

THE EMERGENCE AND GROWTH OF THE ON-LINE SERIOUS GAMES AND PARTICIPATORY SIMULATION GROUP “APLSO”

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AGENDA

- What are **lean simulations** & **why are they important?** (*Introduction*)
- What have **others done** on lean simulations? (*Literature Review*)
- Why is what has been done before **insufficient?** (*Gap to Fill*)
- How did we fill the **gap?** (*Method*)
- What were the **outcomes?** (*Results*)
- What have we learned (*Conclusions*)?

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Introduction

- Lean principles can be **difficult** to grasp conceptually (Liker 2004, Tzortzopoulos et al. 2020)
- Action research of lean on construction sites is helpful, but **controlled scientific experimentation on sites is nearly impossible**, due to confounding variables.
- **Lean simulations offer the types of controlled laboratory conditions usually found in physical and biological sciences** (Rybkowski et al. 2012; Verma 2003).
- Lean simulations therefore impart an “**aha moment**” to participants and give confidence to those who teach lean (Rybkowski et al. 2020; Verma 2003)

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Literature review

- from **Academia**: Simulations are being played in lean construction courses in **universities** throughout the world. Examples of simulations that have and have been developed and tested by academic researchers include:
 - **Silent Squares** (Bavelas 1973)
 - **Parade of Trades** (Tommelein and Riley 1999)
 - **LEAPCON simulation** (Sacks 2007)
 - **Marshmallow Tower TVD simulation** (Rybkowski et al. 2016)
- from **Industry**: LCI estimated about **100 US-based construction companies** use simulations to teach lean to their employees (Kristin Hill, personal communication, February 5, 2021). Examples of simulations that have emerged from industry include:
 - **The Lego™ Airplane Game** (Visionary Products Inc. 2008)
 - **Wood Block Tower Exercise, DPR** (George Zettel, DPR, personal communication, November 2, 2020)

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Literature review

Tsao et al. (2013)

OVERVIEW Instructor	<i>U. Cincinnati</i> Tsao	<i>Arizona State</i> Mitropoulos	<i>San Diego St</i> Altes	<i>S. Illinois U.</i> Azambuja	<i>Amer. U. Beirut</i> Hamzeh	<i>Ill. Inst. Tech.</i> Manches	<i>Texas A&M</i> Rybkauski
SIMULATIONS							
5S Game							X
Airplane Game	X		X	X	X		X
Cocktail Napkin							X
Cups Game		X				X	
Delta Design	X						
Deming's Red-Bead							X
Helium Stick	X				X		
Leapcon				X		X	
Magic Tarp	X						
Maroon-White					Variant		X
Origami Game	X						
Parade Game	X	X	X	X	X	X	X
Radioactive Popcorn				X			
Silent Squares			X	X	X	X	
TVD Game							X
Win As Much As	X				X	X	

Rybkowski, Forbes, and Tsao. (2018)

OVERVIEW Instructor	<i>N Carolina St</i> Liu	<i>Virginia Tech</i> Muir	<i>Colorado St</i> Senior	<i>Michigan St</i> Abdelhamid	<i>Pittsburg St</i> Levens
SIMULATIONS					
5S Game				X	
Airplane Game	X	X		X	
Cocktail Napkin					
Cups Game					
Delta Design				X	
Deming's Red-Bead			X	X	
Helium Stick	X				
Leapcon				X	
Magic Tarp					
Maroon-White				X	
Origami Game					
Parade Game	X	X	X	X	X
Radioactive Popcorn					
Silent Squares	X	X		X	
TVD Game				X	
Win As Much As			X	X	
Additional:					
Ball Game				X	X
DPR Block Tower		X			X
Gemba Walk		X			
Last Planner (AGC)				X	
Leadership Styles				X	X
Lego Hotel/Tower				X	X
Light Fixtures			X	X	
Make-a-Card				Variant	X
Marshmallow Challenge				X	
NASA Survive/ Moon				Variant	X
No./Task Switching				X	
Oops	X				
Original Dice Game				X	
Prison Door Case				X	
Repairman					
Villego	X			X	X

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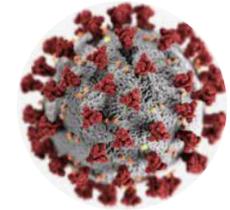
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Gap to fill

- On March 11, 2020, director general of WHO declared the spread of COVID-19 to be a **global pandemic**, transmitted to over 110 countries and territories.
- Many universities and lean consultants around the world transitioned to **on-line or hybrid** format.
- A lean consultant in Germany send an **email appeal** to educators and consultants to figure out how to take lean simulations online (Annett Schöttle, personal communication, March 21, 2020).
- The appeal represented an urgent need (gap) to fill.



