Simulation Solutions, Inc.

Minds-On/Hands-On Training for Operators™

"Taking ChemE-Sports™, from on-site to a Live Virtual Competition"

Mr. Donald C. Glaser
President

Mr. Matthew B. Garvey
Engineering Manager

Simulation Solutions, Inc.
179 Avenue at the Common, Suite 1
Shrewsbury, NJ 07702-4804
Donald.glaser@petroskills.com
Matthew.garvey@petroskills.com

Robert G. Bozic, Ph.D.
Lieutenant Colonel U.S. Army(Retired)
Lecturer
Department of
Chemical Engineering
Columbia University
in the City of New York
rb2335@columbia.edu

Outline

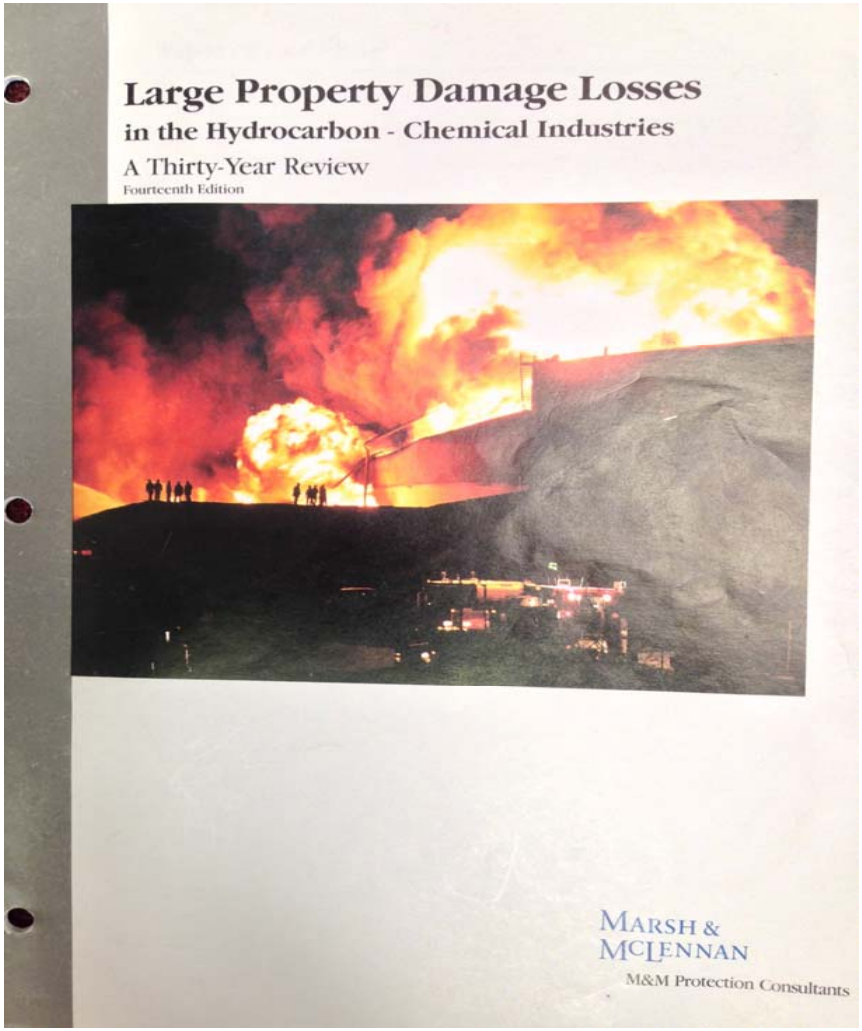
- Background/Motivation
- SURG ChemE-Sports™ Competition, Sun 15 Nov 2020
- Acknowledgements and References
- Conclusion and Future Work

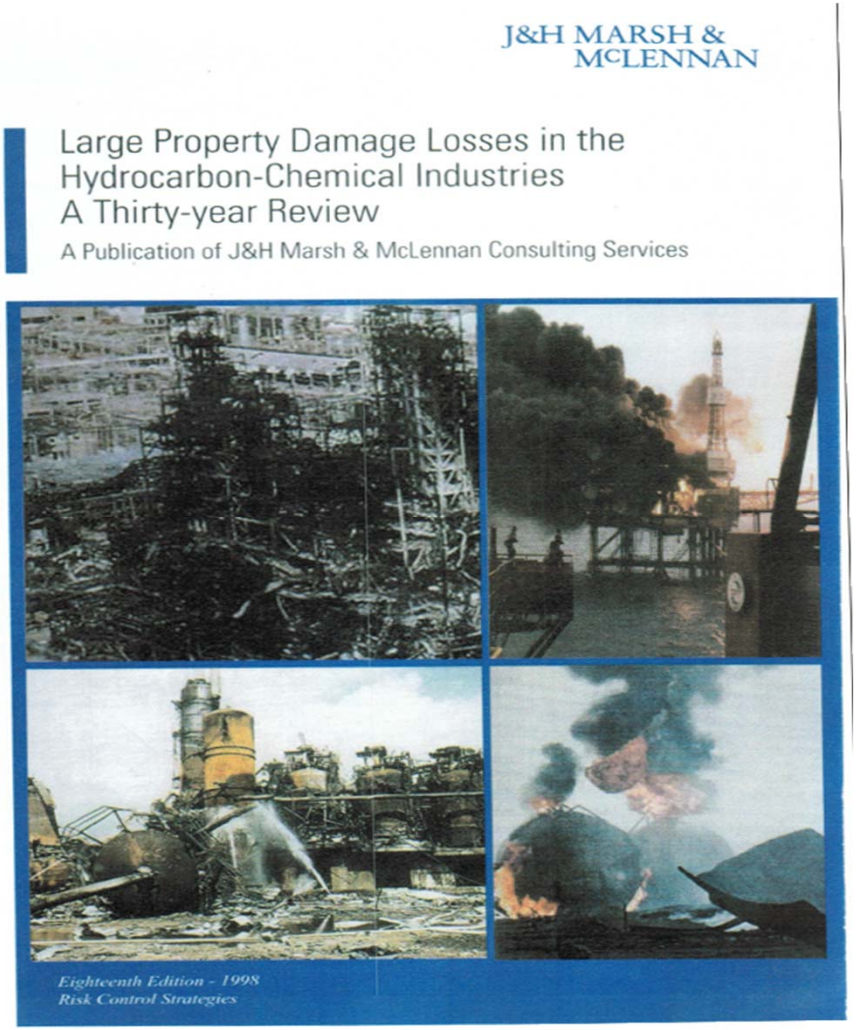
Simulation Solutions, Inc.
Minds-On/Hands-On Training for Operators™

