IGLC IRELAND 2019
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION
DUBLIN | IRELAND | 1ST – 7TH JULY 2019

PAPER 219

CAPABILITY-BUILDING COMPETITION IN CONSTRUCTION: CASE STUDY REINTERPRETATION

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PART 1

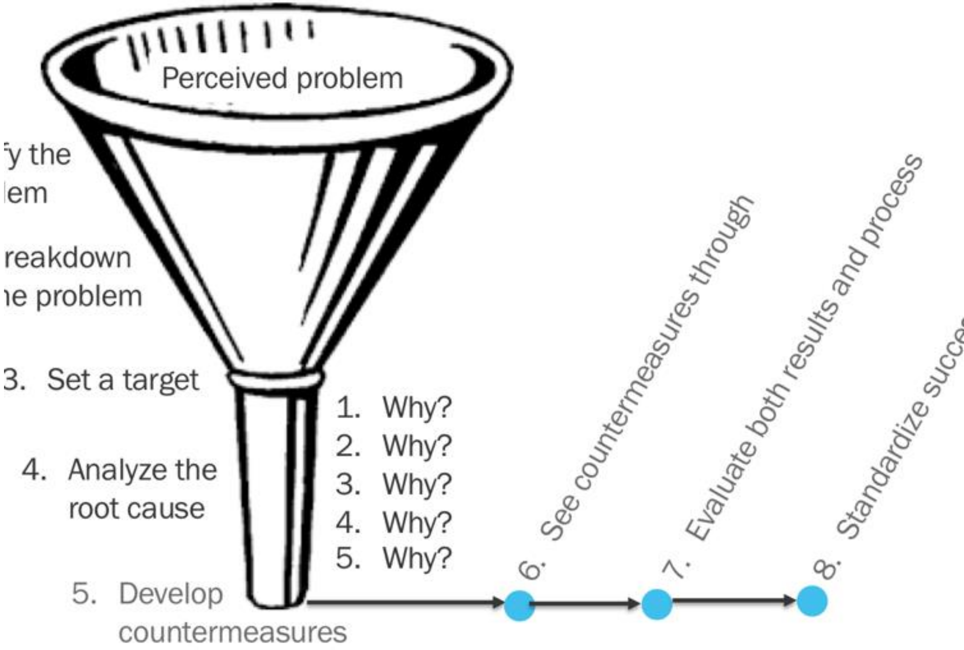
CASE STUDY: EXTERIOR WALL PRE-FABRICATION

ARGUMENTS FOR AND AGAINST X-WALL PRE-FABRICATION

Against	For
the team had never installed without scaffold; architectural design did not accommodate this approach	If we don't do it because we have never done it, then we will never do it
there was not enough time to develop this alternative and meet schedule	having never done it we cannot determine if architectural design does or does not accommodate this new approach
they could not prove in advance that it cost would be lower or neutral, nor that it would be faster	project schedule showed nine months before start of X-wall activities
scaffold was already in the budget – so why not use it?	we'll never know if is not cheaper or faster if we do not try this at least once
developing a new approach would involve lots of work, and what if they failed?	budget saved by not using scaffold can be used by the customer for additional value
	yes, it will involve lots of work

KNOWLEDGE & INFORMATION

From Problem-Solving



yota 8-step structured problem-solving method

Project Descriptions

ID	Date	Name	Description
1	2010	U of A HSEB Medical School	6-story 270,000 square foot medical school building
2	2012	Banner MD Anderson Cancer Center 2	3-story project prefabricated two elevations
3	2012	SkySong 3	4-story project prefabricated all elevations
4	2015	SkySong 4	4-story project prefabricated all elevations and set up the fabrication shop on top of a nearby parking garage due to lack of space
5	2016	U of A BSPB	10-story project prefabricated all elevations. Team introduced quality checks at every step of fabrication. Each panel was water tested prior to hoisting. Pre-concrete pour and post pour scanning were used to greatly improve quality and reduce defects
6	2018	Banner Patient Tower	19-story; pre-fabrication process was very well defined at this point and it was a major contributor to that very successful project

