

# P2SAC FALL 2024 CONFERENCE

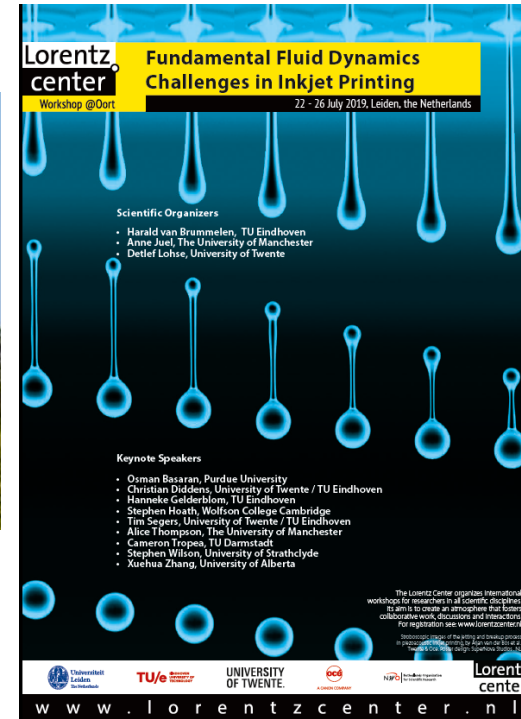
## Welcome, overview and what is P2SAC?



**Safety**  
(npr.org)



**Safety and assurance**  
(agdaily.com)



**Lorentz center** Workshop @Dart

**Fundamental Fluid Dynamics Challenges in Inkjet Printing**

22 - 26 July 2019, Leiden, the Netherlands

Scientific Organizers

- Harald van Brummelen, TU Eindhoven
- Anne Juel, The University of Manchester
- Detlef Lohse, University of Twente

Keynote Speakers

- Osman Basaran, Purdue University
- Christian Diddens, University of Twente / TU Eindhoven
- Hanneke Gelderblom, TU Eindhoven
- Stephen Hoath, Wolfson College Cambridge
- Tim Segers, University of Twente / TU Eindhoven
- Alice Thompson, The University of Manchester
- Cameron Tropea, TU Darmstadt
- Stephen Wilson, University of Strathclyde
- Xuehua Zhang, University of Alberta

The Lorentz Center organizes international workshops for researchers in all scientific disciplines. Its aim is to create an atmosphere that fosters collaboration, work, discussions and interactions. For registration see [www.lorentzcenter.nl](http://www.lorentzcenter.nl)

Universiteit Leiden, TU/e, UNIVERSITY OF TWENTE, oca, NRC, Lorentz center

www.lorentzcenter.nl

**Flow assurance**

## *Osman Basaran*

Burton and Kathryn Gedge Professor and  
Academic and Founding Director of P2SAC

Davidson School of Chemical Engineering/Purdue University

# OUTLINE AND GOALS

- Welcome to the **21st** biannual P2SAC conference!
- At the start of each day, I will go over the agenda and also provide corrections or updates to the program
- At the start of the second day, Ray Mentzer and I will provide an overview of P2SAC as well as a summary of our activities during the previous year
- I will also briefly touch upon the plans for the Spring 2025 conference (to take place in the first half of May 2025)

# CENTER MANAGEMENT

- **Osman Basaran**, Burton and Kathryn Gedge Professor of Chemical Engineering:  
Founding and Academic Director (AD) of P2SAC  
[obasaran@purdue.edu]
- **Ray Mentzer**, Professor of Engineering Practice:  
Executive Director (ED) of P2SAC  
[rmentzer@purdue.edu]
- **Web site:** <https://engineering.purdue.edu/P2SAC>



# EVOLUTION OF TWICE-A-YEAR P2SAC CONFERENCES

- The first conference (Fall 2014) and more than half a dozen subsequent conferences consisted of very full, one-day meetings
- We then introduced multi-day mini-conferences consisting of:
  - **Regular safety mini-conference** (*to be held twice a year*)
  - **Safety in the pharmaceutical industry mini-conference** (*to be held about once a year*)
  - **Flow assurance mini-conference** (*to be held once every few years*)
- A set of **tutorials** lasting half a day were then added to the program in Fall 2019 (*to be held twice a year*) but soon grew into a full-day program

