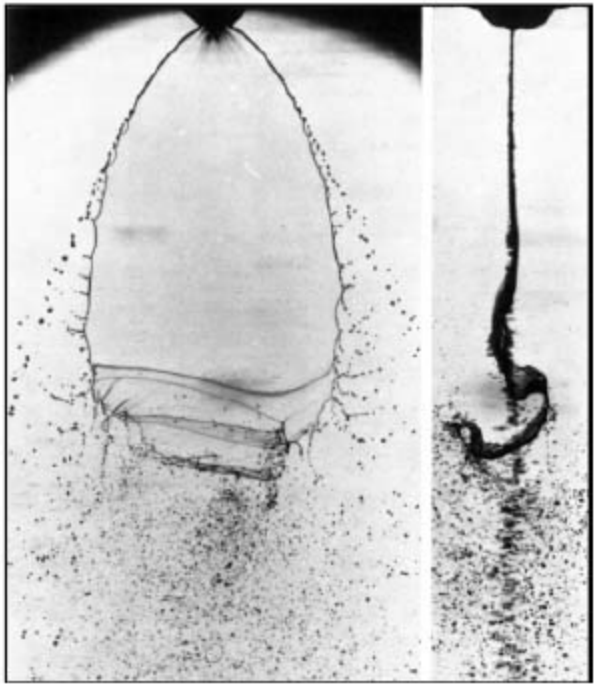
- **Date: Monday, October 13, 2014**
- **Location: FRNY Hall of ChE**
- **Who will be (was) there: Honeywell, BP, ExxonMobil, Eli Lilly, Air Products, … and about ten Purdue ChE faculty plus a few graduate students (*fewer than 20 people*)**
- **What is (was) the agenda: much more modest than what we shall see today**

Why a Purdue Safety Center and what are its unique features?

- There are very few such centers, e.g. Mary Kay O'Connor (MKO) Safety Center at Texas A&M
- Representatives of member companies on the School's Industrial Advisory Committee (IAC), i.e. many of your peers, report that only a small fraction of the needs of industry in the safety arena is met by existing academic centers
- It was strongly recommended by IAC representatives and also other colleagues from industry that the Purdue Center should also focus on **process and/or product assurance**; therefore, the center was named ***Purdue Process Safety and Assurance Center*** (**P2SAC**)
- The approach adopted at P2SAC, while **driven by problems in industry**, would be **research-based** and we would leave more applied safety issues, e.g. the training of first responders, to others

Why Assurance? Spray drift example from crop spraying or crop protection

A liquid sheet from a fan spray nozzle (Crapper et al. JFM 1973; Villermaux ARFM 2007)



Small drops are undesirable because they lead to drift

Spray drift is the most common cause of off-target movement of chemicals (e.g. pesticides) in crop spraying. It can injure or damage plants, animals, the environment or property, and even affect human health. “Drift” is the airborne movement of agricultural chemicals as droplets, particles or vapor.

Nonstandard Inkjets

Annu. Rev. Fluid Mech. 2013. 45:85–113

Osman A. Basaran,[1] Haijing Gao,[1,2] and Pradeep P. Bhat[1,3]

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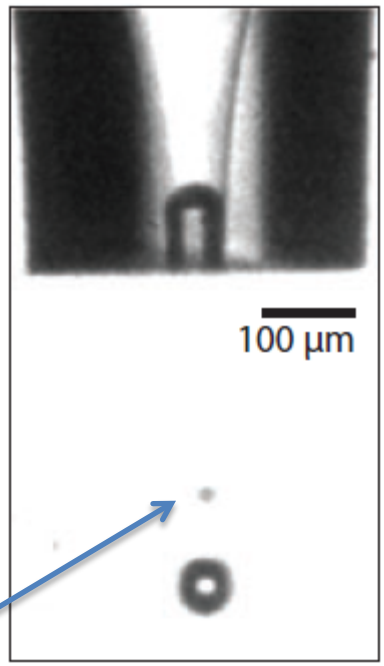
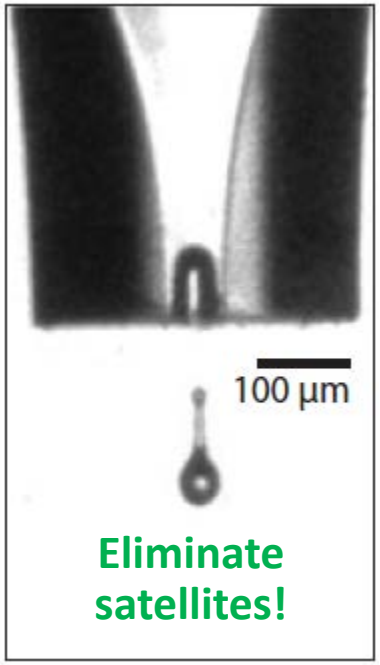
*Production of **monodisperse drops** and prevention of undesirable satellites are also key **flow assurance** issues in **ink jet printing** and **drop-wise (drop-based) manufacturing***

