

TOWARD LEAN MANAGEMENT FOR A REVIEW OF DIGITAL SHARED PRACTICES OF LEAN, DfMA AND DFAB

Ming Shan NG, PhD student and **Daniel M. HALL**, Assistant

Professor ETH Zürich Dept. of Civil, Environmental and Geomatic Engineering

Institute of Construction and Infrastructure
Management Chair of Innovative and Industrial
Construction

PRESENTATION OUTLINE

PROBLEMS & MOTIVATION

STATE-OF-THE-ART

RESEARCH QUESTIONS

METHODOLOGY

FINDINGS

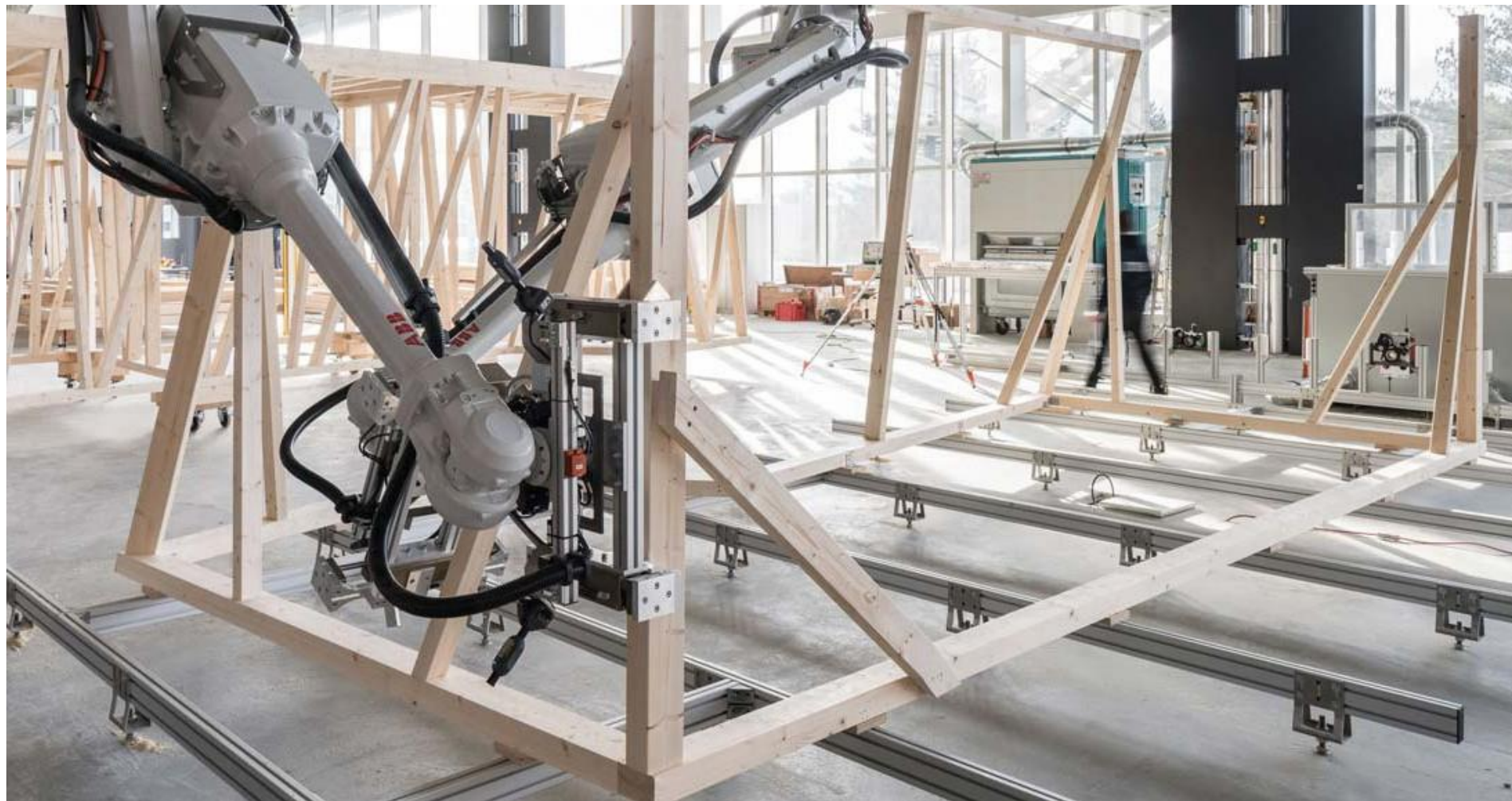
DISCUSSION

FUTURE

RESEARCH

CONCLUSION

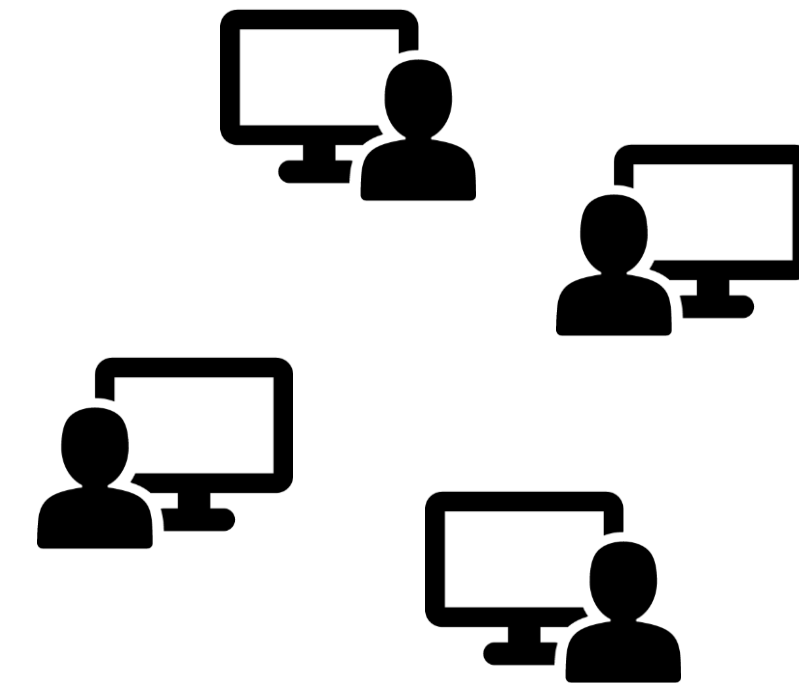
PROBLEMS &



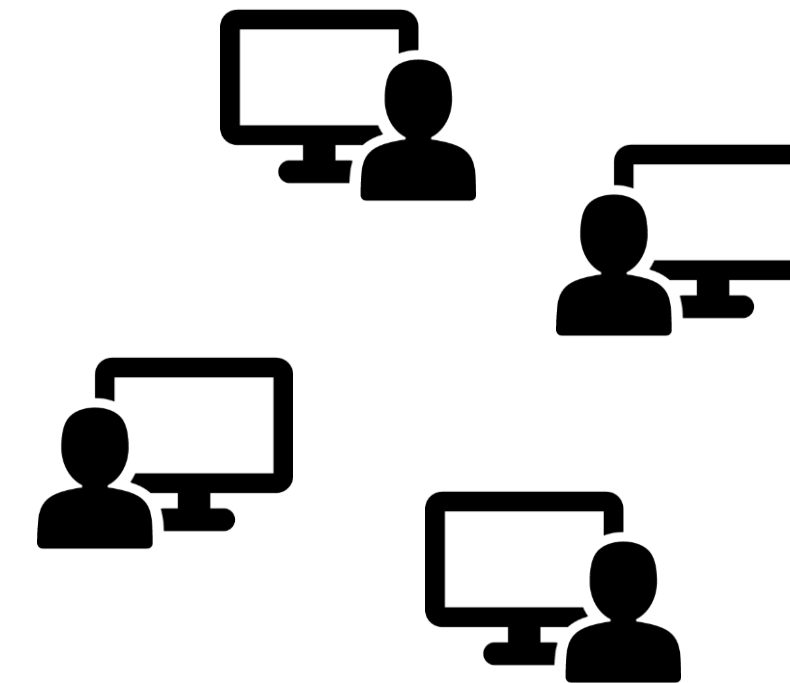
PROBLEMS & MOTIVATION



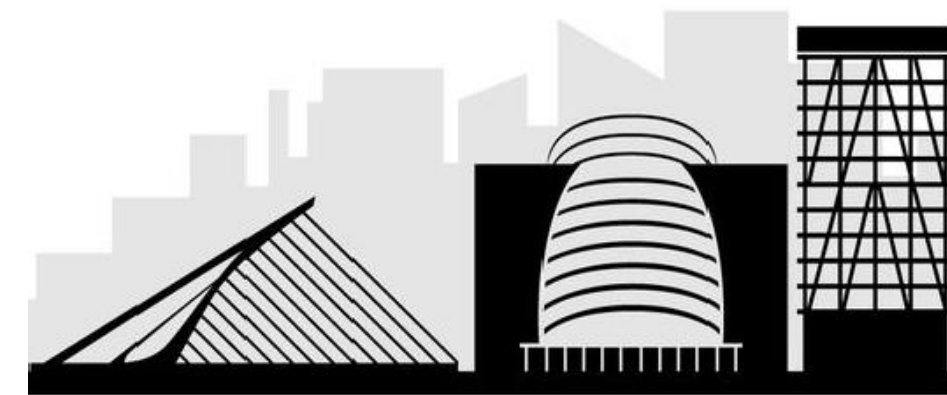
PROBLEMS & MOTIVATION



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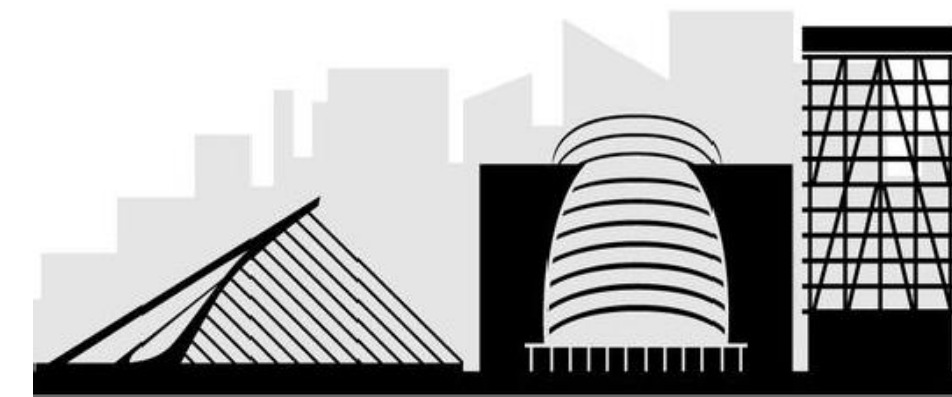


PROBLEMS & MOTIVATION



LEAN

DfMA