# P2SAC CONFERENCES: EVOLUTION AND OUTLOOK

- **Early years:** very full, one-day meetings
- **Subsequent years:** multi-day mini-conferences consisting of
  - **General safety conference** (*twice a year*)
  - **Safety in the pharmaceutical industry conference** (*once a year*)
  - **Flow assurance conference** (*once every couple of years*)
  - **Tutorials** lasting one half to full day (*twice a year*)
- **Recent conferences have also included special sessions/programs:**
  - Fall 2021:** company-led session on discussion of **management systems**
  - Spring 2022:** **open discussion sessions and talks on professional development**
  - Spring 2023:** **additional types of open discussions** (see agenda for S2023)
- After a two-year pause due to Covid 19 when all meetings were virtual, **our conferences have returned to FTF format without a virtual option**

# AGENDA FOR FALL 2024

- Please, see other set of slides for the conference agenda/program
- A couple of noteworthy statistics about our previous conference and the current conference:
  - *Spring 2024 Conference---Nearly 80 attendees from 30 different organizations*
  - *Fall 2024---to be discussed by Ray Mentzer*

# WHAT IS P2SAC?

- P2SAC is an academic research center that is based in the Davidson School of Chemical Engineering at Purdue University.
- P2SAC was conceived in 2013 and launched in 2014 by Professor Osman Basaran who is the Founding and Academic Director of the center (henceforward the AD).
- Dr. Ray Mentzer, an expert on process safety, joined the center as Executive Director (ED) in 2016.
- P2SAC is focused on problems that fall in the large subject area of safety and process and/or product assurance (hence the name the *Purdue Process Safety and Assurance Center, P2SAC*).
- Approach adopted at P2SAC, while **driven by problems in industry**, is **research-based**. P2SAC is not involved in critically important but more applied safety issues, e.g. training of first responders.
- P2SAC is almost entirely funded by membership fees paid by its industrial member companies or sponsors. Additional support has also been provided by the Davidson School of Chemical Engineering.

# CURRENT INDUSTRIAL MEMBERS / SPONSORS\* IN APRIL 2024 (I)



*Lilly*

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Inspiring science, enhancing life



\*The center's Advisory Board also includes **Air Products** and The National Institute for Occupational Safety & Health (**NIOSH**).



# CURRENT INDUSTRIAL MEMBERS / SPONSORS\* IN MAY 2024 (II)



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\*The center's Advisory Board also includes **Air Products** and The National Institute for Occupational Safety & Health (**NIOSH**).

# CURRENT INDUSTRIAL MEMBERS/SPONSORS\* TODAY (III)



\*The center's Advisory Board also includes **Air Products** and The National Institute for Occupational Safety & Health (**NIOSH**).

- We thank our sponsors for both their financial support but also their selfless participation in the center's many activities (as to be discussed). **THE EXTRAORDINARY EXTENT OF PARTICIPATION IS AMONG THE THINGS THAT MAKE P2SAC UNIQUE**
- One out of seventeen engineers is a Purdue graduate. Therefore, our sponsors are making a huge impact with respect to the education, training, and development of future engineering and science talent. Moreover, they in turn reap many benefits by being members of P2SAC (as also to be discussed).