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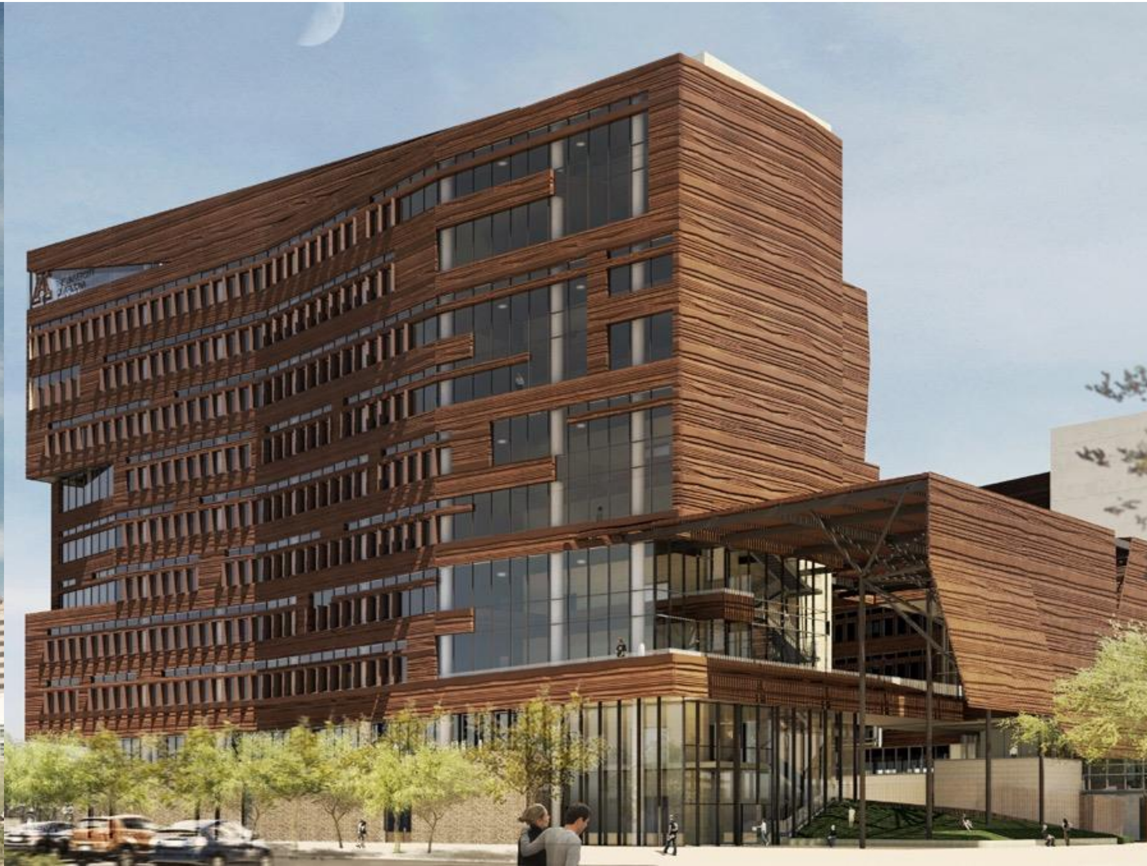
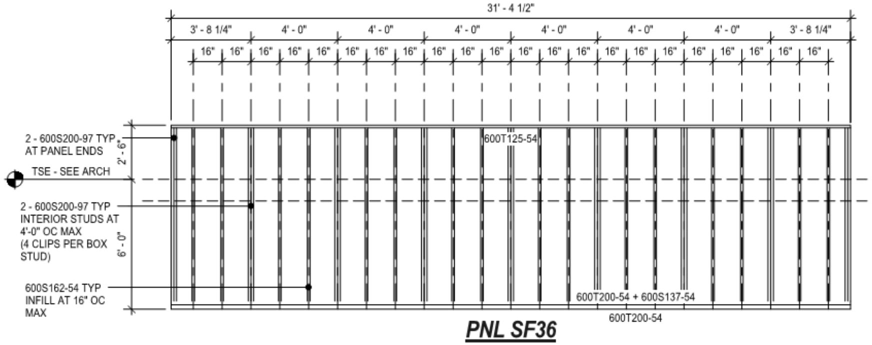


PROJECT # 5: UNIV OF ARIZONA BSPB

- 400 prefabricated, cold form exterior panel sections
- 100 HSS framed panels.
- Panels include sheathing, air/water barrier, z girts and insulation.
- 4985 Copper Panels
- 1843 custom, one off panels
- 33% more copper than HSEB
- 40,005 square feet of glazing.
- 3500 square feet of precast concrete canted panels
- Masonry and Cor-Ten steel.

PROJECT # 5: PROCESS OVERVIEW

- DPR and DPR Drywall decide to prefab entire exterior envelope
- Design coordination with DPR, DPR Drywall, CO, MBJ, Kovach and KT Fab to get to constructible design
- Construction coordination between DPR, Kovach, KT Fab and MBJ. Multiple models coming together.
  - Structural, Z Girt, Glazing
- Final fabrication sheets for panels and z girts created.
- Panels go into production.