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- APLSO participants decided to **meet at the same time every Monday from March 30 until the start of the fall 2020** when meetings became monthly.
- Requests to join **spread by word-of-mouth** and were directed to Texas A&M's organizer; admission was **intentionally open and welcoming**—those who showed interest were invited and given Zoom access.
- Initial efforts to create on-line collaborations were clunky or required participants to give email addresses to commercially available collaborative software (i.e. Mural™) to participate, which created objections, but as more universities and lean consultants worked remotely, more people joined.
- A breakthrough came through the collaborative use of Google Slides™
- Participants voted on rules: (a) all presentations must be interactive (no straight “lecture” allowed) and (b) no recording was allowed, as the purpose of APLSO was to create a testing platform for experimentation and psychological safety was important.
- The organizer started meeting with facilitators the week prior to Monday sessions to conduct first-run studies with the organizing team.

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- Only one facilitation per session, and each facilitation was allocated 90 minutes, with last 15 minutes for Plus-Delta from the participants so facilitators could iteratively improve.

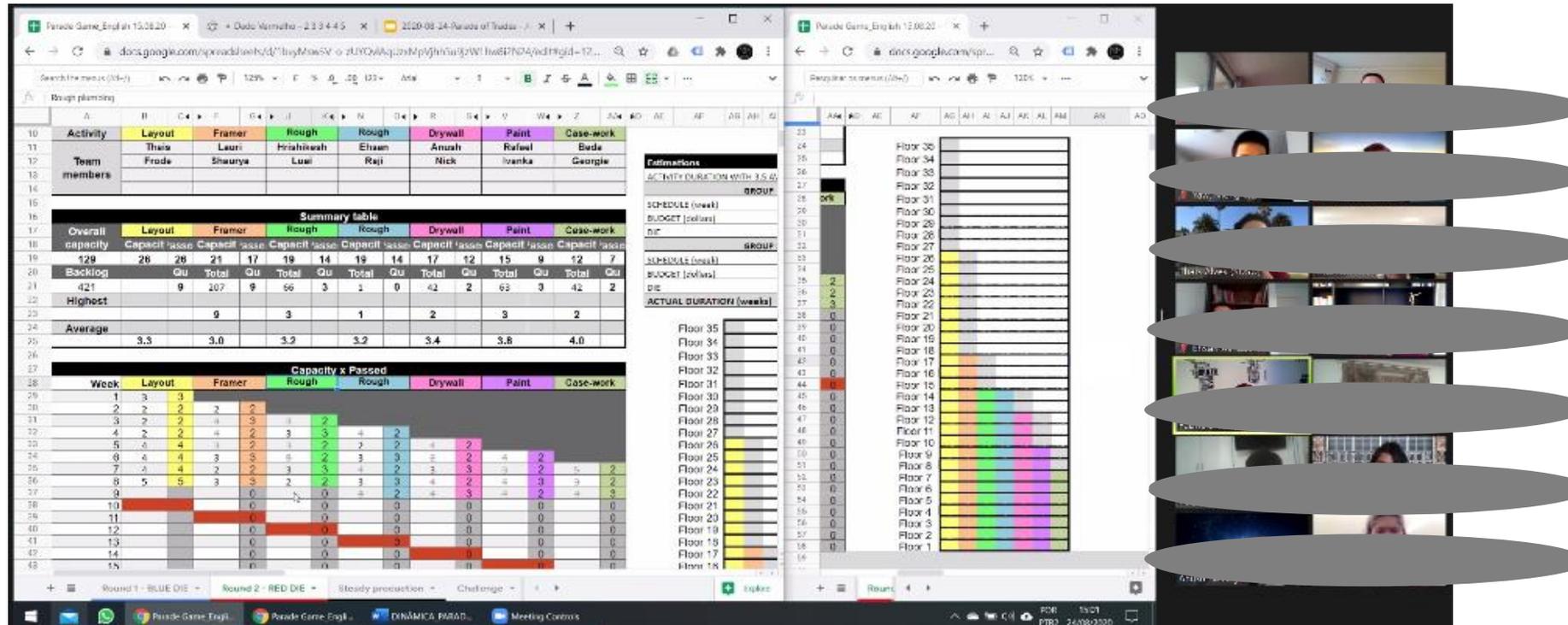


Figure 3: Example of APLSO Simulation Facilitated during APLSO (Parade of Trades, facilitated by Cynthia Tsao and Colin Milberg on August 24, 2020)

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APLSO Presentations

Table 1: APLSO Facilitators, their Affiliations, and their Presentations listed by Date

Date	Facilitator	Affiliation	Simulation
03/30/20	Zofia Rybkowski	Texas A&M Univ., TX USA	Maroon-White Game
04/06/20	Thais Alves	San Diego State Univ., CA USA	Architectural Programming Simulation
04/13/20	Colin Milberg	ASKM Associates, MA USA	Parade of Trades (using Mural)
04/20/20	Alan Mossman	The Change Business Ltd., UK	Repair Co Exercise
04/27/20	Paul Ebbs	WSP, QATAR	Introduction to 8 flows
05/04/20	Zofia Rybkowski	Texas A&M Univ., TX USA	Choosing By Advantages