AIChE
The Global Home of Chemical Engineers

Background and Motivation

Case Study: Marsh and McLennan Reports 14th (1992) and 18th (1998) Editions

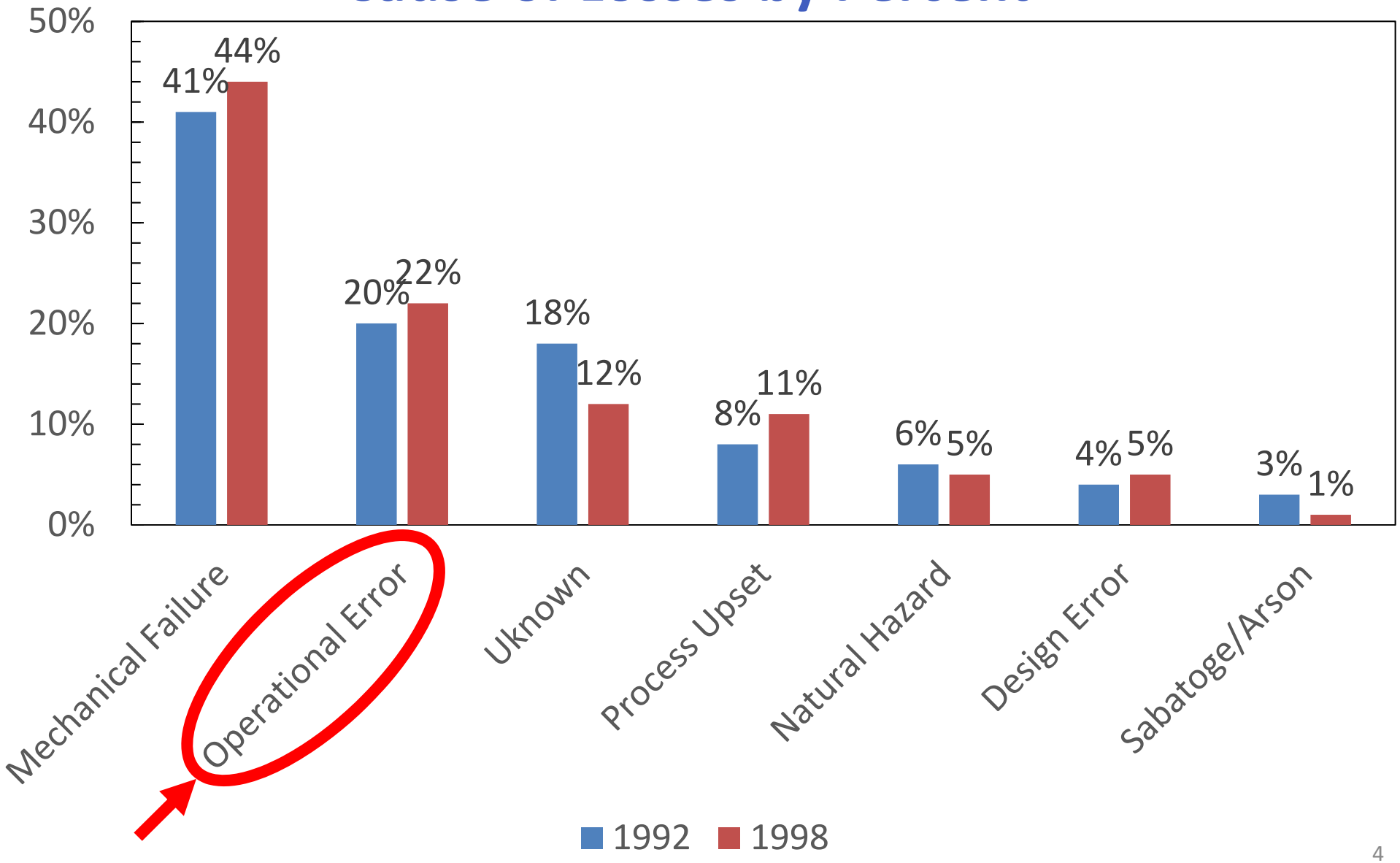




https://www.marsh.com/us/insights/research/the-100-largest-losses-in-the-hyrdocarbon-industry-1974-2015.html

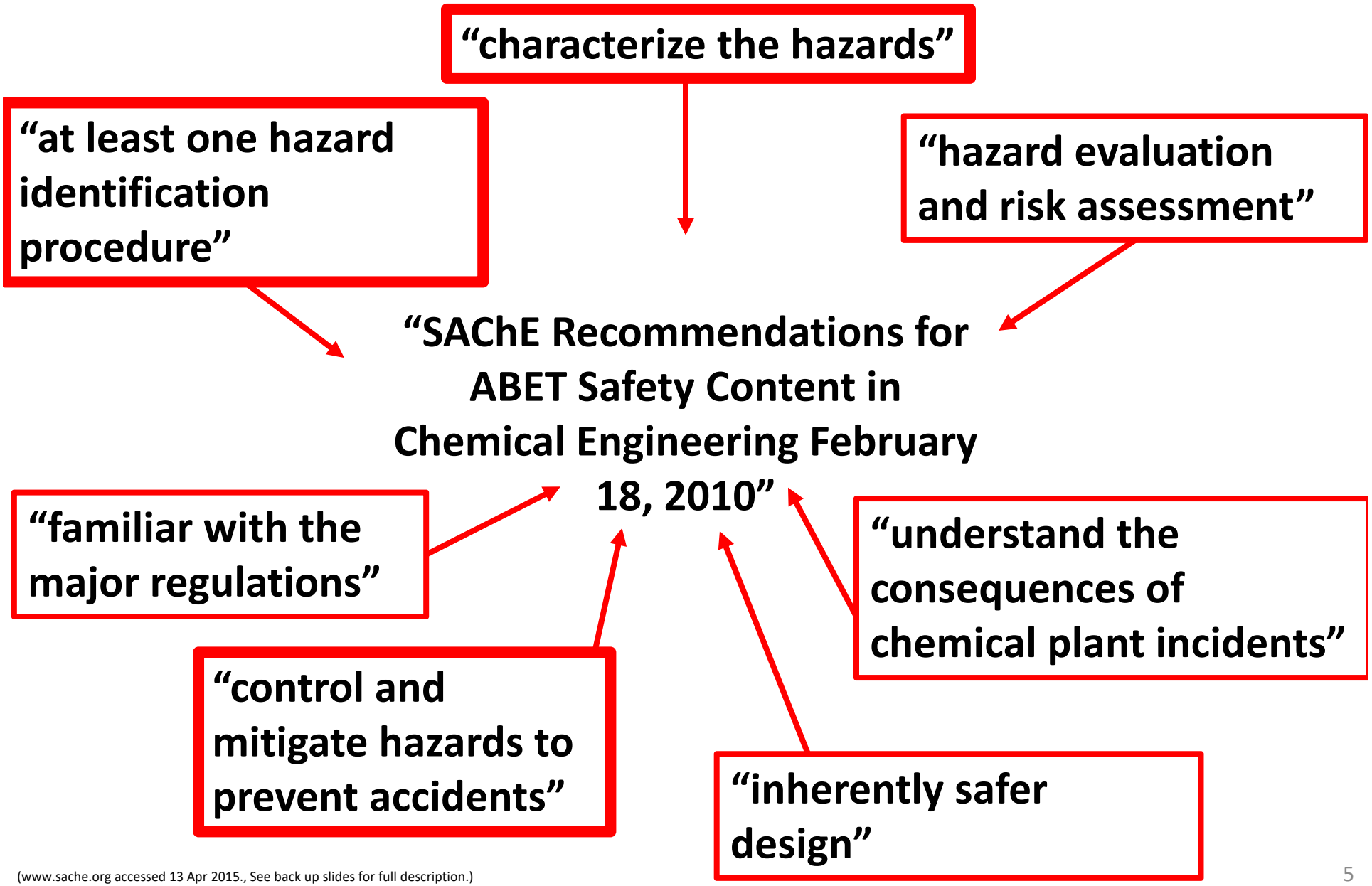
Background and Motivation

Cause of Losses by Percent



Case Study: Marsh and McLennan Reports 14th (1992) and 18th (1998) Editions

Background and Motivation



(www.sache.org accessed 13 Apr 2015., See back up slides for full description.)