31' - 4 1/2"
3' - 8 1/4"
4' - 0"
16"
2 - 600S200-97 TYP AT PANEL ENDS
TSE - SEE ARCH
2 - 600S200-97 TYP INTERIOR STUDS AT 4'-0" OC MAX (4 CLIPS PER BOX STUD)
600S162-54 TYP INFILL AT 16" OC MAX
2' - 6"
6' - 0"
600T125-54
600T200-54 + 600S137-54
600T200-54
PNL SF36


GRACE

- Root Cause: Severe weather, inadequate fasteners into the asphalt.
- Lessons Learned: Engineering design of panel staging area.

panels were standing normal at 5:15am

- Chamber test systems
- Aesthetic Review of new details
- Constructability
- Craftsmen install quality expectation

- Challenge: Overhead formwork walkway above limiting access to slab edge below.
- Solution: Barnhart cantilevered rigging arm.

Layout Studs vs Flashing Depth

- Challenge: Multiple flashing depths.
- Lesson Learned: Coordinate layout studs with flashing jamb depth.

Cold Form Structural Clip Limitations

- Issue: Slab edge out of tolerance.
- Correction: Have EOR provide alternate details early in design.

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Ongoing Overhead Work

- Issue: Ongoing overhead work above exterior trades.
- Solution: Speed Fans netting.

ADDITIONAL LESSONS LEARNED

- Panel strapping vs. clip locations.
- Tower crane weight capacity and sizing of panels – Removed weight and pre stage panels.
- Managing tight logistics onsite to enable onsite fabrication
- Cold Form Engineer and Designer quit midway through design.
- Mock up anchors/clips install into slab to ensure the substrate is compatible.
- Optimize crew sizes.