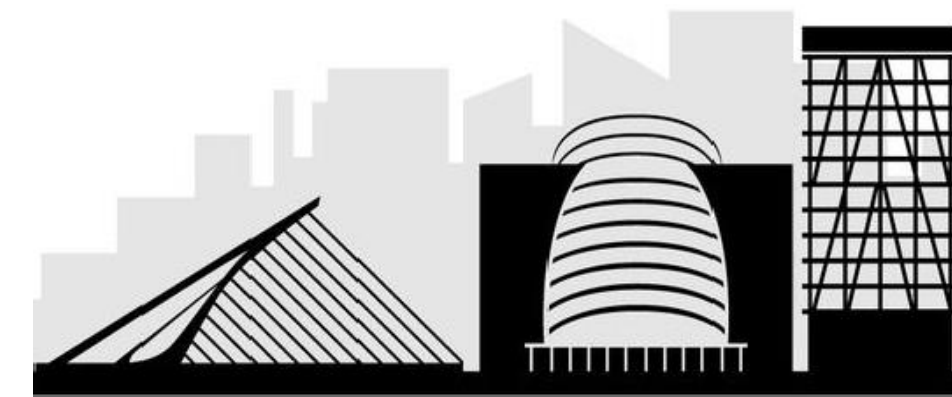
PROBLEMS & MOTIVATION



LEAN

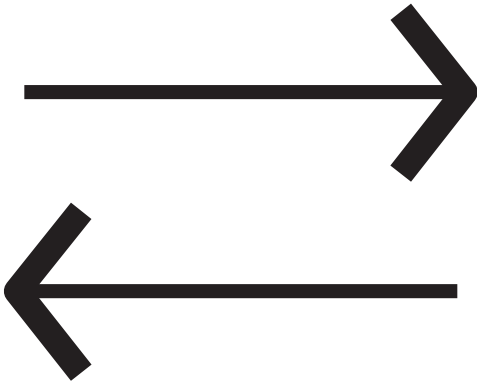
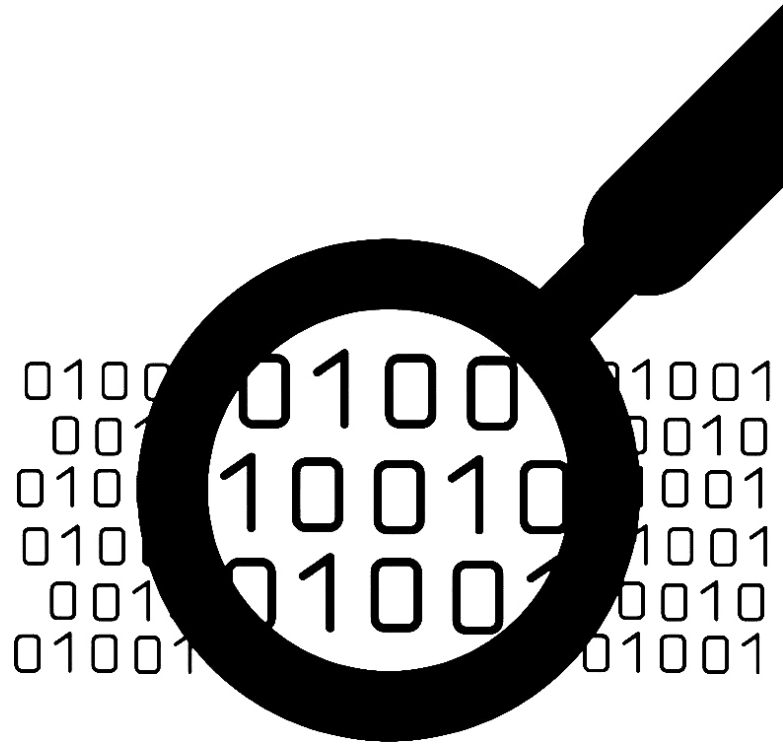
DfMA

DFAB



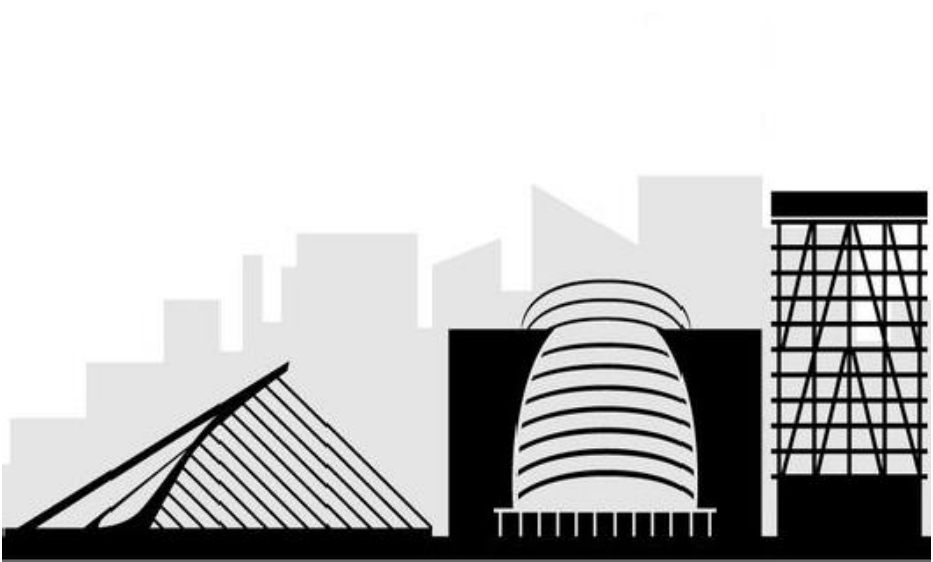
Gershenfeld, N. (2012). "How to make almost anything: the Digital Fabrication Revolution." *Foreign Affairs*, 91(6), 43-57.

DATA



STATE-OF-THE-ART

THINGS



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Bonwetsch, T. (2012). "Robotic Assembly Processes as a Driver in Architectural Design." *Nexus Network Journal*, 14(3), 483-494.

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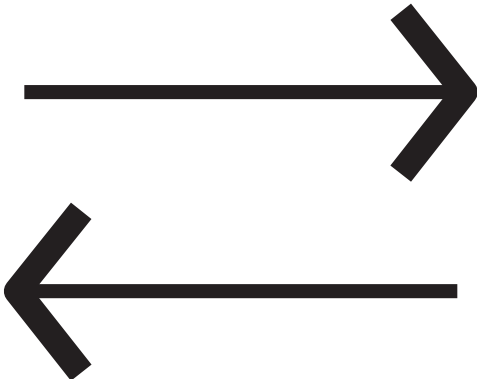
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Buswell, R.A., Soar, R.C., Glbb, A.G.F. and Thorpe, A. (2007). "Freeform Construction: Mega-scale Rapid Manufacturing for construction." *Automation in Construction*, 16, 224-231.