05/11/20	Paul Ebbs	WSP, QATAR	8 flows virtual simulation (cont'd)
05/18/20	Alan Mossman	The Change Business Ltd., UK	List of gaming needs
05/25/20	Colin Milberg	ASKM Associates, MA USA	Batch-Balance-Pull (using Mural Software); Sim. to Lego Airplane simulation
	Annett Schöttle	Refine, GERMANY	
06/01/20	Ehsan Asnaashari	Nottingham Trent Univ., UK	House of Cards
06/08/20	Farook Hamzeh and Salam Khalife	Univ. of Alberta, CANADA	Value capture and value management
06/15/20	Min Liu	North Carolina State Univ., NC USA	Oops Game
06/22/20	Meng Wai ("Nick") Yaw	Texas A&M Univ., TX USA	Multi-skilling game

(cont.)

06/29/20	Hrishikesh Joshi Anush Neeraj	DCEC, Baroda, INDIA Studio Atmosis, Utter Pradesh, INDIA	5S Numbers Game
07/06/20		IGLC28 Conference: APLSO not held	
07/13/20	Alan Mossman	The Change Business Ltd., UK	Discussion about current state of gaming
07/20/20	Romano Nickerson	Boulder Associates, CO USA	DPR Block Game
07/27/20	Zofia Rybkowski and Ratnaprabha Borkar	Texas A&M Univ., TX USA	Set Based Design
08/03/20	Thais Alves	San Diego State Univ., CA USA	Silent Squares
08/10/20	Iris Tommelein, with Rafael Vigarío Coelho, Vishesh Vikram Singh, Sulyn Gomez Villanueva, and Karilin Yfu	Univ. of California, Berkeley, CA USA	Mistakeproofing
08/17/20	Colin Milberg	ASKM Associates, MA USA	PDCA/ Kata game
08/24/20	Cynthia Tsao Fernanda Saidelles Bataglin, Dani Dietz, and Fabricio Vargas	Navilean, MA USA Federal Univ. of Rio Grande do Sul (UFRGS), BRAZIL	Parade of Trades
08/31/20	Ganesh Devkar with Shaurya Bhatnagar, Nimish Sharma, and Georgie Jacob	CEPT Univ., Ahmedabad, INDIA	Pass the Pennies
09/07/20	Paz Arroyo	DPR, CA USA	Choosing by Advantages
10/05/20	Cynthia Tsao	Navilean, MA USA	BBQ pull
11/02/20	Daniel Hall with Ming Shan "Charmaine" Ng	ETH Zurich, SWITZERLAND	TVD simulation
12/07/20	Ganesh Devkar, with Shaurya Bhatnagar, Georgie Jacob, and Nimish Sharma	CEPT Univ., Ahmedabad, INDIA	TVD simulation
01/04/21	Cynthia Tsao	Navilean, MA USA	Parade of Trades: Part I
02/01/21	Cynthia Tsao	Navilean, MA USA	Parade of Trades: Part II
03/01/21	Rajeswari Obulam	Texas A&M Univ., TX USA	5S Puzzle Game

*For a compilation of these simulations and related references, please refer to Rybkowski et al. (2020).