ChemE-Sports™: Distillation Operations Center Competition 10 Nov 2019

Screen 1

Podium and microphone

Screen 2

Team 1 Operations Deck (table, chairs, lab top computer and projector)

Team 2 Operations Deck (table, chairs, lab top computer and projector)

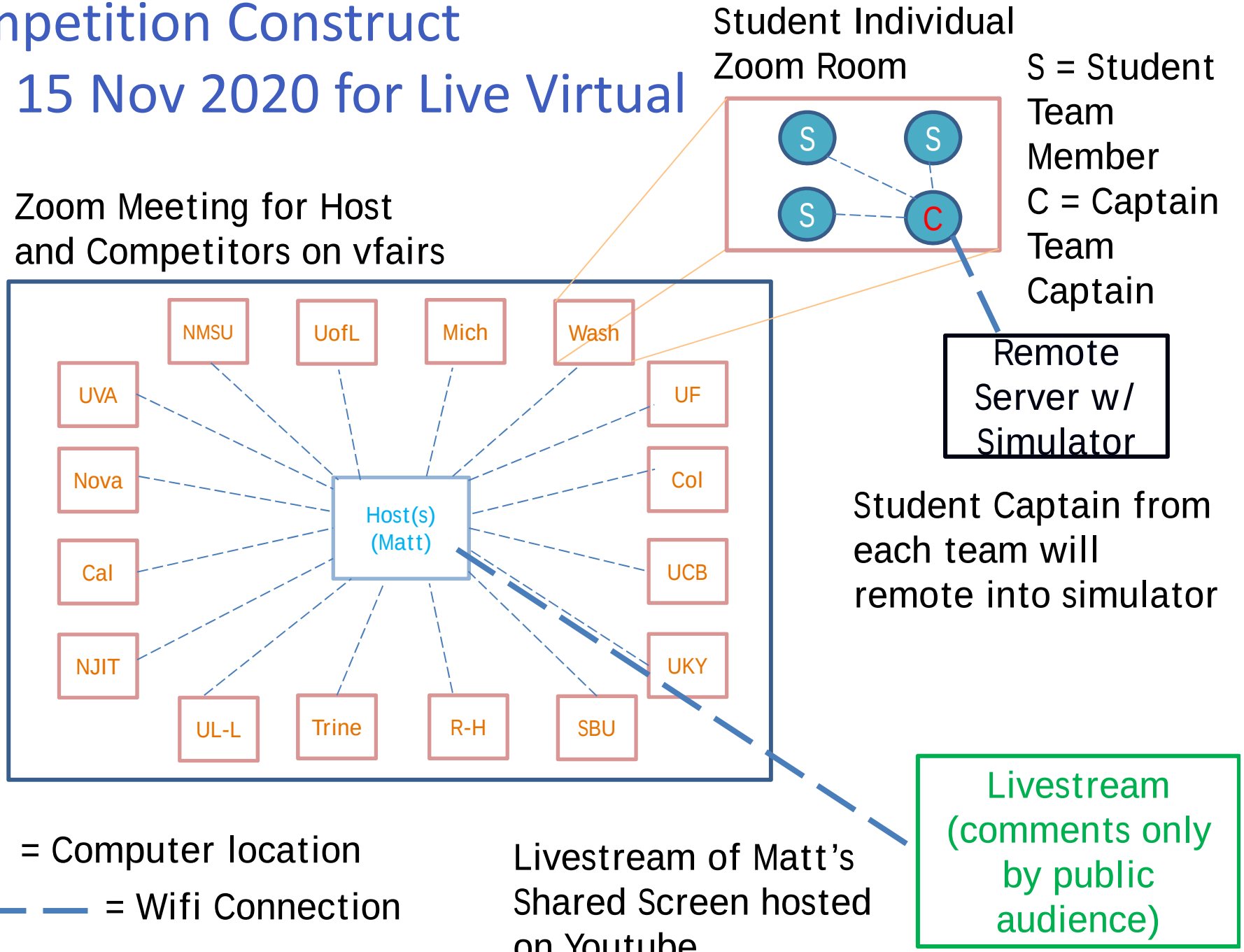
Visitors and ChemE-Sports Fan Seating

Welcome and Sign-in Station

Competition Room
Orlando, Florida Sun 10 Nov 2019

Competition Room
Orlando, Florida Sun 10 Nov 2019

Competition Construct
Sun 15 Nov 2020 for Live Virtual



Sample Competition Timeline from 2019

	1:30 PM	1:35 PM	1:40 PM	1:45 PM	1:50 PM
Group 1	0	5	10	15	20
Group 2	0	5	10	15	20
Directive	Maintain throughput rate and product specs				
Distillation Column Critical Event		Equipment Feed Filter begins clogging for 5 minute span (00:00)		Equipment Condensate Pump, P-130A Failure	

Team Scoring Breakdown

Team Texas A&M (Round 2)	**Profit (25 Points Total)**	**Time in Alarm (37.5 pts possible)**	**# of Alarms (37.5 pts possible)**
Data	$712.50	2743 seconds	27 alarms
Score per Portion:	8.91	16.07	27.38
Total Score:	**52.35**		

Team Louisville (Round 2)	**Profit (25 pts possible)**	**Time in Alarm (37.5 pts possible)**	**# of Alarms (37.5 pts possible)**
Data:	$680.43	2749 seconds	37 alarms
Score per Portion:	8.51	16.02	23.63
Total Score:	**48.15**		

Competition Schedule (Planned)

Time (Pacific)	Event	Remaining Teams
8:30am-9:00am	Competing Teams Sign-In	22 teams
9:00am-9:15am	Introduction for Audience	
9:15am-9:45am	Round 1 Exercise 1	22 teams
9:45am-10:15am	Round 1 Exercise 2	22 teams
10:15am-10:25am	A Historical Perspective of ChemE-Sports	
10:25am-10:55am	Round 2 Exercise 1	16 Teams
10:55am-11:25am	Round 3 Exercise 1	4 Teams
11:25am-11:35am	Looking at the Future of ChemE-Sports	
11:35am-12:00pm	Round 4 Exercise 1	2 Teams
12:00pm-12:15pm	Presentation of Winners	
12:15pm-12:30pm	Wrap-up / Q&A	

Competition Schedule (Actual timeline after 20 minutes time delay based on computer server issue.)