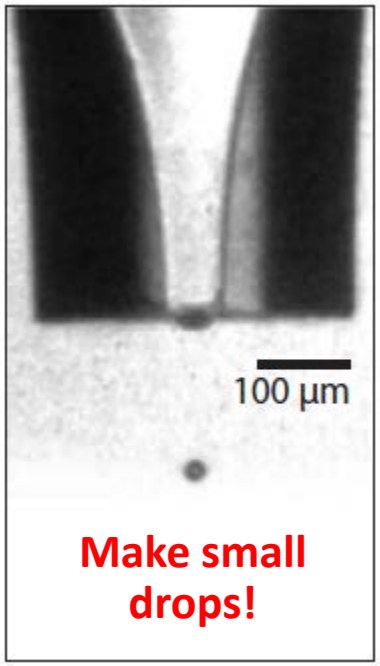
Squeeze-mode piezo sleeve and 35 µm glass nozzle used in DNA microarraying and other cutting edge applications

"Standard" waveform and big drops (plus *undesirable satellites*!)





Eliminate satellites!



Make small drops!

"Novel" waveform(s) invented at Purdue make small drops (we can use nozzles from a 1984 HP Thinkjet to make drops as small as is possible with today's printers!)

Center Vision

- The goal of the Purdue Process Safety and Assurance Center (P2SAC) is to become the world-wide center-of-excellence in research, education, and service in safety as well as process and product assurance
- The aim of P2SAC is to carry out research to address and solve problems having applied as well as fundamental importance in the safe and reliable operation of industrial processes in diverse fields
- However, P2SAC will not be involved in non-research-intensive activities such as the training of first responders
- Work in P2SAC will be quite **broad** but be **focused** on the ***energy, chemical, petrochemical, and pharmaceutical industries*** (among others, **e.g. agriculture**)

Center activities

- Aside from its research activities, the Center will also collaborate with various stakeholders in developing and/or setting standards in various fields of its expertise (goal at founding of center but one which has not been pursued to date)
- Additionally, P2SAC will become a leader in safety education through development and teaching of undergraduate and graduate courses, online courses, and intense short courses / tutorials / seminars (*According to informal/unscientific polling of first year graduate students in our program in spring 2017,* ***Purdue ChE is one of three departments nationally and internationally*** *that requires all undergraduates to take a core course on safety in order to receive a BS degree*)

Member company benefits

- Attendance at the annual program review and technical conferences (one in the spring and the other in the fall)
- Helping to determine and identify projects to be funded and research areas to be pursued *and* guiding projects
- Early access to research findings
- “Royalty-free” use of (some) research findings
- Increased access to uniquely trained graduate students (PhD as well as MS) and postdocs (in addition to undergraduate students) as *permanent hires* and *interns*
- Direct participation in the Center’s research programs via the *technical fellows program*
- Working with other member companies, academic personnel, and other stakeholders in *setting standards*