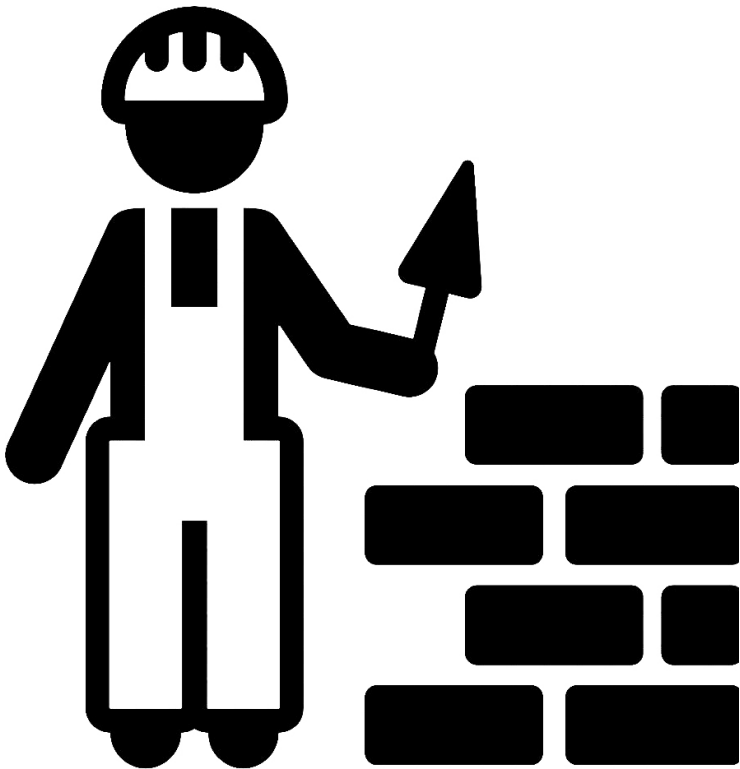
Egan, J. (1998). Rethinking Construction. *The Report of the Construction Task Force*, London, U.K.

STATE-OF-THE-ART

DATA



THINGS

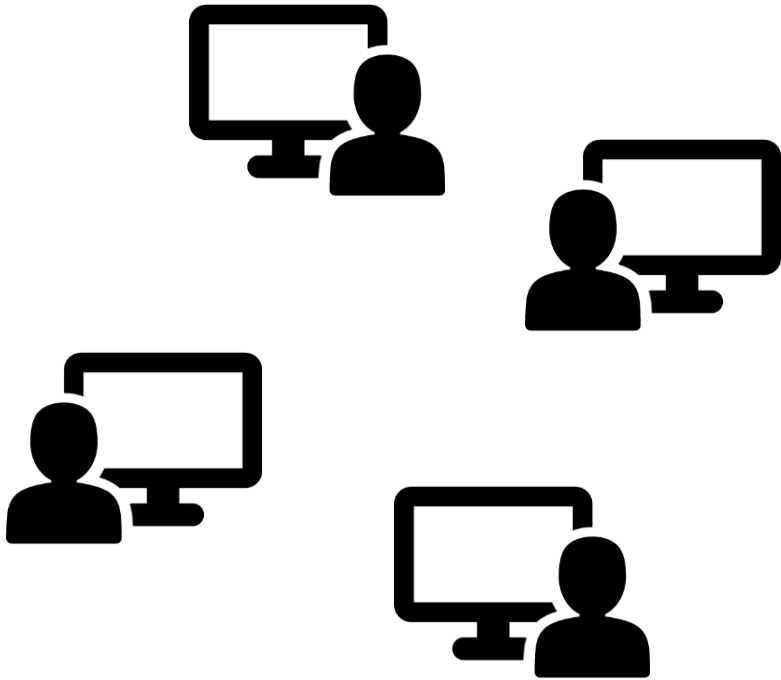


DESIGN

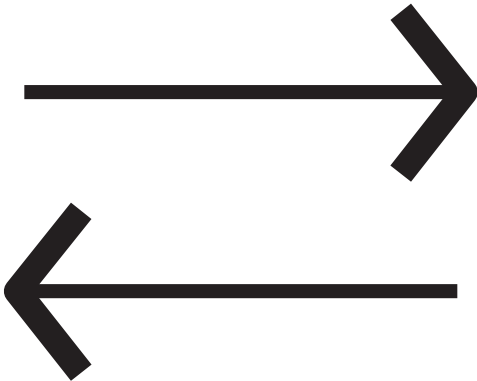
CRAFTMANSHIP

Gershenfeld, N. (2012). "How to make almost anything: the Digital Fabrication Revolution." *Foreign Affairs*, 91(6), 43-57.
Bock, T. (2004). "Construction robotics and automation: past-present-future." In: *Proc. Automation Congress*, World 15, 287-294.
Bonwetsch, T. (2012). "Robotic Assembly Processes as a Driver in Architectural Design." *Nexus Network Journal*, 14(3), 483-494.