Time (Pacific)	Event	Remaining Teams
8:30am-9:00am	Competing Teams Sign-In	22 teams
9:00am-9:15am	Introduction for Audience	
9:15am-9:45am	Resolution of Server Issues	
9:45am-10:15am	Round 1 Exercise 1	22 teams
10:15am-10:45am	Round 1 Exercise 2	22 teams
10:45am-10:55am	A Historical Perspective of ChemE-Sports	
10:55am-11:25am	Round 2 Exercise 1	16 Teams
~~10:55am-11:25am~~	~~Round 3 Exercise 1~~	~~4 Teams~~
11:25am-11:35am	Looking at the Future of ChemE-Sports	
11:35am-12:00pm	Round 3 Exercise 1	4 Teams
12:00pm-12:15pm	Presentation of Winners	
12:15pm-12:30pm	Wrap-up / Q&A	

Breakdown of Each Shift

- Goal:
  - Minimize: Number of Alarms & Time in Alarm
  - Maximize: Profit

- Teams receive mission statement:
  - new specifications that must be reached
  - warnings of changes to the system

- Team Operations: work toward objective in mission, troubleshoot upsets during the shift

Style of Each Round

Round of Competition	Exercise Focus
Round 1 (22 teams)	Every team was asked to increase tower throughput to a specified rate (GPM). A more challenging minimum product purity requirement was given for one of the two products. Minor equipment failures introduced
Round 2 (16 teams)	Product rates and purity requirements did not change. Teams faced major plant upsets.
Round 3 (4 teams)	Teams faced a combination of major upsets as well as new throughput and product purity specifications

Advancing from First Round

- Each team received a score out of 100 that was determined live on the simulator from 3 factors:
  - # of unique times in alarm
  - Total time in alarm
  - Profitability

  (75%) — # of unique times in alarm
  (25%) — Total time in alarm, Profitability

- All 22 teams went through the first two exercises in Round 1. Scores were averaged and the top 16 teams moved on to the Knockout Rounds.

- Every team went through the same exact two exercises in Round 1.

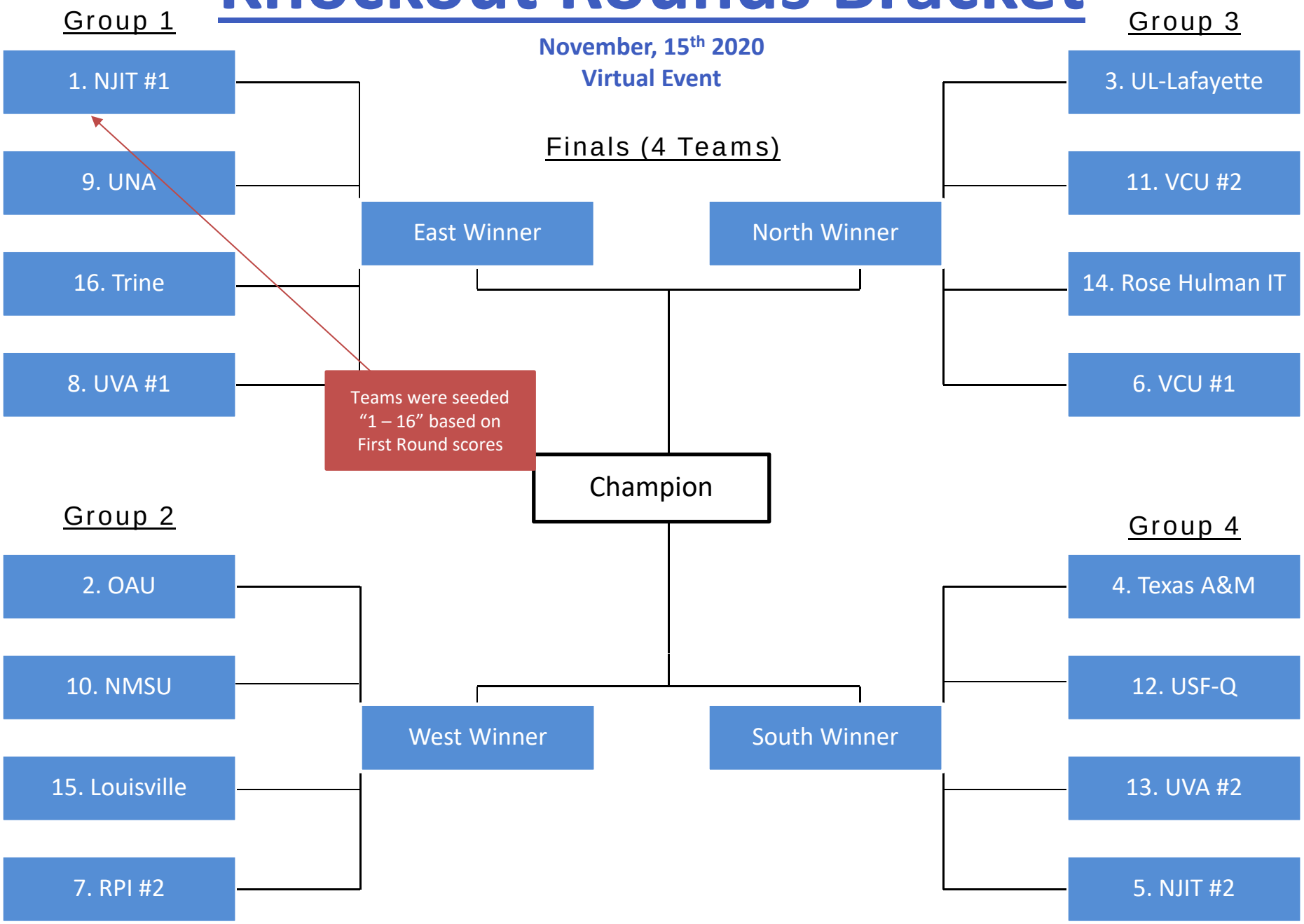
Round 1 Results (Scores are out of 100 possible points)

Top 16 Teams advance to Round 2

Ranking	Team # and School Name	Round 1 Exercise 1	Round 1 Exercise 2	Round 1 Average
1	1 NJIT #1	93.27	95.03	94.15
2	21 OAU	94.73	92.25	93.49
3	9 UL-Lafayette	93.03	92.59	92.81
4	13 Texas A&M	90.6	93.14	91.87
5	4 NJIT #2	92.65	90.41	91.53
6	11 VCU #1	89.04	93.28	91.16
7	15 RPI #2	86.51	93.29	89.9
8	10 UVA #1	83.99	94.09	89.04
9	22 UNA	93.2	83.34	88.27
10	2 NMSU	84.96	91.38	88.17
11	12 VCU #2	84.73	91.16	87.945
12	24 USFQ	88.57	84.77	86.67
13	23 UVA #2	81	91.87	86.435
14	5 Rose Hulman	85.37	86.87	86.12
15	19 Louisville	81.13	84.91	83.02
16	8 Trine	70.65	90.46	80.555
17	14 RPI #1	66.72	93.36	80.04
18	UTEC	82.53	62.35	72.44
19	3 Tulsa	95.21	46.14	70.675
20	6 UC-Riverside	80.87	59.19	70.03
21	17 IIT-Madras	92/08	66.53	66.53
22	18 NITD	74.56	38.66	56.61

