



VISUAL TOOL FOR WORKLOAD LEVELING USING THE WORK DENSITY METHOD FOR TAKT PLANNING

Vishesh V. Singh, Iris D. Tommelein, and Lian Bardaweel
University of California, Berkeley, USA

Supported by
National Science Foundation (NSF) Grant Number CMMI-1563511
and members of P²SL



Research Aim



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- Develop interactive visual tool for takt planning
- Find optimal workload level and associated work space zoning
- Setting takt duration

Method

- Design science research
- Collect data, prototype and test the tool on two projects

Location Based Planning



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- Divide work space so that work can take place in parallel
- Rationale for dividing is not well-articulated nor data-driven
- Divisions that ignore time to complete work, result in uneven work flow

Takt Planning

- Like other location based planning methods, schedules use of work space along with time
- Structures work to be done within regular beat based on customer demand
- Work can be non-repetitive, production rates vary by crew size, scope in an area, means and methods, etc.

Work Density Method



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“Given a certain work area, work density describes how much time a given trade will require to do their work in that area, based on the product design and the scope of work done by that trade for a given task in the schedule (thus depending on work already in place and work that will follow), the means and methods the trade will use to do their work while accounting for their crews’ capabilities and crew size.” (Tommelein 2017)

$$\textit{Work Density [time/area]} = \textit{Quantity [units/area]} * \textit{Production Rate [time/unit]}$$

Case Study

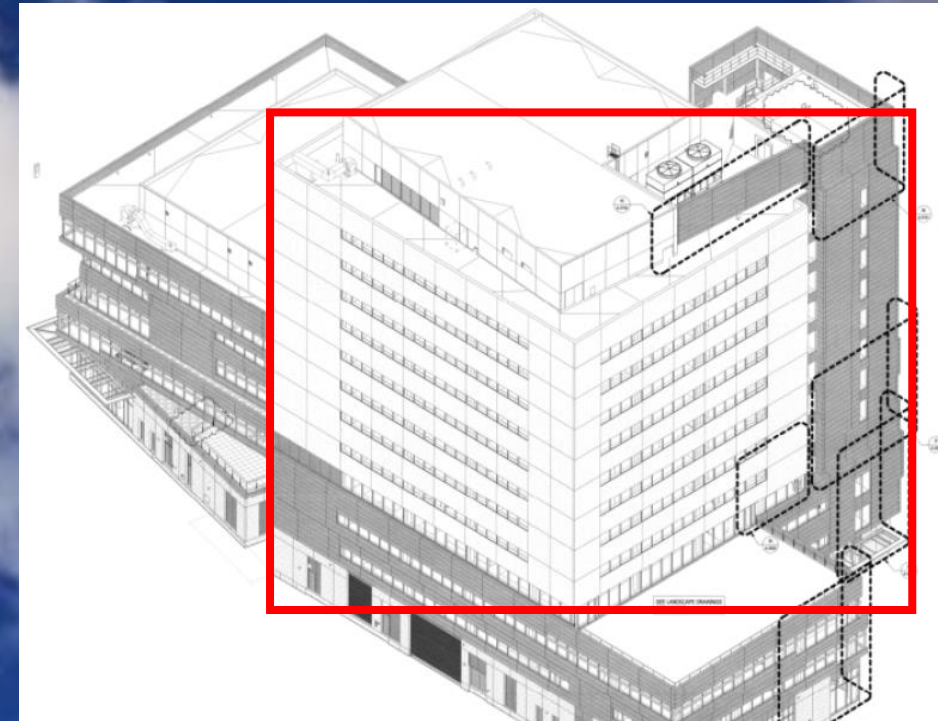


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- Study #1: Multi-story medical office building in the San Francisco Bay Area - repetitive floors 2 to 5
- Study #2: Mixed-use building located in San Francisco – repetitive floors 6 to 12