DATA

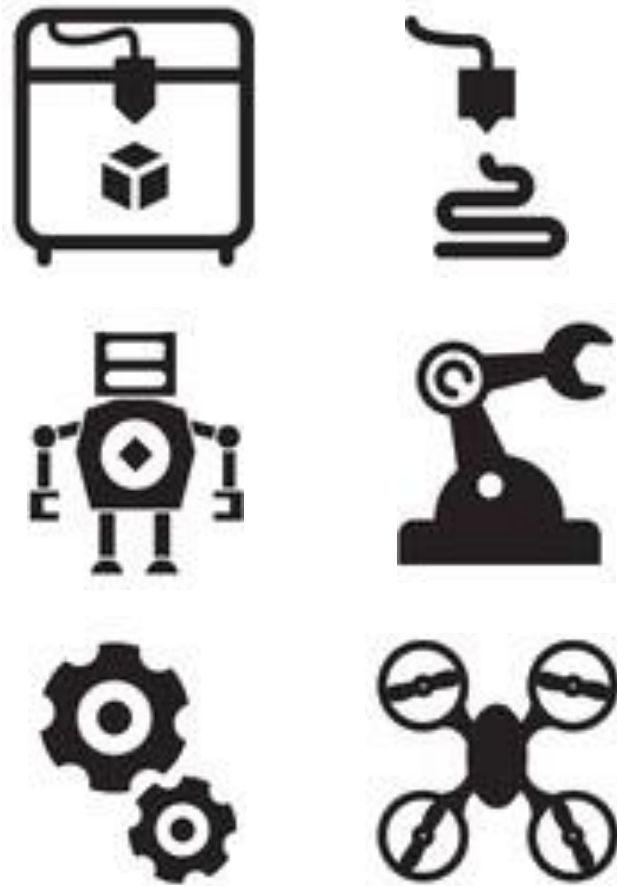


CAD



STATE-OF-THE-ART

THINGS

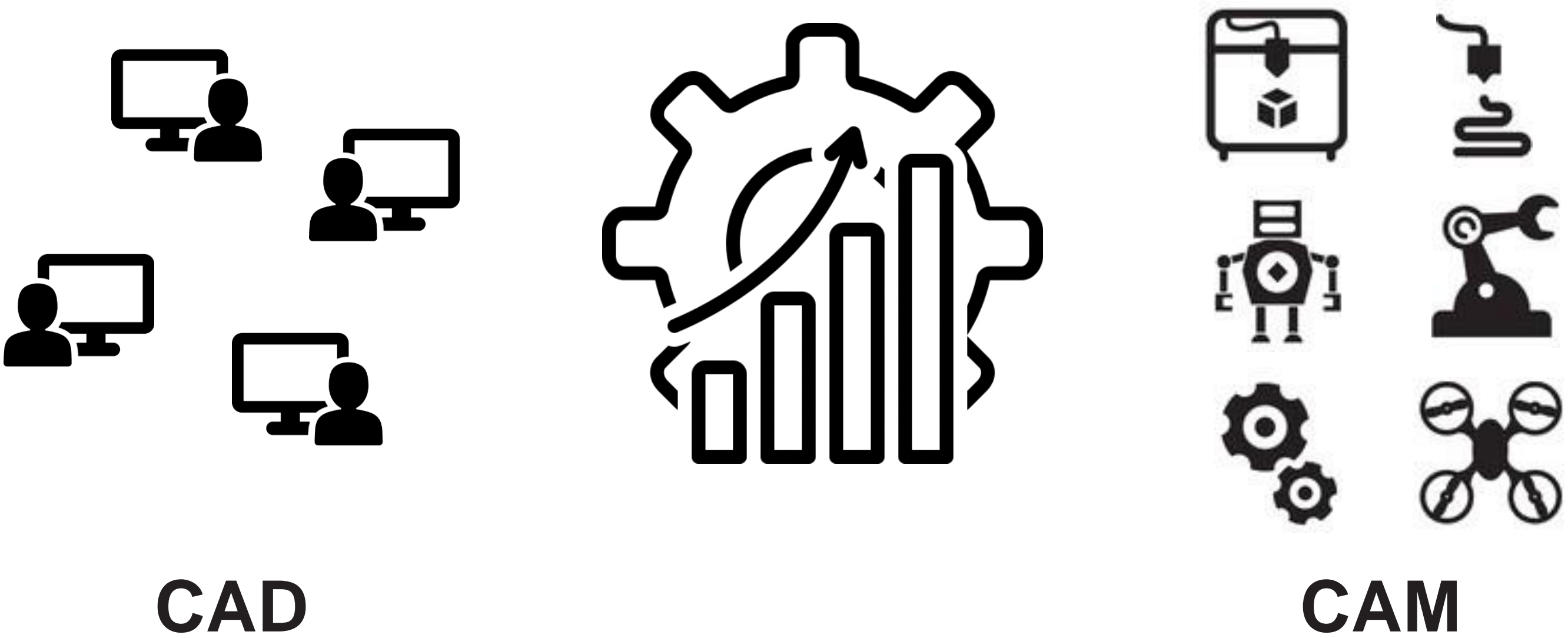


CAM

de Soto, B.G., Augstí-Juan, I., Hunhevicz, J., Joss, S., Graser, K., Habert, G. and Adey, B.T. (2018a). "Productivity of digital fabrication in construction: Cost and time analysis of a robotically built wall." *Automation in Construction*, 92, 297-311. Bock, T. (2004). "Construction robotics and automation: past-present-future." In: *Proc. Automation Congress*, World 15, 287-294.

STATE-OF-THE-ART

QUALITY, PRODUCTIVITY, ROI



Koskela, L. and Howell, G.A. (2002). "The theory of project management: explanation to novel methods." In: *Proc. 10th Ann. Conf. of the Int'l. Group for Lean Construction*, Gramado, Brazil, 6-8. Womack, James P. and Jones, Daniel T. (1996). *Lean Thinking*. Simon & Schuster, New York, U.S.
Ballard, G. and Koskela, L. (1998). "On the agenda of Design management research." In: *Proc. 6th Ann. Conf. of the Int'l. Group for Lean Construction*, Guarujá, Brazil, 13-15.

STATE-OF-THE-ART

VALUE-ADDING

WASTE REDUCTION

**SUPPLY-CHAIN
INTEGRATION**

**EARLY
STAKEHOLDER'S
INVOLVEMENT**

QUALITY IMPROVEMENT

STATE-OF-THE-ART

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Miron, L.I.G., Kaushik, A. and Koskela, L. (2015). "Target Value Design: The Challenge of Value Generation." In: *Proc. 23rd Ann. Conf. of the Int'l. Group for Lean Construction*, Perth, Australia, 815-825.

Kim, Y. and Lee, H.W. (2010). "Analyzing User Costs in a Hospital: Methodological Implication of Space Syntax to Support Whole-Life Target Value Design." In: *Proc. 18th Ann. Conf. of the Int'l. Group for Lean Construction*, Haifa, Israel, 93-102.

VALUE-ADDING

WASTE REDUCTION

CONCURRENT
ENGINEERING

SUPPLY-CHAIN
INTEGRATION

SET-BASED DESIGN

EARLY
STAKEHOLDER'S
INVOLVEMENT

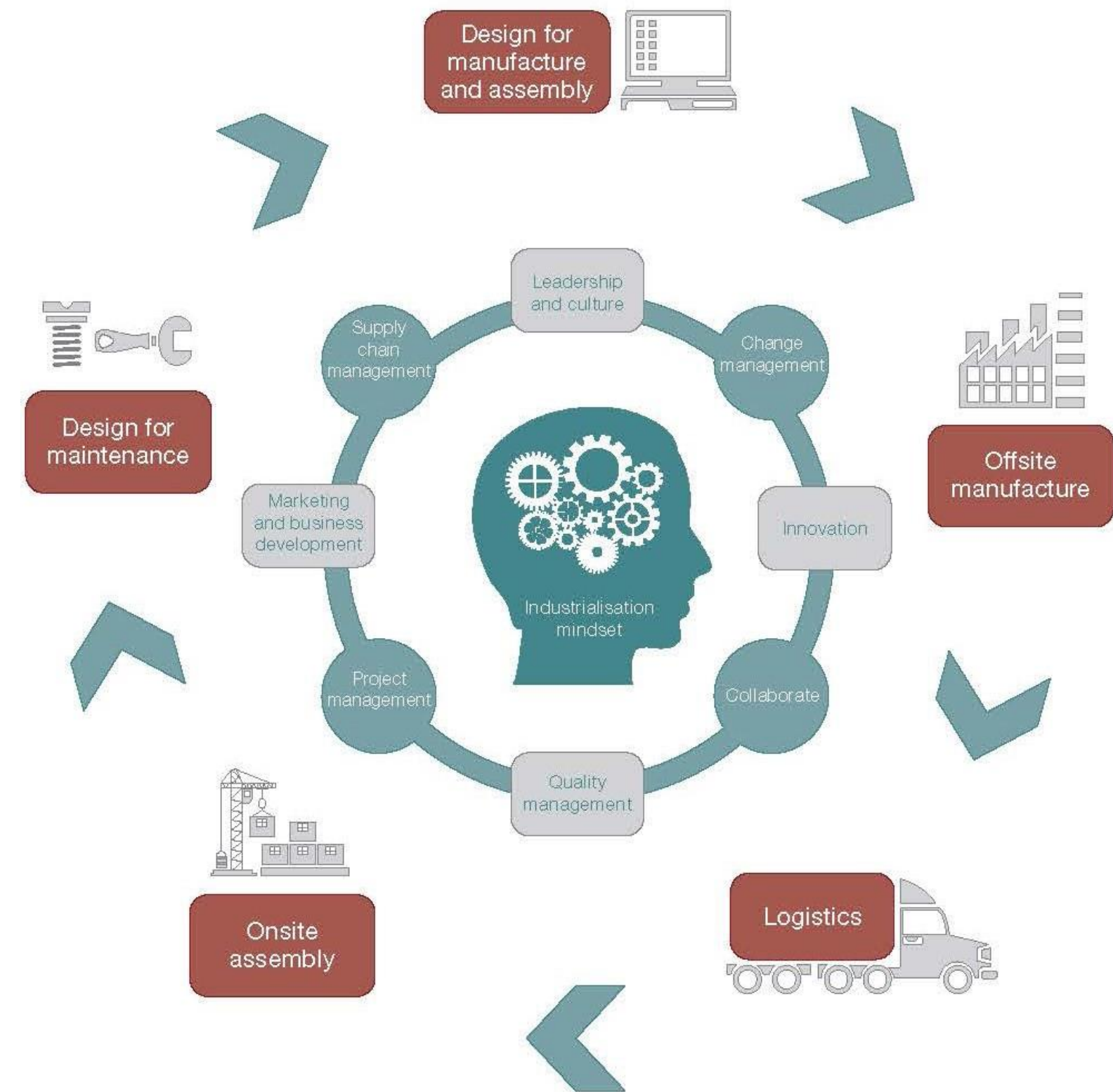
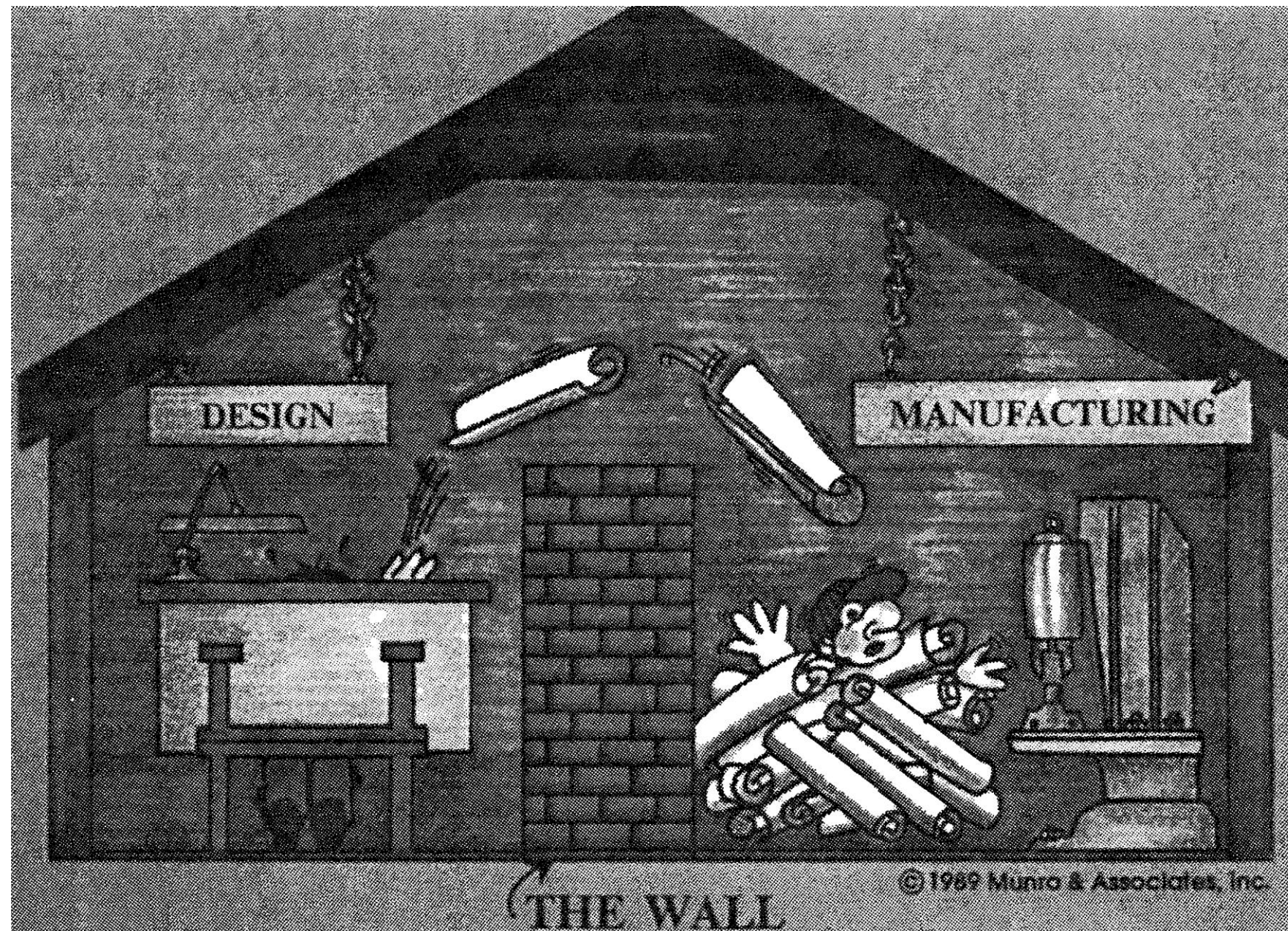
CHOOSING BY ADVANTAGE