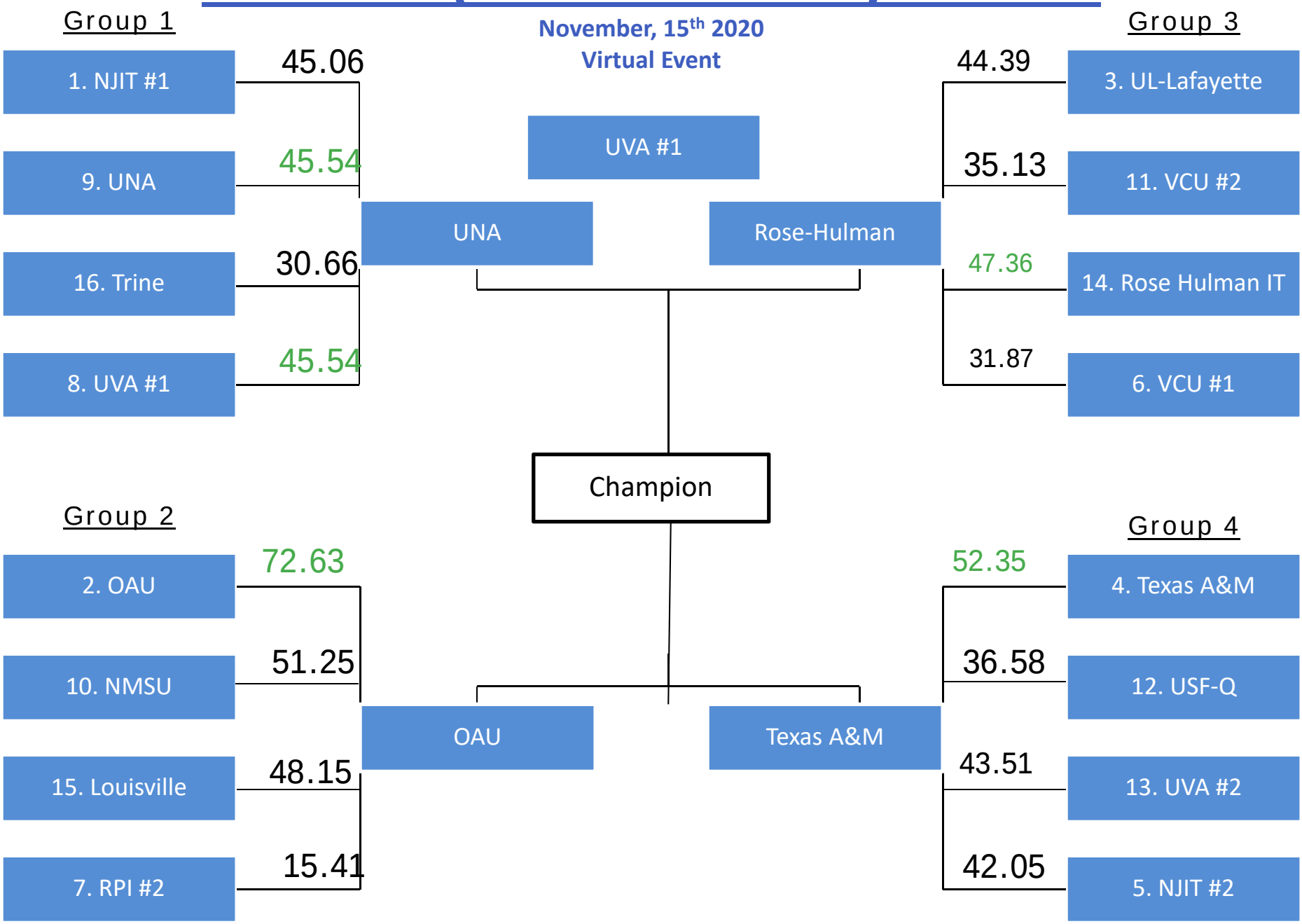
Knockout Rounds Bracket

November, 15th 2020
Virtual Event



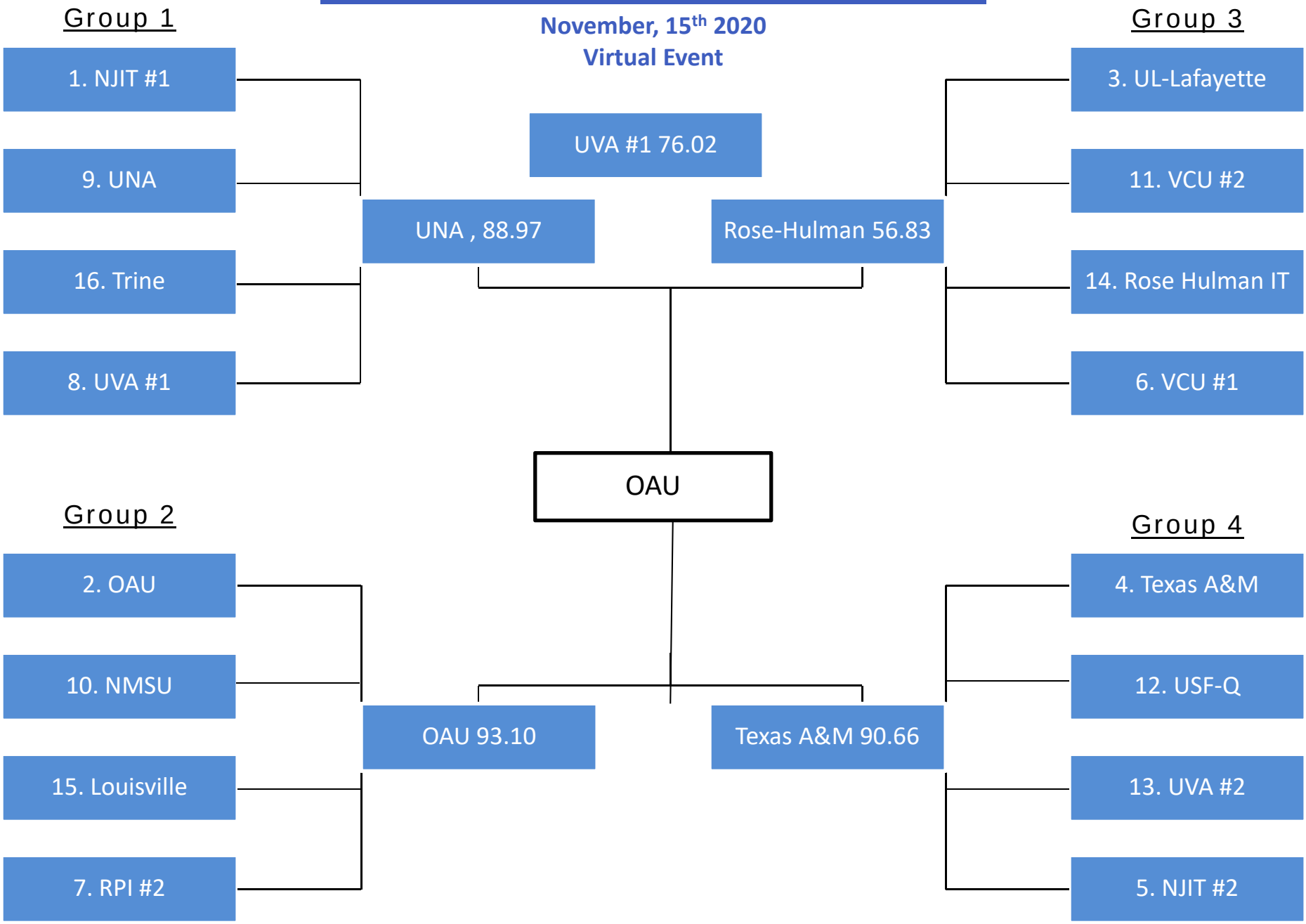
Round 2 ("Round of 16") Results

November, 15th 2020
Virtual Event