Process Steps

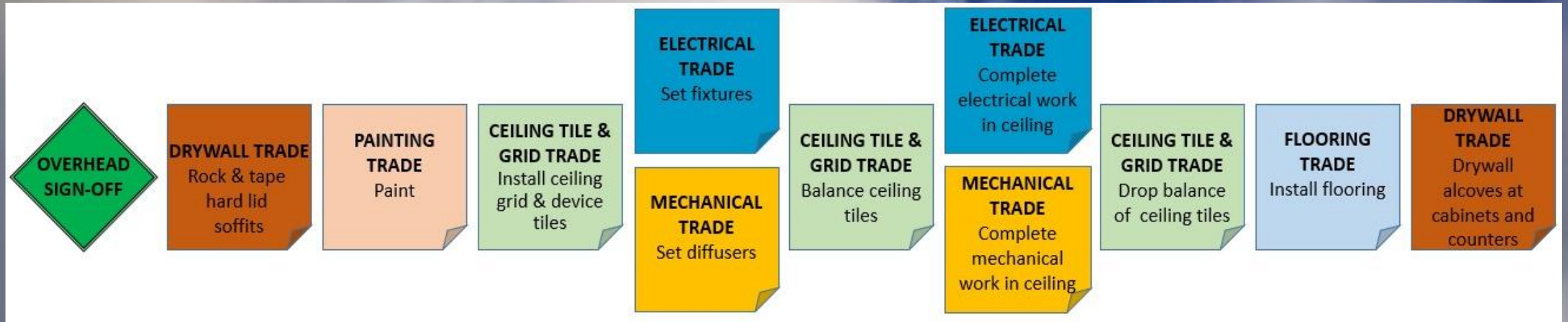


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- Identify work spaces by type of work, e.g., corridor, open area, office, bathroom
- Define trades involved and steps to complete work in each work space
- Define sequence of steps to include in process map
- Iterate