TARGET VALUE DESIGN

QUALITY IMPROVEMENT

STATE-OF-THE-ART

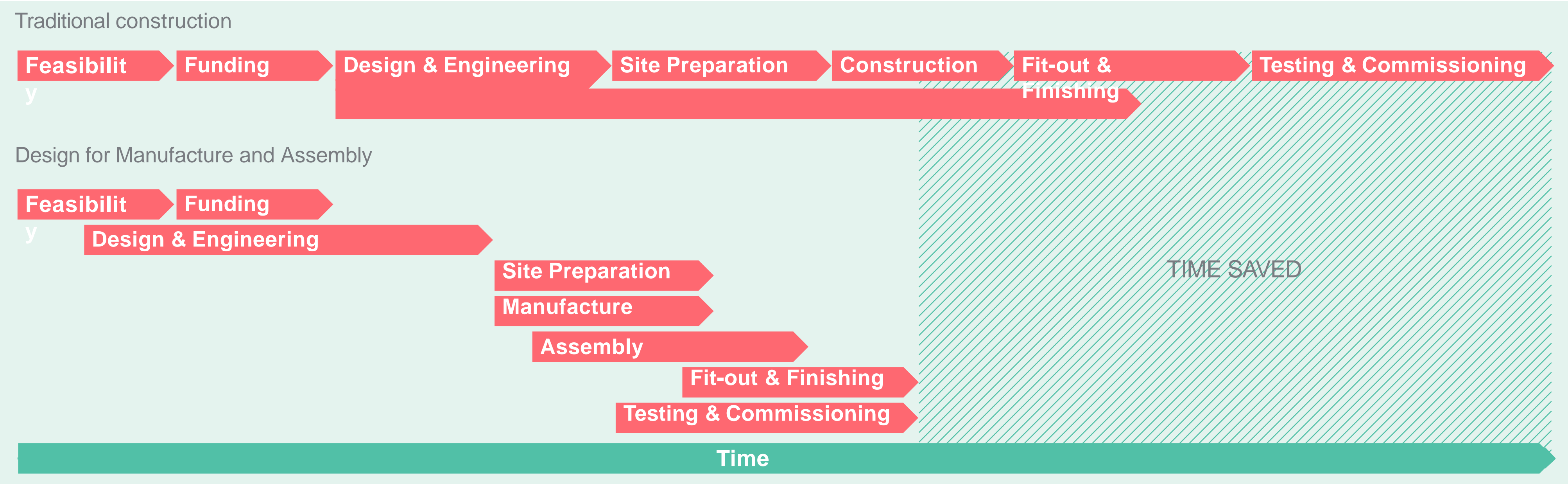
Boothroyd, G., Dewhurst, P. and Knight, W. (2002). *Product Design for Manufacture and Assembly*. 2nd ed. CRC Press Taylor & Francis, Boca Raton, U.S. RIBA (2013). "RIBA Plan of Work 2013: Design for Manufacture and Assembly".
Liang O'Rourke (2013). "The future of DfMA is the future of construction." *Engineering Excellent Journal*, 77,76.



(left) "Over the wall" design, historically the way of doing business (Boothroyd et al. 2002). (right) DfMA model (RIBA 2013).

STATE-OF-THE-ART

Boothroyd, G., Dewhurst, P. and Knight,W. (2002). *Product Design for Manufacture and Assembly*. 2nd ed. CRC Press Taylor & Francis, Boca Raton, U.S. RIBA (2013). "RIBA Plan of Work 2013: Design for Manufacture and Assembly".
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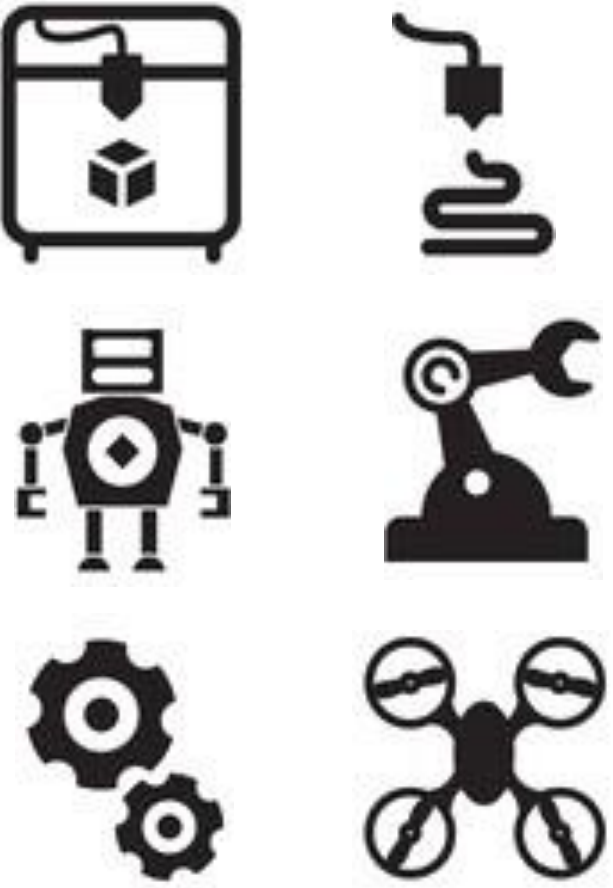
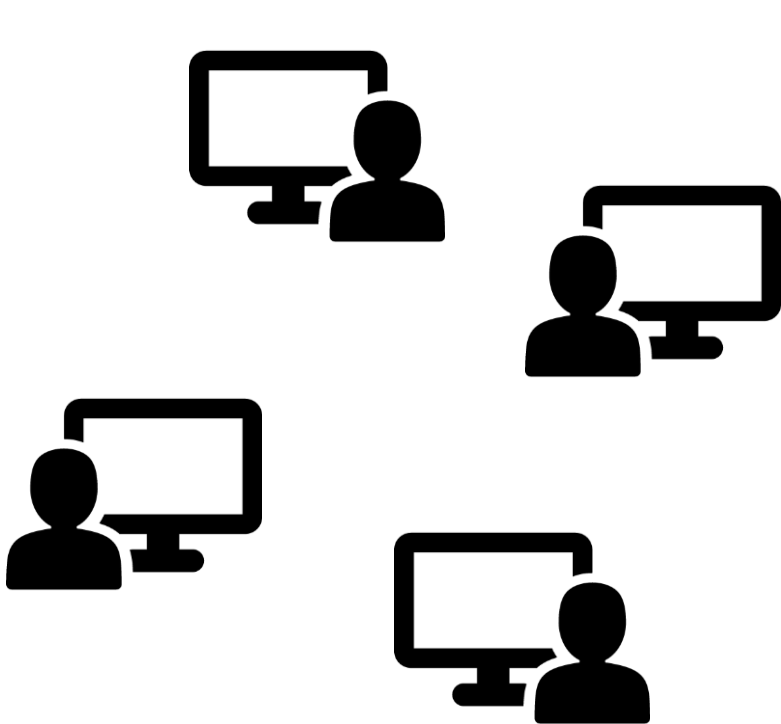
Impact of DfMA on Design and Construction programme (Liang O'Rourke 2013).