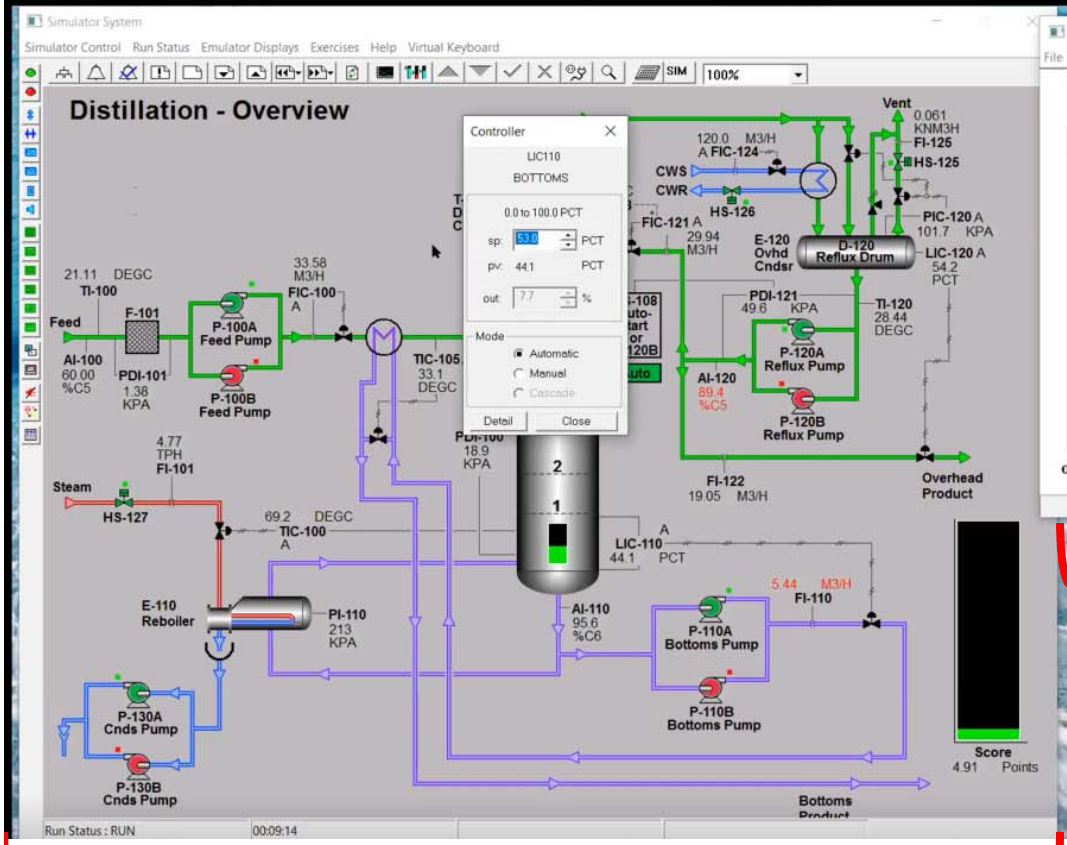


Round 3 (Finals) Results

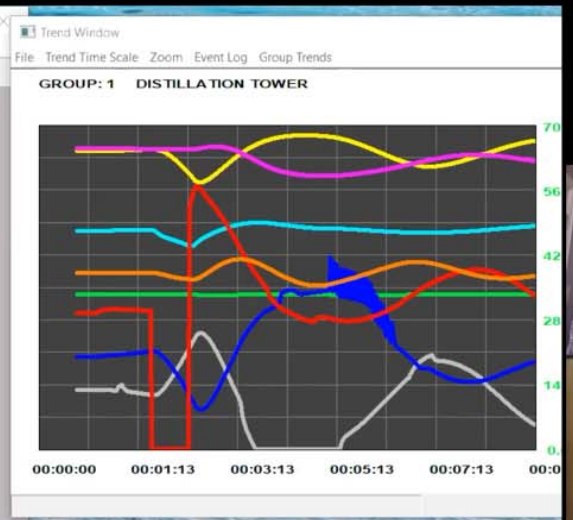
November, 15th 2020
Virtual Event



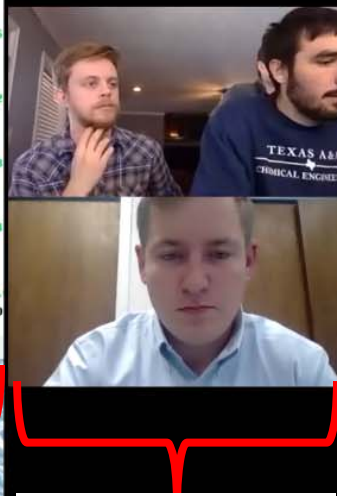
15 Nov 2020 ChemE-Sports™ Competition Day