P2SAC Organization by Sectors

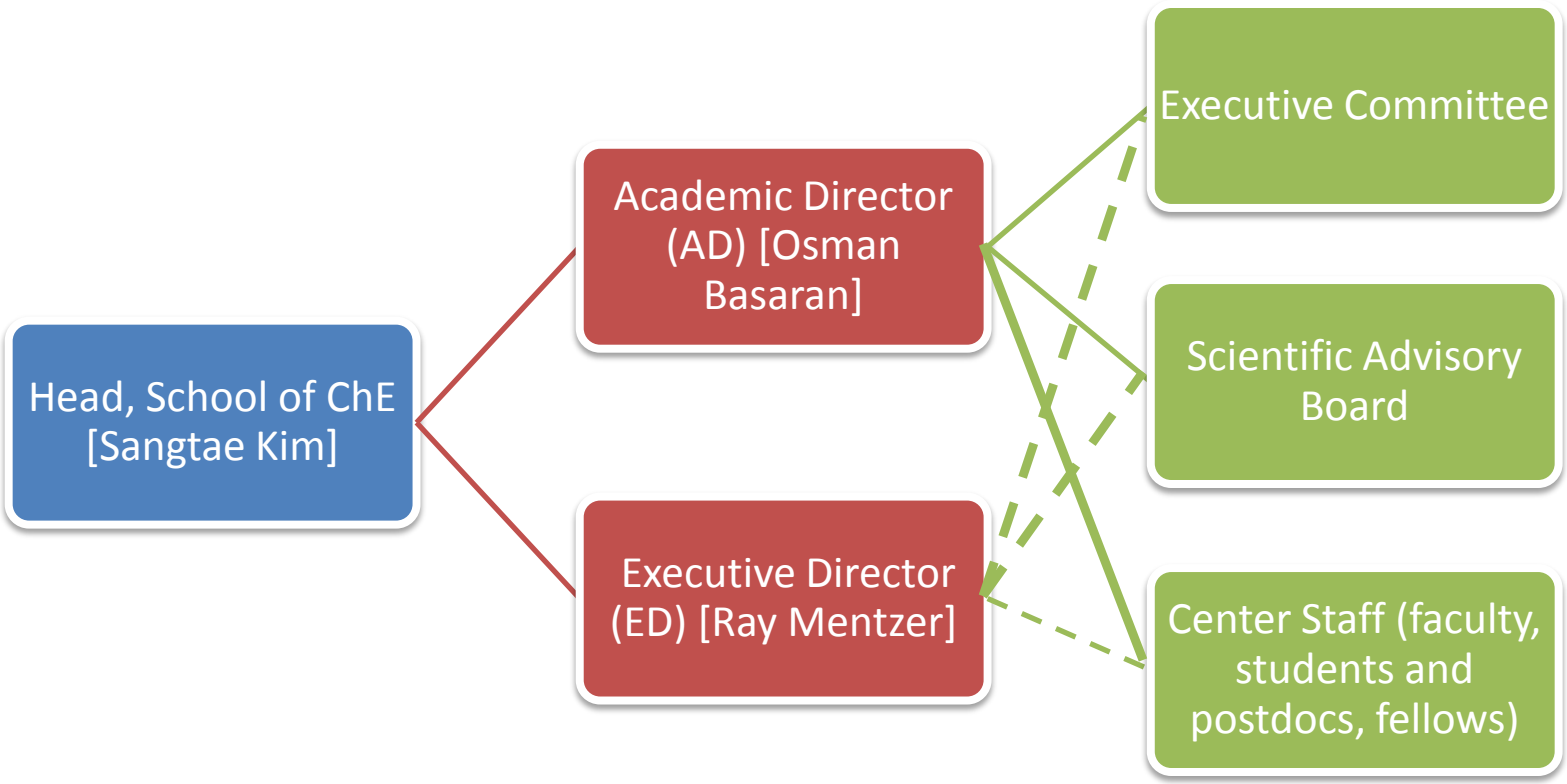
- Oil, gas, and petrochemicals
- Chemicals
- Technology, including consumer products and diversified manufacturing
- Pharmaceuticals
- (Future) Agriculture [more on this from Ray Mentzer]

Bring people together from different industries, backgrounds, and interests who normally would not interact with one another with the goal of creating synergisms that may not arise under ordinary circumstances