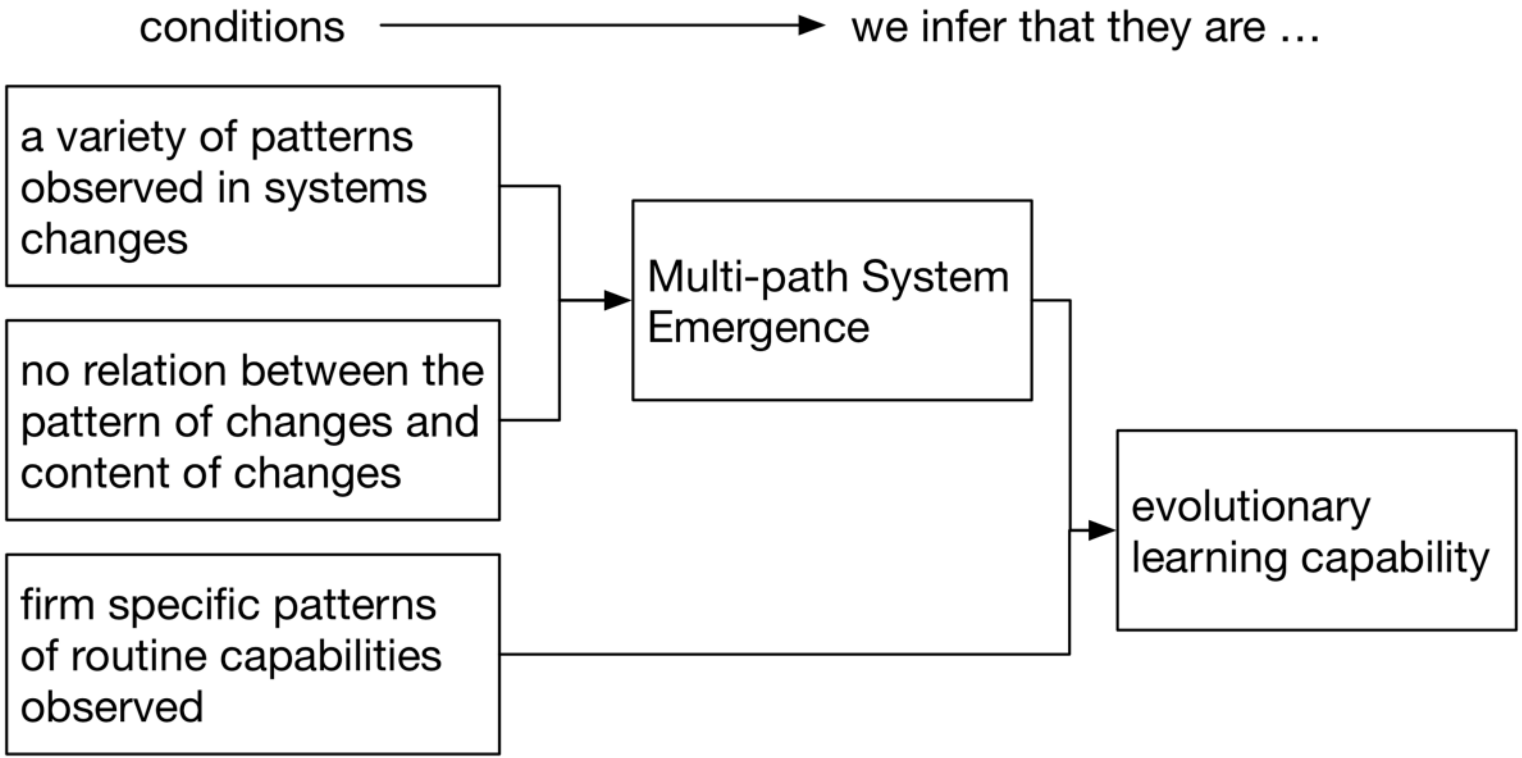
PART 2

THEORY OF CAPABILITY-BUILDING COMPETITION

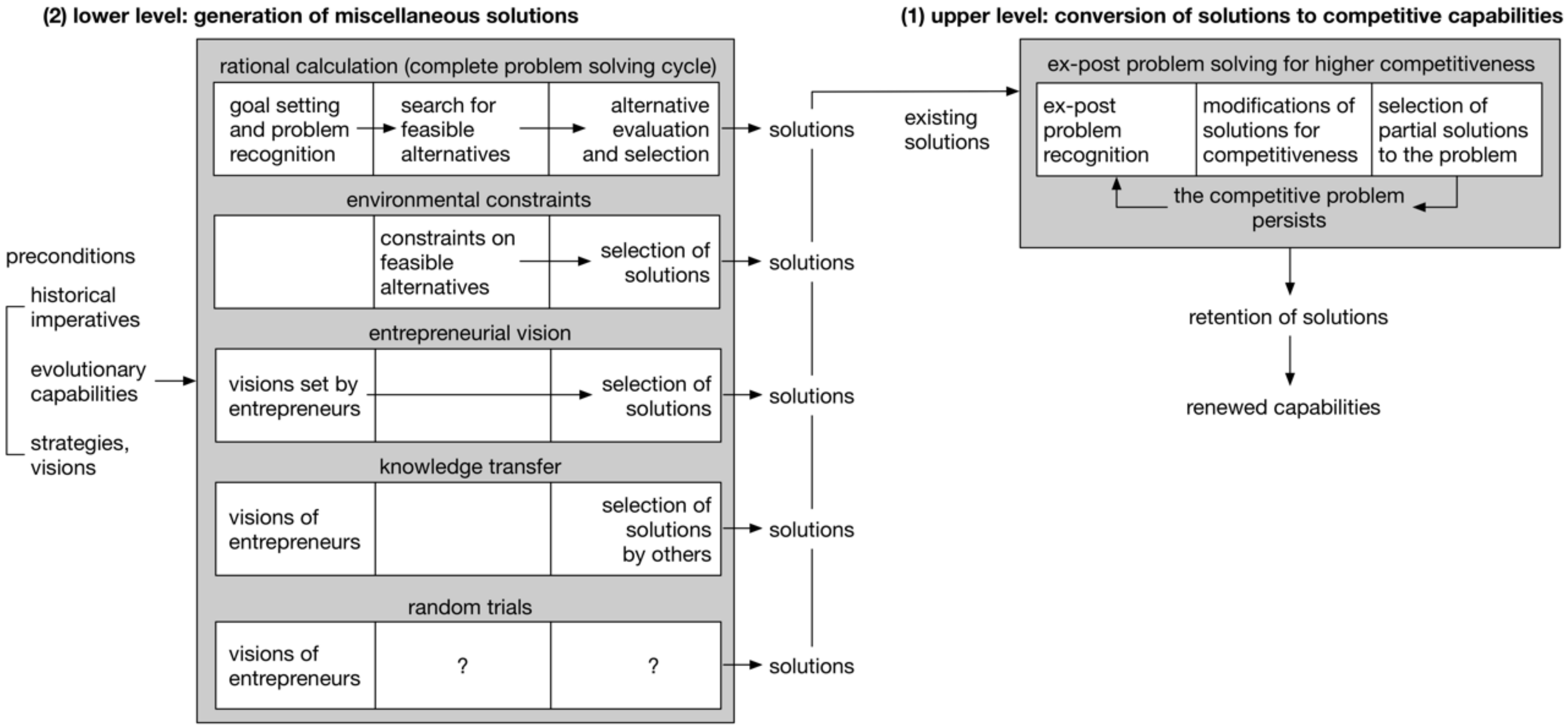
Three Levels of Manufacturing Capability