DCS Screen

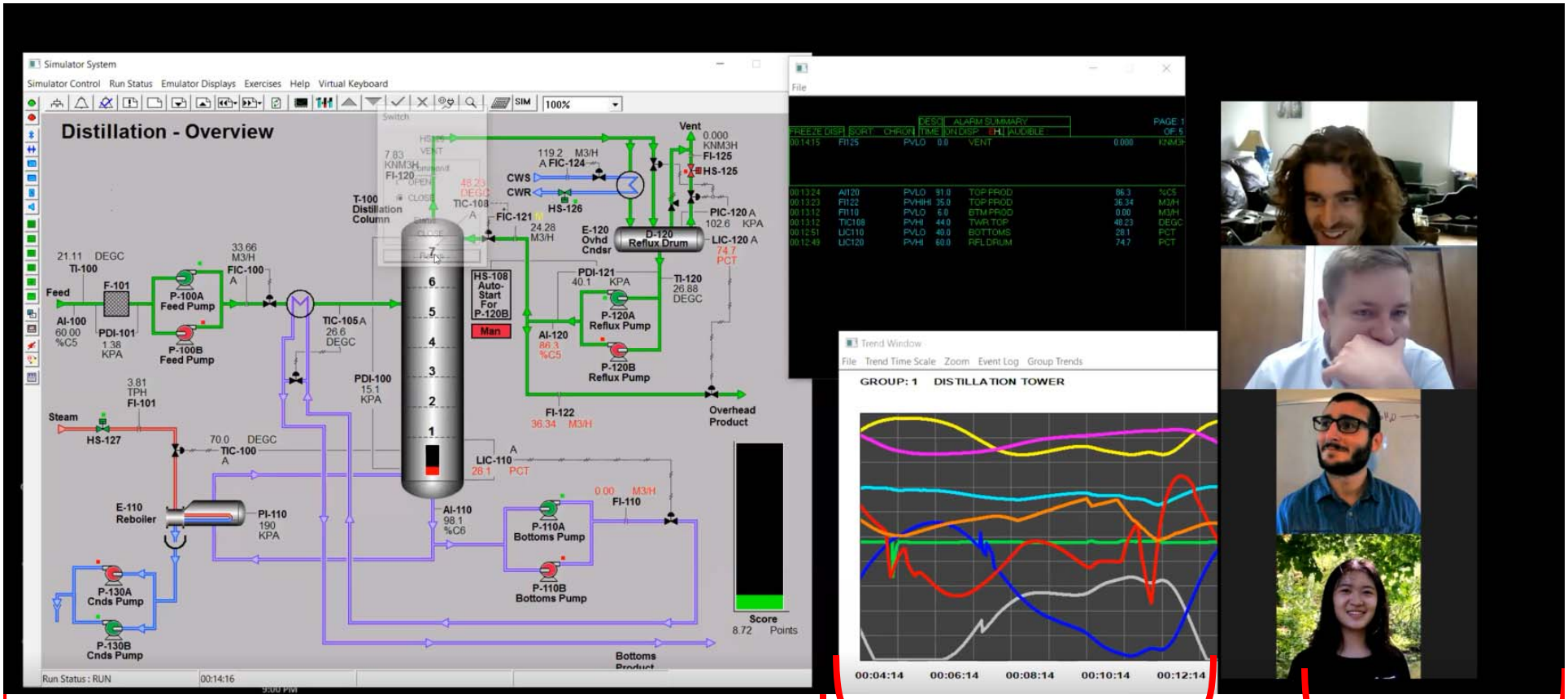


Process Variable Trendline



Competitors and Matt Garvey, Competition Controller

15 Nov 2020 ChemE-Sports™ Competition Day

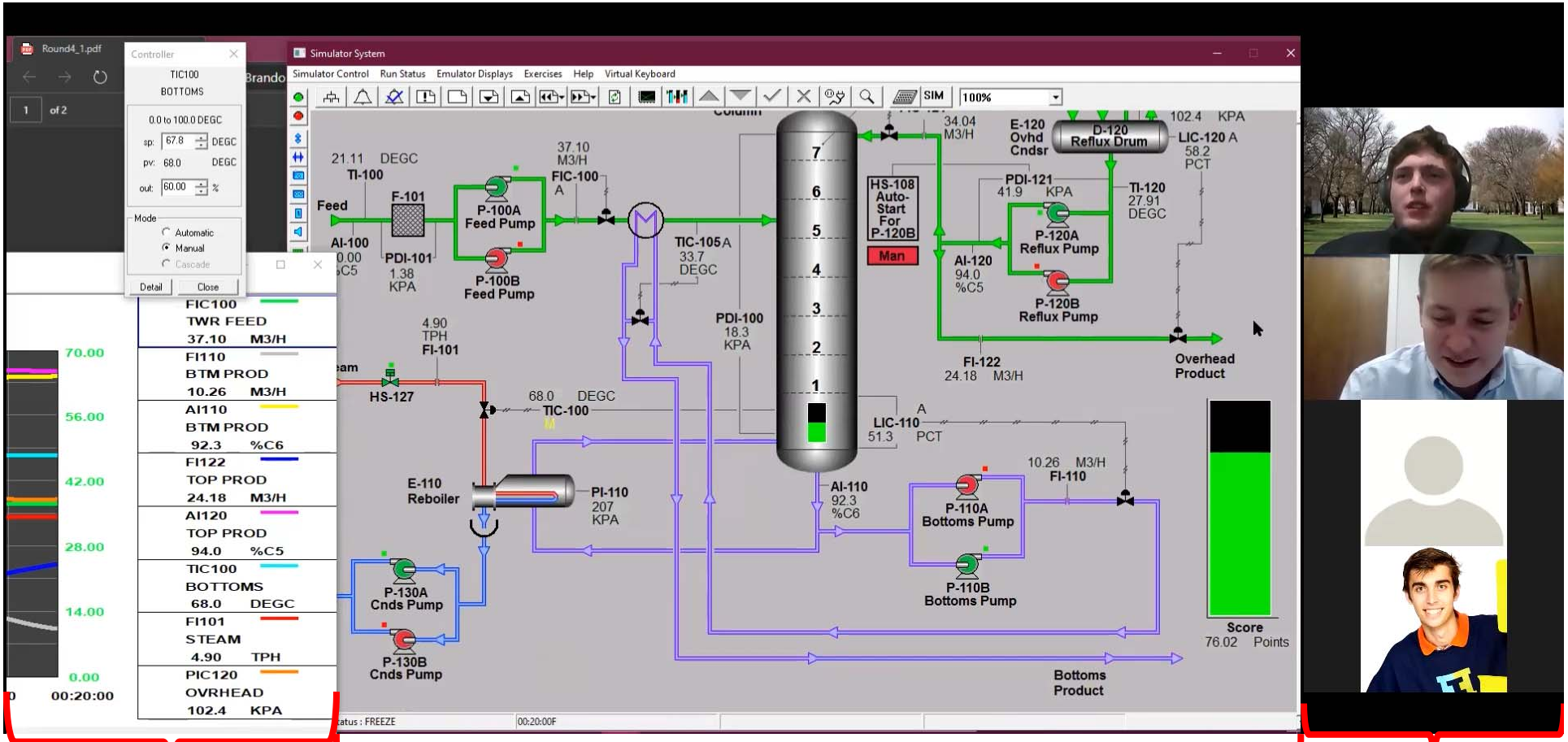


DCS Screen

Alarm Summary And Process Variable Trendline

Competitors and Matt Garvey, Competition Controller

15 Nov 2020 ChemE-Sports™ Competition Day

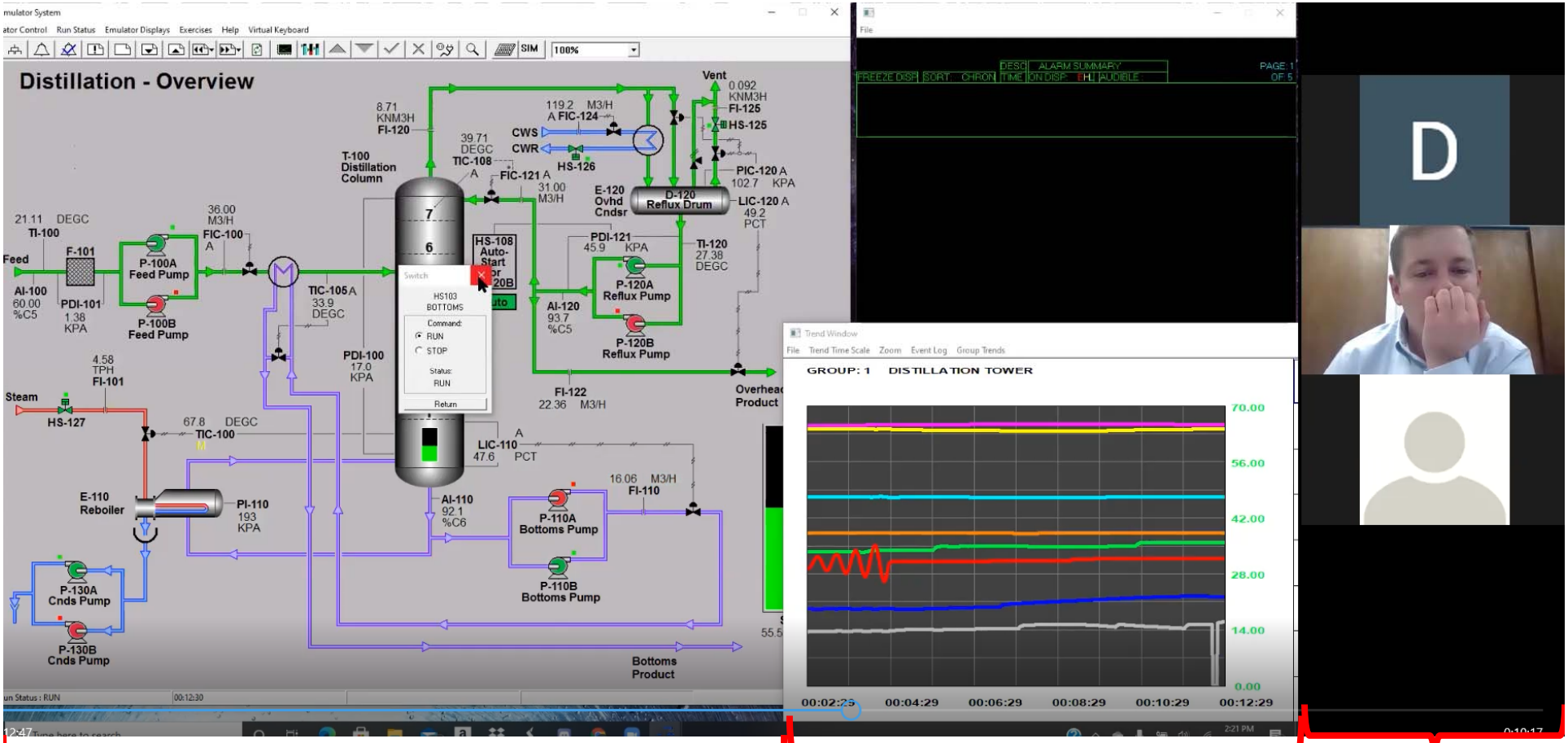


Controller Faceplate and Partial Process Variable Trendline

DCS Screen

Competitors and Matt Garvey, Competition Controller

15 Nov 2020 ChemE-Sports™ Competition Day



DCS Screen

Alarm Summary and Partial Process Variable Trendline

Competitors and Matt Garvey, Competition Controller

ChemE-Sports™ Competitor Survey Results

For each statement below, 5 indicates strong agreement and 1 indicates strong disagreement.

Question	Average	Standard Deviation
1. As a result of this competition my ability to understand the importance of process safety and the resources and commitment required has improved. (SAChE Rec 1, As of 18 Feb 2010)	4.22	0.76
2. As a result of this competition my ability to understand how to control and mitigate hazards to prevent accidents has improved (SAChE Rec 4, As of 18 Feb 2010)	4.31	0.66
3. As a result of this competition my ability to understand process control and chemical engineering design concepts has improved. (ABET Criterion III, Outcome 1 and 6. ABET Website 5 Oct 2019)	4.53	0.80

*36 students who competed in the event completed survey and 35 responded to the questions above.

Survey Results

For each statement below 5 indicates strong agreement and 1 indicates strong disagreement.

Question	Average	Standard Deviation
5. I was provided with enough material to prepare for the ChemE-Sports Competition:	4.38	0.82
6. The online webinars (and recordings) were helpful during my preparation for the ChemE-Sports competition:	4.27	0.83
7. I was able to install and operate the Simulator Software with ease:	4.44	0.72
10. I would recommend competing in the ChemE-Sports Competition to fellow students:	4.67	0.75

For the question below, 5 indicates exceeded expectations and 1 indicates below expectations

Question	Average	Standard Deviation
9. In general, did the ChemE-Sports Competition meet your expectations?	4.0	0.84

*36 students who competed in the event completed survey and responded to the questions above, less question 9 where 34 of 36 responded.

Lessons Learned from ChemE-Sports™ 2020

1. Reduced additional audio/visual needs because of access to internet.

2. Host location for on-line format is key to success.

3.Based on success of virtual competition, a hybrid format was developed in order to create more participation.

4. Based on demand, regional competitions are in the planning stage for the future.

Acknowledgements

Thanks to all
ChemE-Sports™ Student Teams!

Thanks to Don Glaser and Matthew Garvey and Nancy McCarthy!

Simulation Solutions, Inc.
Minds-On/Hands-On Training for Operators™

Conclusion and Future Work

Successful ChemE-Sports™ competition with projected growth for the future.