Bridgewater, C. (1993). "Principles of design for automation applied to construction tasks." *Automation in Construction*, 2(1), 57-64.

Bogus, S., Molenaar, K.R. and Diekmann, J.E. (2006). "Strategies for overlapping dependent design activities." *Construction Management and Economics*, 24(8), 829-837.

Goulding, J.S., Rahimian, P., Arif, M. and Sharp, M. (2014). "New offsite production and business models in construction: priorities for the future research agenda." *Architectural Engineering and Design Management*, 11(3), 163-184.

STATE-OF-THE-ART



RESEARCH QUESTIONS

POTENTIAL SYNERGIES LEAN, DfMA & DFAB

what are the shared practices?

how to manage dfab for innovation adoption?

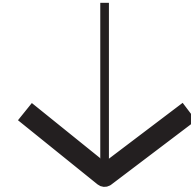
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Table 1: Keywords used in the literature search

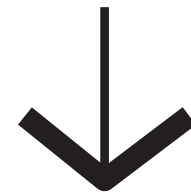
LEAN CONSTRUCTION	DfMA	DIGITAL FABRICATION
Pull-Planning	Customisation	Automation
Just-in-Time	Modularisation	Robotics
Concurrent Engineering	Design for Automation	

METHODOLOGY

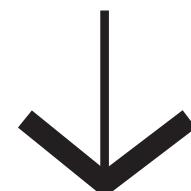
SEARCH WITH KEYWORDS



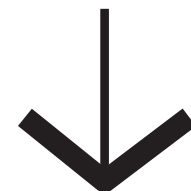
JOURNAL & CONFERENCE PAPERS



FURTHER SELECTION & FILTERING



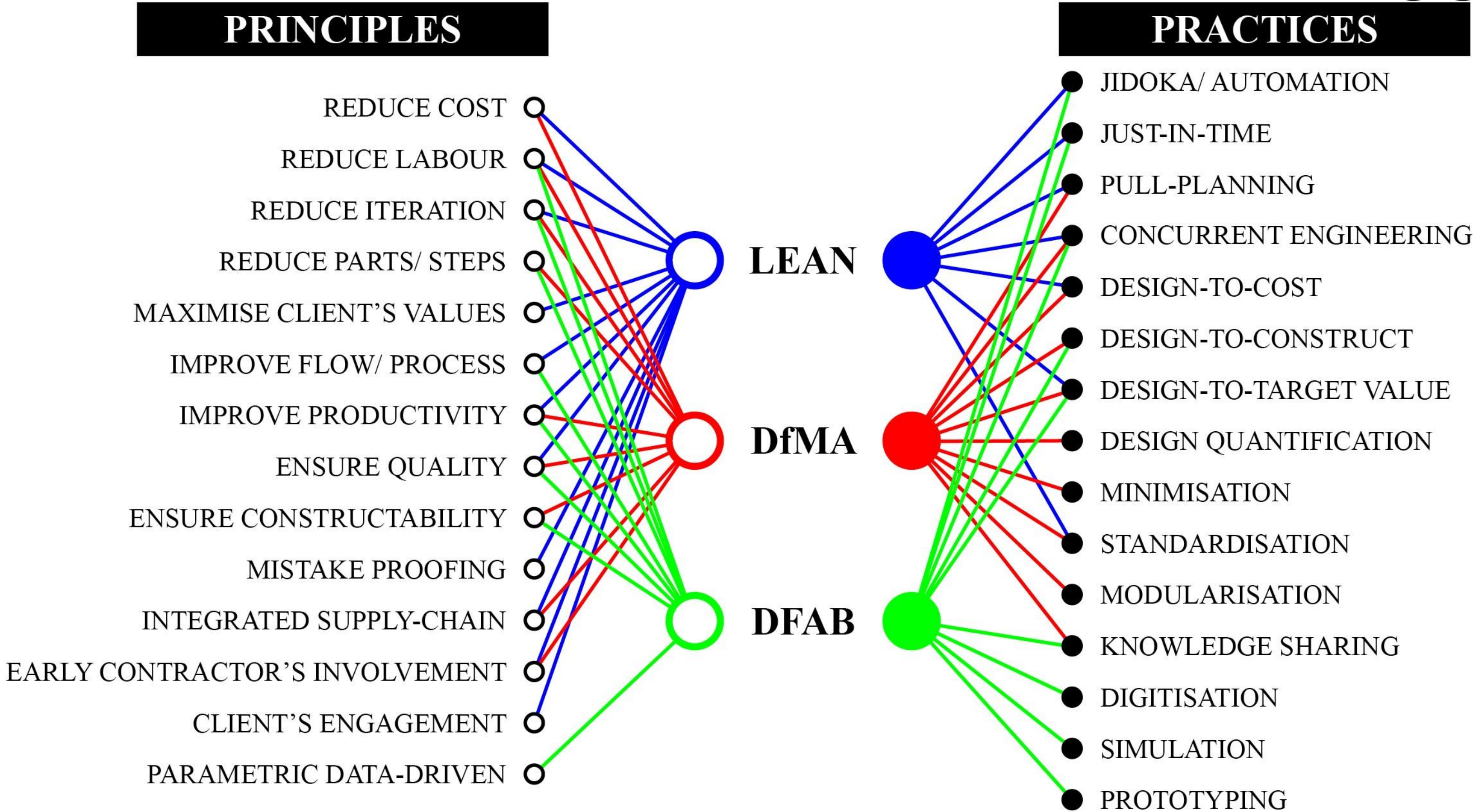
FINDINGS: SHARED PRACTICES & REVIEW OF 19



LITERATURES FUTURE RESEARCH

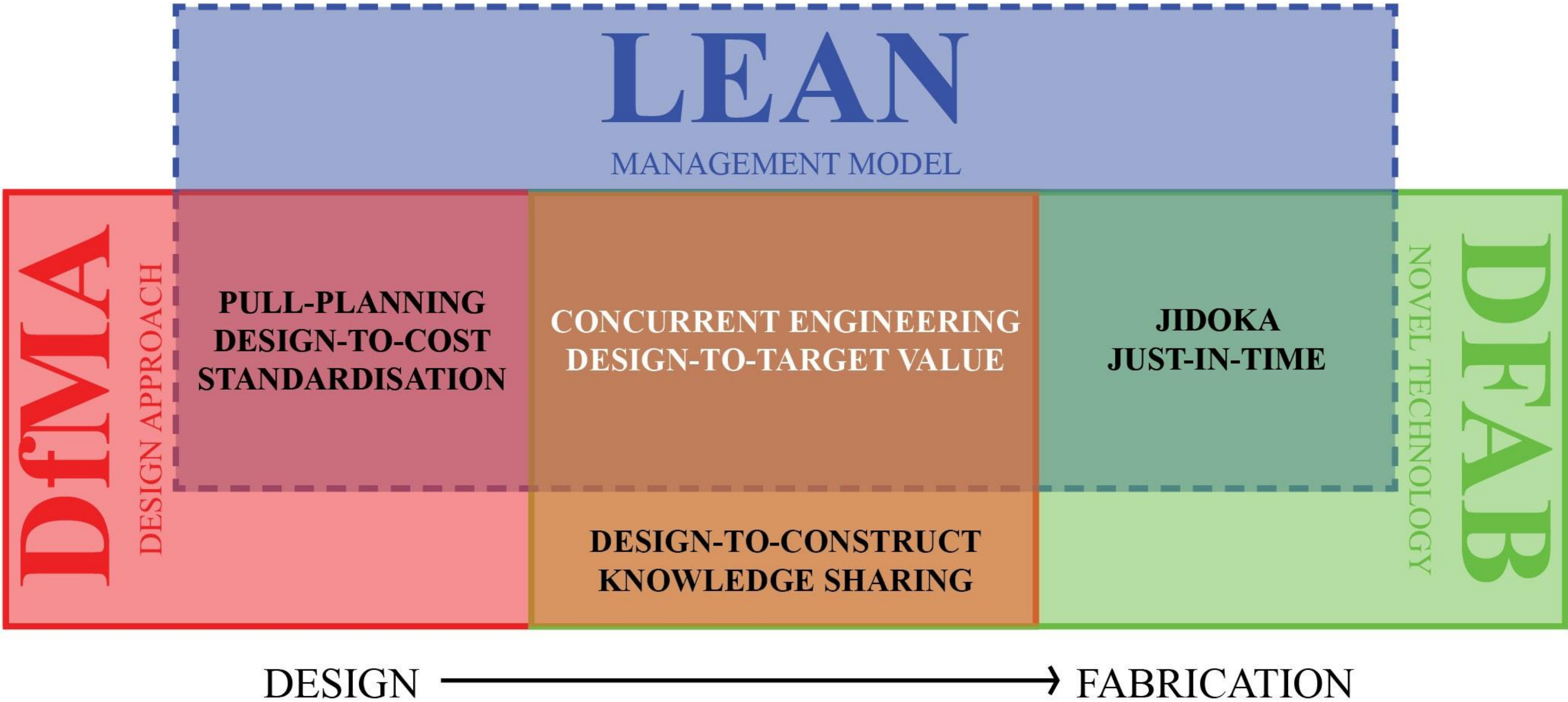
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LEAN x DfMA x DFAB (3)

Fischer, M. (2006). “Formalizing Construction Knowledge for Concurrent Performance-Based Design.” *Intelligent Computing in Engineering and Architecture*, EG-ICE 2006, Smith, I.F.C. (ed.), 186-205. Lecture Notes in Computer Science, vol 4200. Springer, Berlin.