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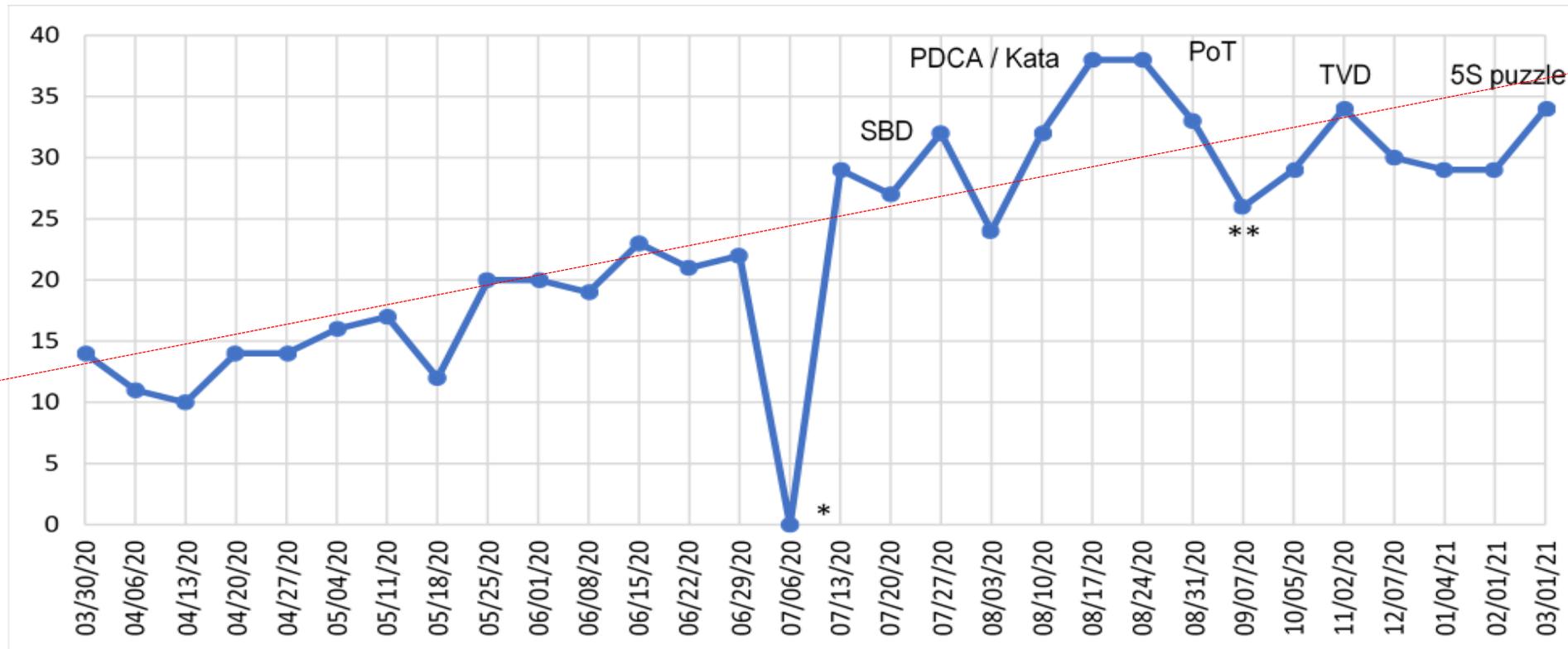
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Numbers of Unique Participants over Time



* APLSO meeting not held during IGLC 28; instead, on-line Greg Howell simulation sessions offered during IGLC