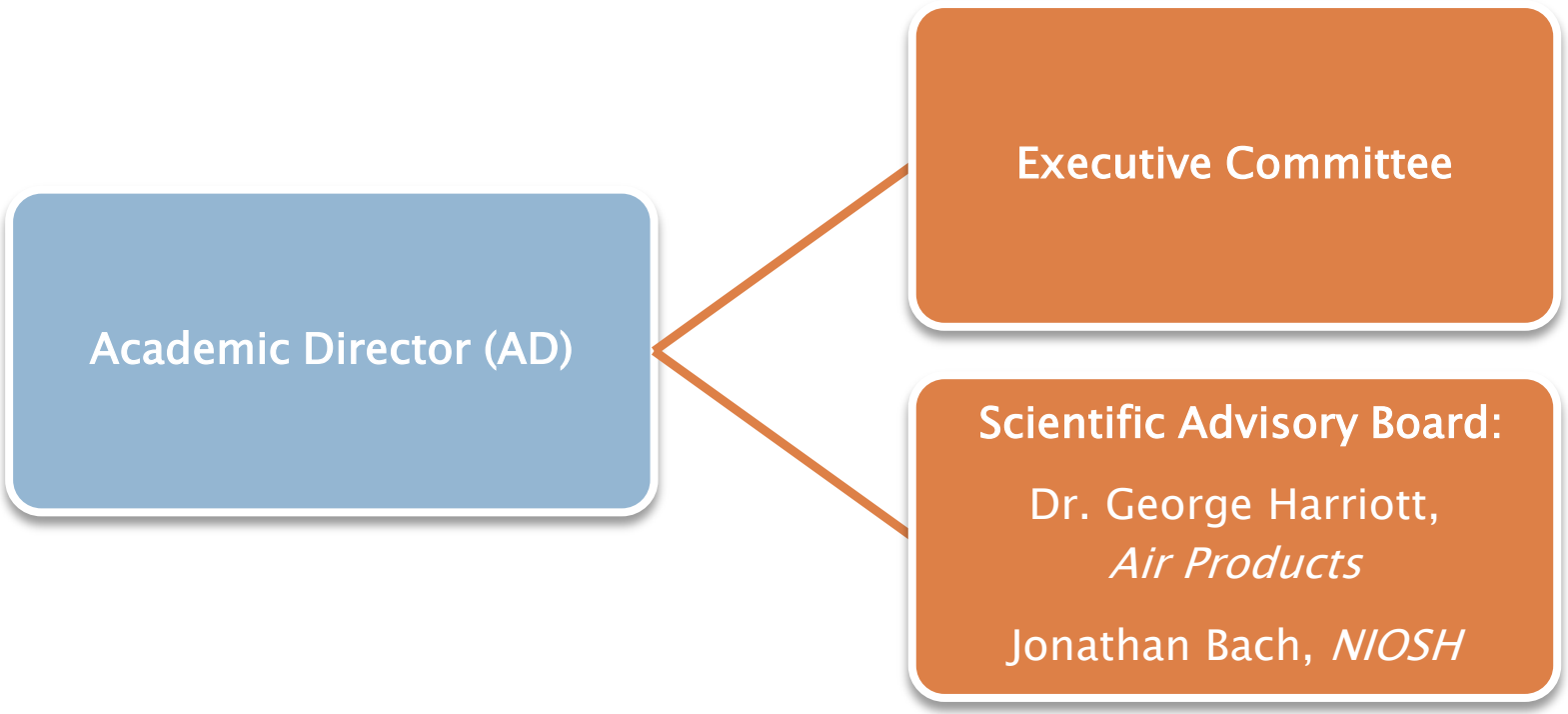
Sector companies that provided advice in helping to launch P2SAC

- Oil, gas, and petrochemicals
  - BP (Ron Unnerstall and others)
  - ExxonMobil (Rob Crane)
- Chemicals
  - Eastman (Peter Lodal)
  - Air Products (Phil Armstrong)
- Technology, including consumer products and diversified manufacturing
  - Honeywell (Prasad Goteti)
- Pharmaceuticals
  - Eli-Lilly (Jennifer Lopez, Cassandra Shell, and others)
  - Pfizer (Arindam Bose)