Capability Level	Basic Nature	Influence	Characteristics
1. Routinized manufacturing capability	Static & routine	Competitive performance in stable environment	Firm-specific pattern of a steady-state information system in terms of efficiency and accuracy of repetitive information transmission
2. Routinized learning	Dynamic & routine	Changes or recoveries of competitive performance	Firm-specific ability of handling repetitive problem-solving cycles or a routinized pattern of system changes
3. Evolutionary learning	Dynamic & non-routine	Changes in patterns of routine capability	Firm-specific ability of handling system emergence or non-routine patterns of system changes in building routine capabilities

Multi-path System Emergence & Evolutionary Learning Capability



Dual-Layer Problem-Solving



PART 3

CASE STUDY REINTERPRETATION

Competitiveness of Routines

ID	Project	1	2	3	4	5	6
	Routines & Improvement in Competitiveness						
1	As-Built Scanning	10%	20%	20%	20%	30%	30%
2	Fabrication Drawings	10%	20%	20%	20%	30%	40%
3	Fab Shop	15%	15%	15%	25%	30%	30%
4	Pull Production Schedule	10%	20%	20%	20%	25%	30%
5	Panel Production	15%	35%	70%	70%	50%	70%
6	Quality at the Source	0%	0%	0%	0%	40%	15%
7	Rigging & Hoisting	5%	10%	10%	20%	40%	40%
8	Install	10%	20%	20%	20%	40%	60%
9	Pre-Pour Scan	0%	0%	0%	0%	15%	0%
10	Post Pour Scan	0%	0%	0%	20%	40%	15%
	Improvement in Project Competitiveness	75%	140%	175%	215%	340%	330%

Multi-path System Emergence & Evolutionary Learning Capability

Project	P-S	EC	EV	KT	RT	PRC	ELC
1	90%	20%	30%	0%	10%	0%	0%
2	70%	10%	0%	70%	0%	14%	10%
3	70%	10%	10%	70%	0%	28%	30%
4	80%	20%	20%	80%	0%	46%	20%
5	100%	20%	30%	80%	20%	64%	90%
6	90%	20%	20%	80%	20%	84%	80%

Competitiveness of Routines Analysis –U of A BSPB

ID	Scores Routines	Safety # (0-5)	Safety % Wt. = 25%	Quality # (0-5)	Quality % Wt. = 25%	Schedule # (0-5)	Schedule % Wt. = 25%	Cost # (0-5)	Cost # Wt. = 25%	U of A BSPB Biomed Research
1	As-Built Scanning	0	0%	3	15%	3	15%	0	0%	30%
2	Fabrication Drawings	0	0%	3	15%	3	15%	0	0%	30%
3	Fab Shop	1	5%	2	10%	3	15%	0	0%	30%
4	Pull Production Schedule	2	10%	0	0%	3	15%	0	0%	25%
5	Panel Production	2	10%	3	15%	5	25%	0	0%	50%
6	Quality at the Source	0	0%	5	25%	2	10%	1	5%	40%
7	Rigging & Hoisting	4	20%	0	0%	4	20%	0	0%	40%
8	Install	4	20%	0	0%	4	20%	0	0%	40%
9	Pre-Pour Scan	0	0%	0	0%	0	0%	3	15%	15%
10	Post Pour Scan	0	0%	3	15%	0	0%	5	25%	40%
Improvement in Project Competitiveness			65%		95%		135%		45%	340%

Multi-path System Emergence & Evolutionary Learning Capability Analysis

Routine	P-S (Y/N)	EC (Y/N)	EV (Y/N)	KT (Y/N)	RT (Y/N)	Paths Total	PRC (0-5)	ELC (Y/N)
As-Built Scanning	1	1	0	1	0	3	4	1
Fabrication Drawings	1	0	0	1	0	2	4	1
Fab Shop	1	1	0	1	0	3	4	1
Production Scheduling	1	0	0	1	0	2	4	1
Panel Production	1	0	0	1	0	2	4	1
Quality at the Source	1	0	0	0	1	2	0	0
Rigging & Hoisting	1	0	1	1	1	4	4	1
Install	1	0	0	1	0	2	4	1
Pre-Pour Scan	1	0	1	0	0	2	0	1
Post Pour Scan	1	0	1	1	0	3	4	1
As-Built Scanning	1	1	0	1	0	3	4	1
% of Path Use in All Routines	100%	20%	30%	80%	20%	%PRC %ELC	64%	90%

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A FIRST CASE STUDY REINTERPRETATION