** APLSO transitioned from weekly to monthly meetings to accommodate academic schedules

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Participation
by
research institutes
& universities

Table 3: Participation by Research Institutes and Universities

Affiliation	Country	Freq.	Affiliation	Country	Freq.
The University of Melbourne	<i>Australia</i>	1	Nottingham Trent University	<i>UK</i>	1
University of Technology, Sydney	<i>Australia</i>	1	University College London	<i>UK</i>	1
Federal University of Rio Grande do Sul (UFRGS)	<i>Brazil</i>	3	University of Huddersfield	<i>UK</i>	4
Universidade Paranaense	<i>Brazil</i>	1	Arizona State University	<i>USA</i>	1
École de Technologie Supérieure	<i>Canada</i>	1	Brigham Young University	<i>USA</i>	1
University of Alberta	<i>Canada</i>	3	Catholic University of America	<i>USA</i>	1
University of Toronto	<i>Canada</i>	1	Colorado State University	<i>USA</i>	1
FEUC - Federación de Estudiantes de la Universidad Católica	<i>Chile</i>	1	Florida International University	<i>USA</i>	1
Pontificia Universidad Católica de Chile	<i>Chile</i>	1	George Mason University	<i>USA</i>	1
Aalto University	<i>Finland</i>	2	Michigan State University	<i>USA</i>	2
Centrale Lille, a French Graduate Engineering School	<i>France</i>	1	North Carolina State University	<i>USA</i>	3
Karlsruhe Institute of Technology	<i>Germany</i>	1	Northern Arizona University	<i>USA</i>	4
CEPT University	<i>India</i>	4	San Diego State University	<i>USA</i>	1
American University of Beirut	<i>Lebanon</i>	2	Texas A&M University	<i>USA</i>	17
Auckland University of Technology	<i>New Zealand</i>	1	UC Denver	<i>USA</i>	1
University of Auckland	<i>New Zealand</i>	2	University of California, Berkeley	<i>USA</i>	6
Norwegian University of Science and Technology	<i>Norway</i>	1	University of Kentucky	<i>USA</i>	2
ETH Zurich (Swiss Federal Institute of Technology)	<i>Switzerland</i>	2	University of Oklahoma	<i>USA</i>	1
Huddersfield University / Birmingham City University	<i>UK</i>	1	Virginia Tech	<i>USA</i>	1
Total # of Universities					38
Total # of Academic					80

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Participation by country (115 total participants, 38 universities in 17 countries)



Figure 1: Location of Registered, Unique Participants

Table 2: Unique Registered Participants by Country and Type of Occupation

Country	R/U	C	Total	Country	R/U	C	Total
USA	43	19	62	Finland	2		2
Canada	5	4	9	Lebanon	2		2
UK	7	2	9	Switzerland	2		2
India	6	3	9	Denmark		1	1
New Zealand	3	3	6	France	1		1
Brazil	4		4	Germany		1	1
Australia	2		2	Italy	0	1	1
Chile	2		2	Norway	1		1
				Qatar		1	1
R/U:	Research Institute/ University				80	35	115
C:	Company/ Consultancy				70%	30%	100%

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- The purpose of this paper was to **document and share** the inception, growth, outcomes, and impacts of an **international on-line simulation group** called APLSO (Administering and Playing Lean Simulations Online) which emerged during the COVID-19 pandemic.
- In total, 39 faculty members, 41 graduate students, and 35 individuals from companies/consultancies (i.e. **115 participants** total) from consultancies and **38 universities** in **17 countries** have thus far participated in the APLSO sessions.
- APLSO also led to some **unexpected outcomes**, such as an invitation from the IGLC organizers to create a number of on-line game rooms for the first time during the conference, as well as an initiative from LCI to partner with several APLSO facilitators to convert on-line simulations into dedicated educational offerings.
- The agenda of APLSO was simple—to regularly make available a **90-minute interactive session** where lean enthusiasts could collaboratively test simulations they had developed with participants who care about lean—and in turn receive their feedback.
- **Respect for people is a key tenet of lean.** Organizers believe that creating an **open, inviting, safe, and inclusive research community dedicated to continuous improvement** that embraces **multiple cultures and time zones** has contributed to its growth.

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THANK YOU!

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