Martinez, S., Jardon, A., Gimenez, A., Balaguer, C., Navarro, J.M. and Barcena, C. (2008). “Robotized lean assembly in the Building Industry.”, In: *Proc. of the 25th Int’l. Symposium on Automation and Robotics in Construction*, Vilnius Lithuania, 195-201. O’Connor, J.T., O’Brien, W.J., Choi, J.O. (2014). “Critical Success Factors and Enablers for Optimum and Maximum Industrial Modularization.” *Journal of Construction Engineering and Management*, 140(6).

LEAN x DfMA (7)

Gann, D.M. (1996). “Construction as a manufacturing process? Similarities and Differences between industrialized housing and car production in Japan.” *Construction Management & Economics*, 14, 437–450. Pasquire, C.L. and Connolly, G.E. (2003). “Design for manufacture and assembly.” In: *Proc. 11th Ann. Conf. of the Int’l. Group for Lean Construction*, Blacksburg, U.S.A., 184-194.

Bogus, S., Molenaar, K.R. and Diekmann, J.E. (2006). “Strategies for overlapping dependent design activities.” *Construction Management and Economics*, 24(8), 829-837. Gerth, R., Boqvist, A., Bjelkemyr, M. and Lindberg, B. (2013). “Design for construction: utilizing production experiences in development.” *Construction Management and Economics*, 31(2), 135-150. Goulding, J.S., Rahimian, P., Arif, M. and Sharp, M. (2014). “New offsite production and business models in construction: priorities for the future research agenda.” *Architectural Engineering and Design Management*, 11(3), 163-184. O’Connor, J.T., Rusch, S.E. and Schulz, M.J. (1987). “Constructability concepts for engineering and procurement.” *Journal of Construction and Engineering Management*, 113(2), 235-248.

Gao, S., Low, S.P. and Nair, K. (2018). “Design for Manufacturing and Assembly (DfMA): a preliminary study of factors influencing its adoption in Singapore.” *Architectural Engineering and Design Management*, 14(6), 440-456.

DfMA x DFAB (6)

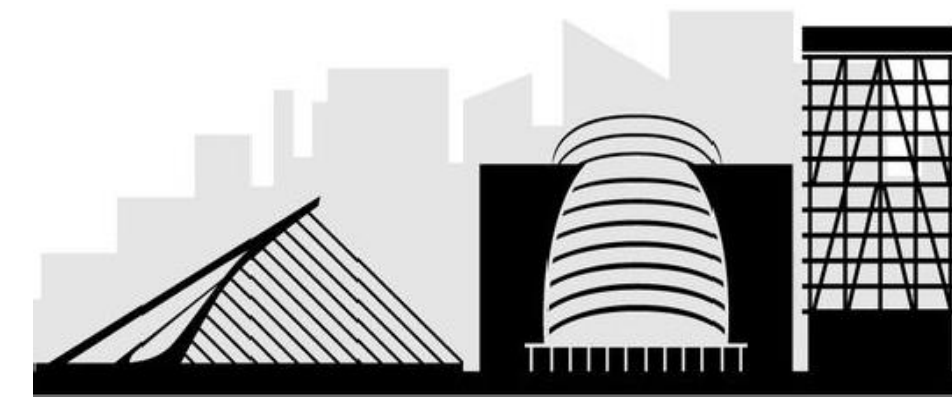
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Martinez, S., Jardon, A., Victores, J.G. and Balaguer, C. (2013). “Flexible Field Factory for Construction Industry.” *Assembly Automation*, 33(2), 175-183. Montali, J., Overend, M., Pelken, P.M. and Sauchelli, M. (2018). “Knowledge-Based Engineering in the design for manufacture of prefabricated facades: current gaps and future trends.” *Architectural Engineering and Design Management*, 14(1-2), 78-94. Arashpour, M., Miletic, N., Williams, N. and Fang, Y. (2018). “Design for Manufacture and assembly in off-site construction: Advanced production of modular façade systems.” In: *Proc. 35th ISARC*, Berlin, Germany, 224-229.

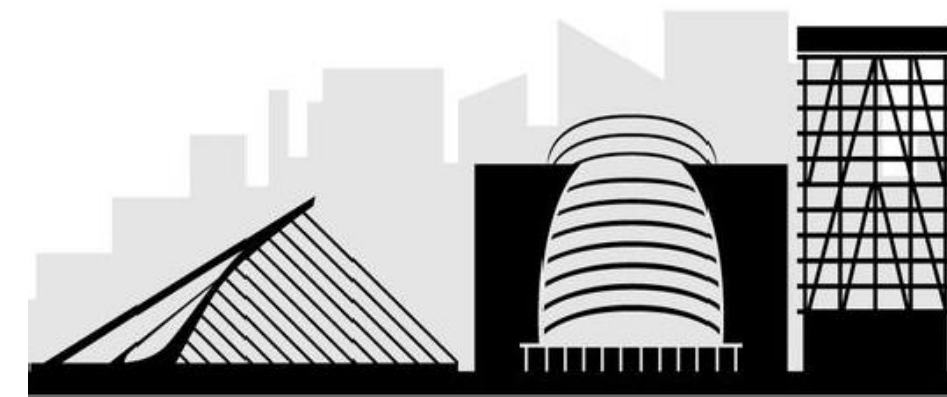
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LEAN x DFAB (3)