P2SAC Organizational Chart



P2SAC Organization



FALL 2017 CONFERENCE AGENDA

PURDUE PROCESS SAFETY AND ASSURANCE CENTER (P2SAC)

AGENDA FOR FALL 2017 CONFERENCE

Monday, December 4 (day prior to the conference)

6:00 pm Pre-conference dinner (Industrial members/guests and faculty)
Location: La Scala Italian Restaurant , 312 Main St, Lafayette, IN 47901
(765) 420-8171 www.lascalaitalianrestaurant.com

George **Harriott** (Air Products): Leak detection on gas pipelines
[Also guest lecture with educational component on safety in graduate core course ChE 620 (Advanced Transport Phenomena): 3:30-4:30 pm, Monday, December 4, FRNY 1043]

Tuesday, December 5, FRNY 3059

7:30-7:55	Coffee, tea, and light snacks
8:00-8:15	**Osman Basaran** (Professor of ChE and Academic Director P2SAC, Purdue): Welcome, status of P2SAC, interplay between safety and assurance, and agenda
8:15-8:45	**Ray Mentzer** (Visiting Professor of ChE and Executive Director P2SAC, Purdue): Vision of P2SAC, UG and MS research projects, and undergraduate/graduate safety course
8:45-9:25	**Carl Laird** (Professor of ChE, Purdue): (a) Systems engineering and optimization techniques for improved safety and security of critical infrastructure and process industries; (b) Gas detector placement in petrochemical and chemical facilities
9:25-10:05	**Raj Gounder** (Professor of ChE, Purdue): Prevention through catalyst design for applications in the petrochemical industry
10:05-10:20	Coffee and snack break

10:20-10:50 **Kingsly Ambrose** (Professor of AE, Purdue): Dust explosions: preventive precautions

10:50-11:30 **George Harriott** (Air Products): Leak detection on gas pipelines
[Also guest lecture with educational component on safety in graduate core course ChE 620 (Advanced Transport Phenomena): 3:30-4:30 pm, Monday, December 4, FRNY 1043]

11:30-12:00 **Brett Savoie** (Professor of ChE, Purdue): Using high-throughput simulations to predict safety figures of merit for organic compounds

12:00-12:50 Catered lunch for participants (industrial reps, faculty, graduate and undergraduate students, and other guests)

12:50-1:30	**Zoltan Nagy** (Professor of ChE, Purdue): Robust fault-tolerant control for continuous direct compaction and runaway reactions and overview of research in pharmaceutical engineering
1:30-2:00	**Stan Kolis** (Eli Lilly): Early phase thermal hazard assessments in the pharmaceutical industry
2:00-2:40	**Prasad Goteti** (Honeywell): SIL rated communication protocols
2:40-3:10	**Jonathan Bach** (NIOSH/CDC): Prevention through design (PTD)
3:10-3:25	Refreshment break

3:25-3:55	**Marabeth Holsinger** and **Steve Horsch** (Dow): Calorimetric determination of the oxidation of solids and organics adsorbed on solids
3:55-4:25	**Linda Wang** (Professor of ChE, Purdue): Economical and environmentally sound technology for producing rare earth elements and others from coal fly ash
4:25-4:55	**Letian Dou** (Professor of ChE, Purdue): Lead-containing halide perovskites nanomaterials for energy harvesting and related safety issues
4:55-5:25	**Osman Basaran** (Professor of ChE and Academic Director P2SAC, Purdue): Drop and bubble coalescence, thin films, and flow assurance
5:25-5:35	Short break

5:35-6:15	**Open discussion, industry needs, and future center projects (to be continued at dinner)**
6:15	Adjournment (dinner to follow---see below)

7:00 pm **After conference dinner and discussion** (Industrial members/guests and Profs. Mentzer and Basaran)

Location: Thai Essence, 1534 Win Hentschel Blvd, W. Lafeyette, IN 47906
(765) 269-9380 http://www.thaiessence.net/