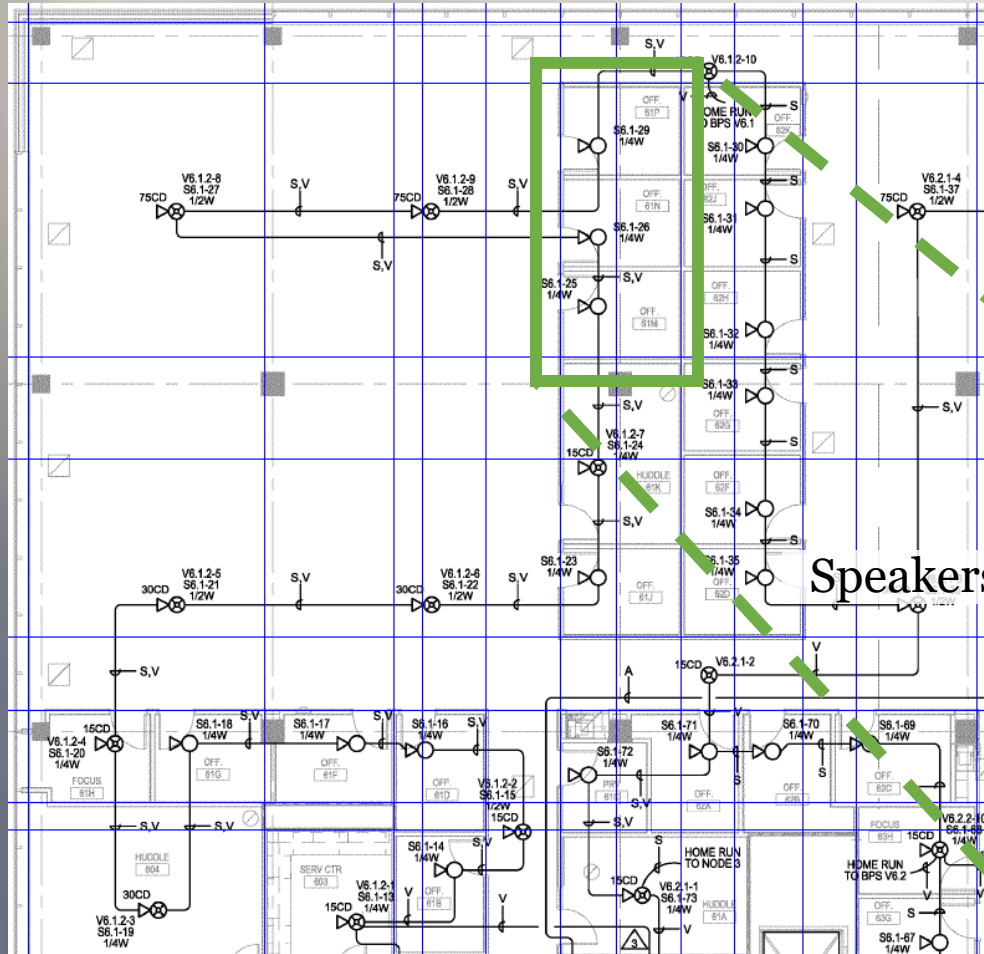
Data Collection



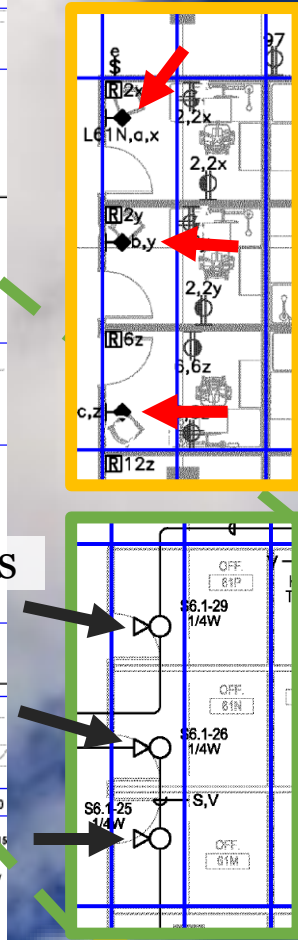
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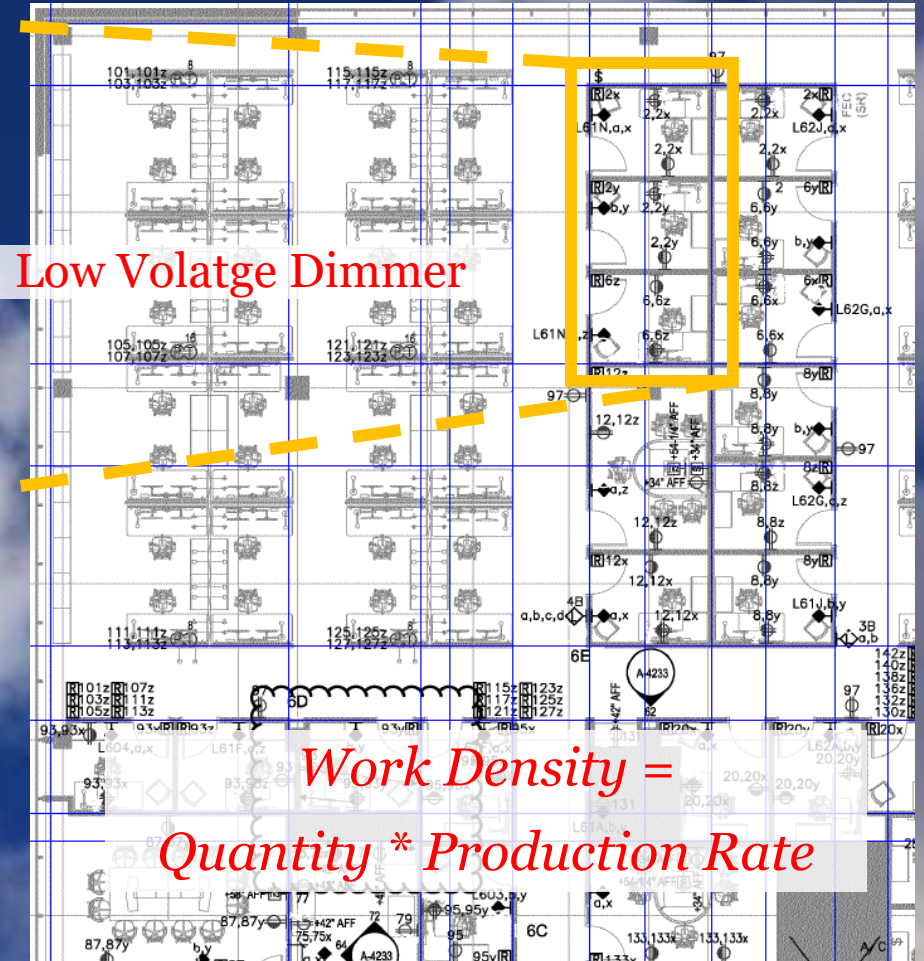
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Fire Alarm Plan



Speakers



Low Voltage Dimmer

*Work Density =
Quantity * Production Rate*

Electrical Wall Device Plan

Defining Cells



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- Cells are basic units that make up a zone
- One cell or several cells combined form a zone
- Cell size and shape allow flexibility to try different zoning scenarios
- Each cell tied to each step in the processes
- Work density calculated at cell level
- Considerations when defining cell grid:
 - Finer grid requires greater up-front effort to set up
 - Grid lines must consider trade preferences and process requirements