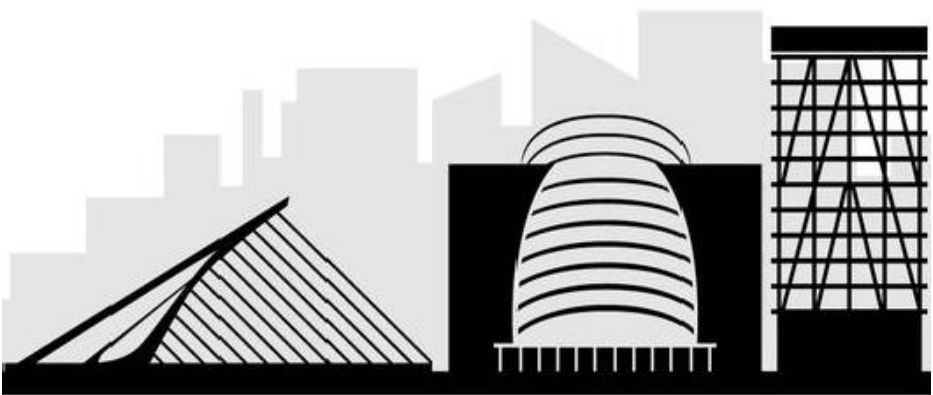
DISCUSSION



DISCUSSION



DISCUSSION

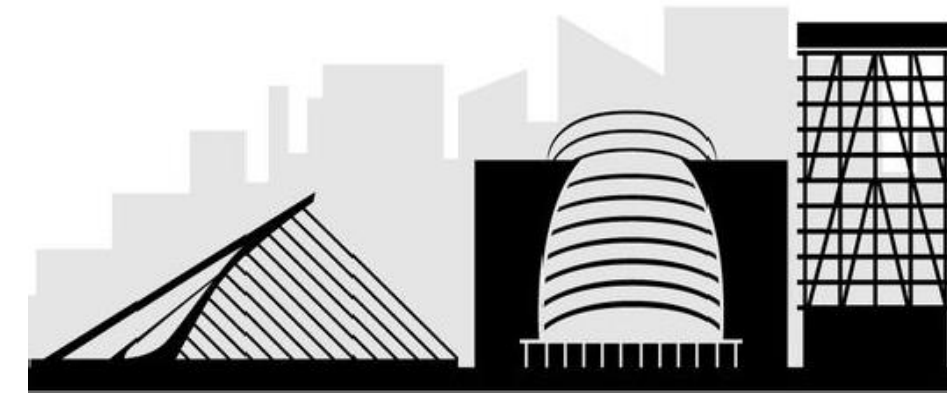


INNOVATION

DISCUSSION

LEA

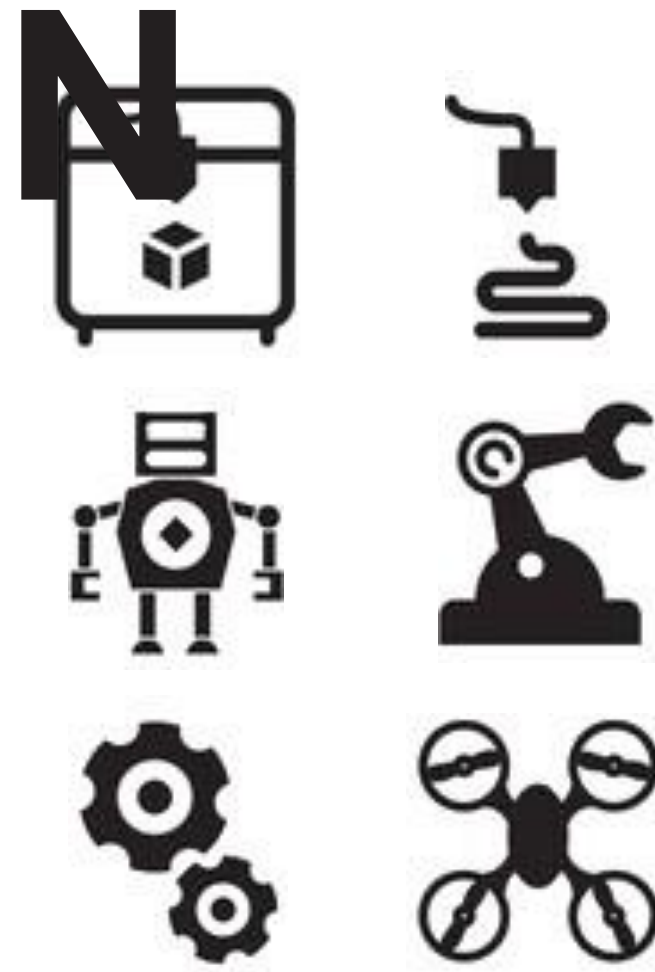
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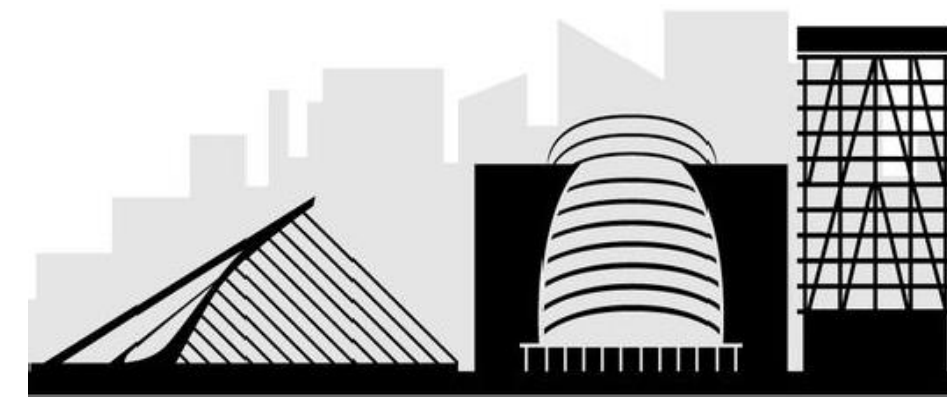
INNOVATION

DISCUSSION

LEA



INNOVATION



DIGITAL FABRICATION

DESIGN & CONSTRUCTION MANAGEMENT



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FUTURE RESEARCH

LEAN DESIGN MANAGEMENT FOR DFAB

DfMA FOR BESPOKE BUILDING SYSTEMS USING LEAN & DFAB

DESIGN GUIDELINES FOR DFAB WITH LEAN & DfMA

ORGANISATION MODELS FOR DFAB FOR LEAN ADOPTION

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FUTURE RESEARCH

LEAN DESIGN MANAGEMENT FOR DFAB



**CONCURRENT
ENGINEERING**

SET-BASED DESIGN

CHOOSING BY ADVANTAGE

TARGET VALUE DESIGN

**FUTURE
RESEARCH**

VALUE-ADDING

WASTE REDUCTION

**CONCURRENT
ENGINEERING**

**SUPPLY-CHAIN
INTEGRATION**

SET-BASED DESIGN

**EARLY
STAKEHOLDER'S
INVOLVEMENT**

CHOOSING BY ADVANTAGE

QUALITY IMPROVEMENT

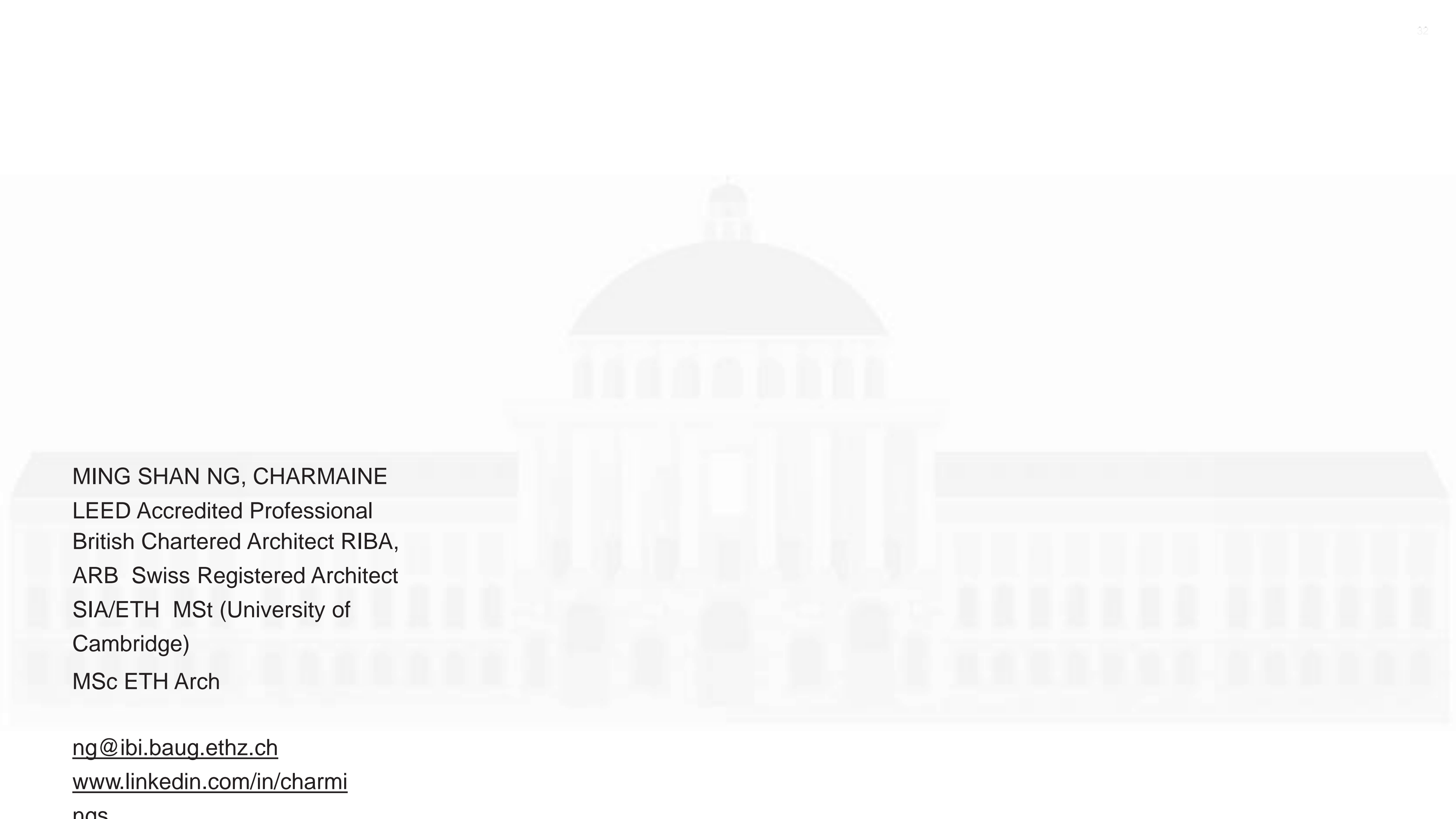
TARGET VALUE DESIGN

CONCLUSION

POTENTIAL SYNERGIES LEAN, DfMA & DFAB

9 shared practices

Lean management for dfab



MING SHAN NG, CHARMAINE
LEED Accredited Professional
British Chartered Architect RIBA,
ARB Swiss Registered Architect
SIA/ETH MSt (University of
Cambridge)
MSc ETH Arch

ng@ibi.baug.ethz.ch

www.linkedin.com/in/charmi

ngs