# CURRENT INDUSTRIAL MEMBERS/SPONSORS\* (IV)

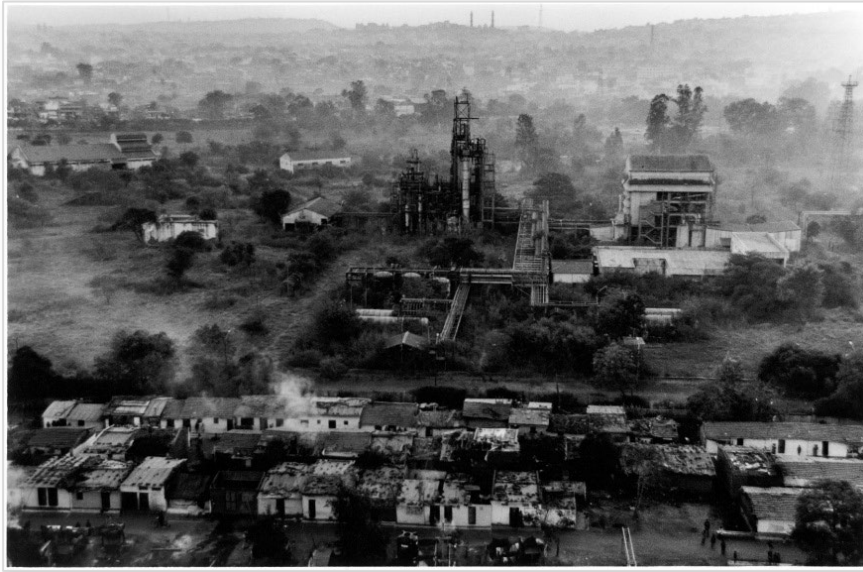


\*The center's Advisory Board also includes Air Products and The National Institute for Occupational Safety & Health (NIOSH).

As we will discuss during the conference, some *benefits of membership* include:

- Direct as well as indirect involvement in research programs/efforts
- Early and/or first access to research results
- Preferential treatment with respect to licensing patentable technology
- Unique opportunity and advantage in identifying *safety* and *other* professionals as potential permanent hires
- Preferential treatment in identifying and hiring talent for internships which in some cases lead to permanent positions when the students finish their studies

# PURDUE PROCESS SAFETY & ASSURANCE CENTER (P2SAC)



**Bhopal, India (1984):** At least 3,787 and over 16,000 claimed fatalities



**West Pharmaceuticals, NC (2003):** 6 fatalities



**BP Texas City (2005):** 15 fatalities

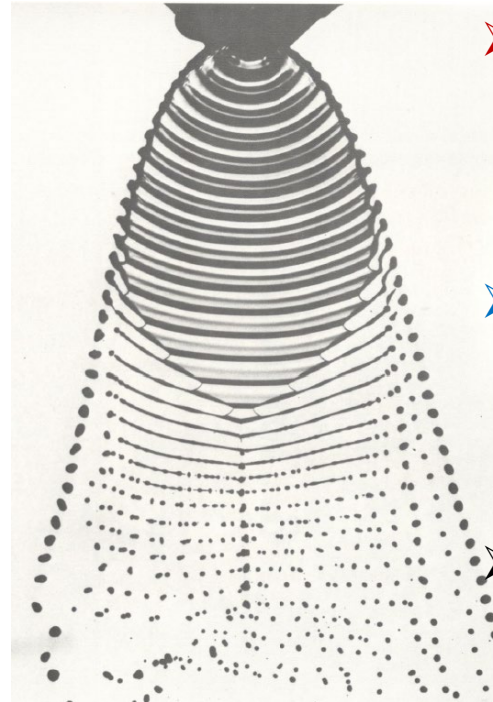


**Imperial Sugar, Georgia (2008):** 14 fatalities

# WHY **ASSURANCE**? SPRAY DRIFT EXAMPLE FROM CROP SPRAYING OR CROP PROTECTION



Liquid sheet from a fan spray nozzle  
(Crapper et al. JFM 1973; Villermaux ARFM 2007; Altieri and Cryer Biosys. Eng. 2018)



➤ **Small drops are undesirable because they lead to spray drift.**

➤ **Mystery: modern spray solutions do not disintegrate like pure fluids! Why?**

➤ **Image of rupturing sheet: Dombrowski (Van Dyke 1982).**

- **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.**

# SAFETY

**Texas Fertilizer Plant Explosion (West, TX)**  
(April 23, 2013, Washington Post)



**Refinery explosion: How Philly dodged a catastrophe**  
(June 21, 2019, Philadelphia Inquirer)



12/10/2024

# ASSURANCE

## FLOW ASSURANCE:

- **Coalescers, dehydrators, desalters, and oil-water-gas separators (in O&G industry)**
- Hydrate formation in oil and gas pipelines
- **Spray drift in agriculture**
- **“Drop size-modulation” and “satellite droplet or misting prevention” in ink jet printing and additive manufacturing operations**
- **Bottle filling (detergent bottles or drug vials)**
- **Rupture/integrity of coated films on substrates and free thin films/sheets (important in atomization and polymer processing)**