Promote ChemE-Sports™ Safety and Optimization Competition in the Chemical Engineering Community

References

ASPENTECH V8.8 Software (used for design work)

Beer, David and David McMurrey, *A Guide to Writing as an Engineer 2nd Edition*. Wiley, New York, 2005

Crowl, Daniel A. and Joseph F. Louvar, *Chemical Process Safety" Fundamentals with Applications 3rd Edition*, Pearson, New York, 2011

Felder, Richard M. and Ronald W. Rousseau, *Elementary Principles of Chemical Processes 3rd Edition,* 2000, John Wiley and Sons, New York, New York. Section 4.3a Flowcharts, p90-92

Graham, Nasby, "Using Process Flowsheets as Communication Tools" *Chemical Engineering Progress*, Volume 108, No. 10.Oct 2012. p36-44, Available in Chemical Engineering Progress on line

i.ytimg.com/vi/8A1xSCUtB-M/hqdefault.jpg accessed 22 Jan 2015

Perry, Robert H. and Don W Green, *Perry's Chemical Engineering Handbook*, 7th Edition, 1997, McGraw Hill, New York, New York

Seborg, Dale E., Thomas F. Edgar, and Duncan A. Mellichamp, *Process Dynamics and Control*. Wiley Inc, New York, New York (1989) p7-9

Walker, Vornel, "Designing a Process Flowsheet" *Chemical Engineering Progress*, Volume 105, No.5. May 2009. p15-21, Available in Chemical Engineering Progress on line

www.aiche.org/academy/courses/sache/sache-certificate-program accessed 19 Jan 2015

www.aiche.org/ccps/community/students-teachers-and-communities/certificate-safety-achievement accessed 19 Jan 2015

www.bing.com/images/search?q=jacksonville%2C%20florida%20chemical%20plant%20dec%202007&qs=n&form=QBIRMH&pq=jacksonville%2C%20florida%20chemical%20plant%20dec%202007&sc=0-0&sp=-1&sk=#view=detail&id=757F70F7B398E519B65D6CACB55A59E57E50CB72&selectedIndex=5 accessed 22 Jan 2015

www.bing.com/images/search?q=pasadena%20texas%20oct%201989&qs=n&form=QBIR&pq=pasadena%20texas%20oct%201989&sc=0-19&sp=-1&sk=#view=detail&id=1A52930A92CCEC5F28D374DBCC19EA634FE9A02F&selectedIndex=1 22 Jan 2015

www.csb.gov accessed 3 Feb 2015 used for case study videos

www.csb.gov/assets/1/7/Tesoro_Anacortes_2014-May-01.pdf accessed 28 Jan 2015

www.csb.gov/assets/1/19/Final_Report_small.pdf accessed 28 Jan 2015

https://www.marsh.com/us/insights/research/the-100-largest-losses-in-the-hyrdocarbon-industry-1974-2015.html accessed 2 May 2017

www.sache.org accessed 2 Jan 2015, used for SaChE

www.srai.org/wp-content/uploads/2010/06/pic2.jpg accessed 22 Jan 2015

www.toxipedia.org/download/attachments/9353/Seveso.chem.jpg?version=1&modificationDate=1238498605000&api=v2 andhttp://www.bing.com/images/search?q=Seveso+Disaster+Affected+Area&Form=IQFRDR#view=detail&id=A9CEBE175583891AADF628A0E49D369903208B4E&selectedIndex=0 accessed 22 Jan 2015

www.bing.com/images/search?q=port%20wentworth%20georgia%20feb%202008&qs=n&form=QBIR&pq=port%20wentworth%20georgia%20feb%202008&sc=0-24&sp=-1&sk=#a accessed 22 Jan 2015

www.bing.com/images/search?q=texas%20city%20mar%202005&qs=n&form=QBIR&pq=texas%20city%20mar%202005&sc=8-11&sp=-1&sk=#view=detail&id=F2A258E4AD124686AFE250ED468FBB03FA6C7066&selectedIndex=6