## OTHER EXAMPLES:

- **Avoiding polymorphs in the pharma industry**
- **Personalized medicine: printing drugs on edible substrates**
- **Control of particle (or capsule) size as well as shape**
- **Safety, reliability, and durability of biomedical (e.g. implants) and surgical devices**

# CENTER ACTIVITIES AND UNIQUE FEATURES (I)

- Involve **multiple faculty** (rather than a single person), **PhD students** (2 or 3 year projects), **PMP students** (intense summer projects **mentored by member companies**), and exceptional **undergraduates** in safety-related research.
- Additionally, P2SAC aims in the long term to become a leader in certain aspects of safety education through development and teaching of primarily undergraduate and graduate courses. *(According to informal polling of first year graduate students in our program, **Purdue ChE is one of a handful of departments nationally and internationally that requires all undergraduates to take a rigorous core course on **safety** to receive a BS degree**) (The course is also offered to graduate students, which is even more unusual.)*

# CENTER ACTIVITIES AND UNIQUE FEATURES (II)

- Our goal/mission is not to focus on a single or primarily one industry segment, e.g. we do not just want to have members that are oil and gas (O&G) producers
- Synergism: bring together people from different industries, e.g. pharma and O&G, who may not typically attend the same conferences and/or interact with one another on a regular basis



# SUMMARY OF TYPES OF P2SAC RESEARCH PROJECTS

- PhD research projects: a listing of recent and/or ongoing current projects will be provided
- Professional Master's Program (PMP) capstone research projects: to be covered by Ray Mentzer
- Undergraduate (UG) research projects: also to be covered by Ray Mentzer

# PROCESS FOR DETERMINING AND FUNDING PhD PROJECTS

(Program managed by Osman Basaran, AD)

- Projects are funded for at least two but for no more than three years.
- **There are two ways of coming up with new projects:**
  - Faculty or groups of faculty propose new projects on their own *or*
  - Faculty work with industrial members to develop new projects.
- **Timing for formulating projects:** *summer and early fall.*
- **Timing and mechanism for proposing new projects:** submitting a 1.5-page written project proposal to Osman Basaran (AD) by the middle to the end of December of that year.
- **How are projects to be funded determined?** AD may continue to fund some ongoing projects for the third year but will also seek advice from member companies to evaluate newly proposed projects. Members are asked to send their rankings to the AD in January.
- **Final determination on funding:** AD selects projects to be funded based on input received from members, importance and relevance of newly proposed and/or existing projects to the center, and availability of funds.

# ADDITIONAL COMMENTS ON PhD PROJECTS AND FUNDING

- Call for proposals have typically been issued every other year. In December 2022, proposals for projects were submitted by the faculty for consideration for funding during the period 2023-2024.
- Upon receiving proposals for new projects, AD then asks member companies to evaluate and/or rank-order the proposed projects.
- Beginning in December 2024, calls for proposals will be issued yearly with the provisos that projects will be funded for at least two years and some projects may be funded for three years.
- Interesting fact: An unexpected but desirable commonality among projects to be funded has been that almost all successful proposals involve participation and/or active involvement by one or more P2SAC member companies, i.e. lone-ranger projects do not appear to receive high ratings from our members.

**LISTING OF PhD PROJECTS  
FUNDED DURING 2023-2024**

# PhD PROJECTS 2023-2024

## *New faculty project 1*

**Project title:** Machine Learning-aided Safety Hazard Detection and Identification\*

**PI:** Prof. Can Li\*\*, Davidson School of Chemical Engineering, Purdue University

**Project suggested/proposed or championed by:** Can Li and Edward Marszal (Kenexis)

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\*This proposal and Professor Li's research area(s) is (are) of tremendous current interest given the importance of machine learning, big data, and AI.

\*\*One of the goals of P2SAC is to find and/or entice new faculty to engage in safety research and fund their work through the center.

# PhD PROJECTS 2023-2024 CONT'D

## *New faculty project 2*

**Project title:** Safe and Effective Partial Oxidations via Electrocatalysis\*

**PI:** Prof. Brian Tackett, Davidson School of Chemical Engineering, Purdue University

**Project suggested/proposed or championed by:** Brian Tackett

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\*This proposal and Professor Tackett's research area(s) is (are) of tremendous current interest given the growing importance of electrification of all sorts of traditional and emerging manufacturing and/or processing operations.

# PhD PROJECTS APPROVED FOR FUNDING (2023-2024) CONTINUED

**Project title:** New Computational Tools for Predicting Reactivity\*

**PI:** Prof. Brett M. Savoie, Davidson School of Chemical Engineering, Purdue University

**Project suggested/proposed or championed by:** Brett M. Savoie (Purdue) and virtually all members of P2SAC from the pharmaceutical industry

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\*This is a relatively recent and rapidly growing area of research in P2SAC, and its impact on safety-related work at member companies has already been demonstrated and will also become clear during the conference.

# PhD PROJECTS 2023-2024 CONT'D

**Project title:** Manufacture and Field Evaluation of Low-Cost Gas Sensors\*

**PI:** Bryan W. Boudouris, Davidson School of Chemical Engineering, Purdue University

**Project suggested/proposed or championed by:** Bryan W. Boudouris (Purdue), Hariprasad Janakiram Subramani (Chevron), and others.

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\*Research methodology can be applied to all sorts of sensors. During a previous funding period, the focus was primarily on hydrogen gas sensors.



# PhD PROJECTS 2023-2024 CONT'D

**Project title:** Real-time Li-ion Battery Monitoring using Impedance Spectroscopy and Gas/Pressure Sensors for Early Thermal Runaway Detection\*

**PI:** Prof. Vilas Pol, Davidson School of Chemical Engineering, Purdue University

**Project suggested/proposed or championed by:** Vilas Pol (Purdue); Edward Marszal, James Mcglone (Kenexis) and Erich Binder (Worley)

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\*This proposal as well as some of its predecessors have always come together after weeks of back and forth discussions between Prof. Pol and industry representatives.

# PhD PROJECTS 2023-2024 (CONCLUDED)

**Project title:** Analysis and prediction of the role of additives, e.g. surfactants, polymers, and drops/particles, on spray dynamics with applications to flow assurance, minimization of fines, and prevention of drift\*

**PI:** Prof. Osman A. Basaran, Davidson School of Chemical Engineering, Purdue University

**Project suggested/proposed or championed by:** Pritish M. Kamat (Dow) and Osman A. Basaran (Purdue)

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\*Although the general area of sprays is an active research area in the Basaran group, this particular project was initially suggested by Dow.

# EXAMPLES OF HIGHLY SUCCESSFUL PhD PROJECTS

Journal of Loss Prevention in the Process Industries 51 (2018) 29–35



Contents lists available at [ScienceDirect](#)

Journal of Loss Prevention in the Process Industries

journal homepage: [www.elsevier.com/locate/jlp](http://www.elsevier.com/locate/jlp)



A global stochastic programming approach for the optimal placement of gas detectors with nonuniform unavailabilities



Jianfeng Liu<sup>a</sup>, Carl D. Laird<sup>b,\*</sup>

<sup>a</sup> School of Chemical Engineering, Purdue University, USA

<sup>b</sup> School of Chemical Engineering, Purdue University, PMTS, Discrete Mathematics and Optimization, Sandia National Laboratories, USA

Process Safety and Environmental Protection 132 (2019) 47–58



Contents lists available at [ScienceDirect](#)

Process Safety and Environmental Protection

journal homepage: [www.elsevier.com/locate/psep](http://www.elsevier.com/locate/psep)

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

A mathematical programming approach for the optimal placement of flame detectors in petrochemical facilities



Todd Zhen<sup>a</sup>, Katherine A. Klise<sup>b</sup>, Sean Cunningham<sup>c</sup>, Edward Marszal<sup>c</sup>, Carl D. Laird<sup>a,b,\*</sup>

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<sup>b</sup> Sandia National Laboratories, Albuquerque, NM, USA

<sup>c</sup> Kenexis Consulting Corporation, Columbus, OH, USA

# P2SAC SPRING 2025 CONFERENCE

- The spring 2025 conference will take place in early to mid May 2025 (*most likely May 6-8 or May 6-9*)
- The conference will last **three** or *possibly four* days:
  - Day 1: tutorials
  - Day 2: pharmaceutical safety conference
  - Day 3: general safety conference
  - Day 4: *flow assurance conference (tentative)*
- Details will be communicated to the stakeholders during January/February 2025