ViWoLZo Dashboard

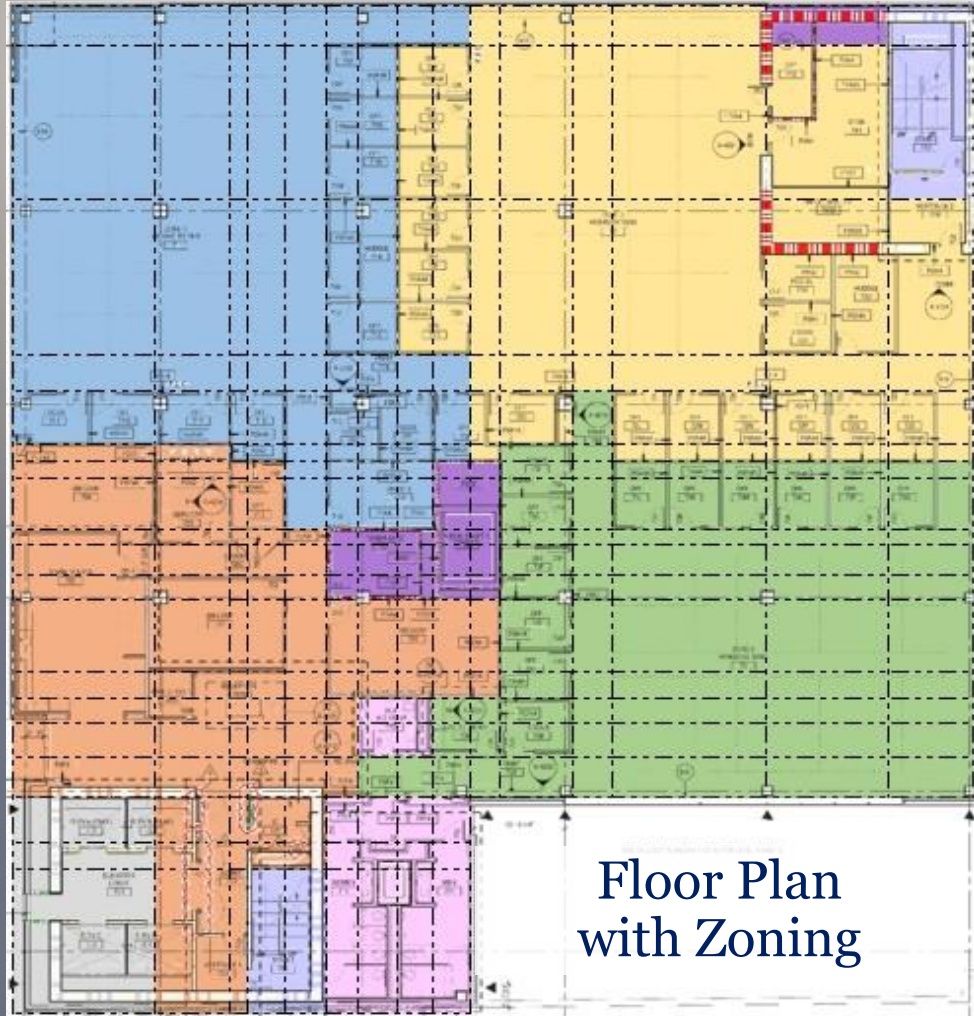
(Visual Workload Leveling and Zoning)



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Floor Plan
with Zoning

4	4	4	4	4	4	4	4	4	2	2	2	2	8	6
4	4	4	4	4	4	4	2	2	2	2	2	2	2	6
4	4	4	4	4	4	4	2	2	2	2	2	2	2	2
4	4	4	4	4	4	4	4	4	2	2	2	2	2	2
4	4	4	4	4	4	4	4	4	2	2	3	2	2	2
1	1	4	4	4	4	4	4	4	2	3	3	2	2	2
1	1	4	4	4	4	4	4	8	8	3	3	3	3	3
1	1	1	1	4	4	4	4	8	8	3	3	3	3	3
1	1	1	1	1	8	8	8	8	8	3	3	3	3	3
1	1	1	1	1	8	8	8	8	8	3	3	3	3	3
1	1	1	1	1	8	8	8	8	8	3	3	3	3	3
1	1	1	1	1	1	1	1	1	1	3	3	3	3	3
1	1	1	1	1	1	1	1	1	1	3	3	3	3	3
1	1	1	1	1	1	5	5	3	3	3	3	3	3	3
1	1	1	1	1	1	5	5	3	3	3	3	3	3	3
1	1	1	1	1	1	3	3	3	3	3	3	3	3	3
7	1	1	1	1	5	5	5	5						
7	1	1	1	1	5	5	5	5						
7	1	1	6	6	5	5	5	5						

Zoning Input Tool

ViWoLZo Dashboard

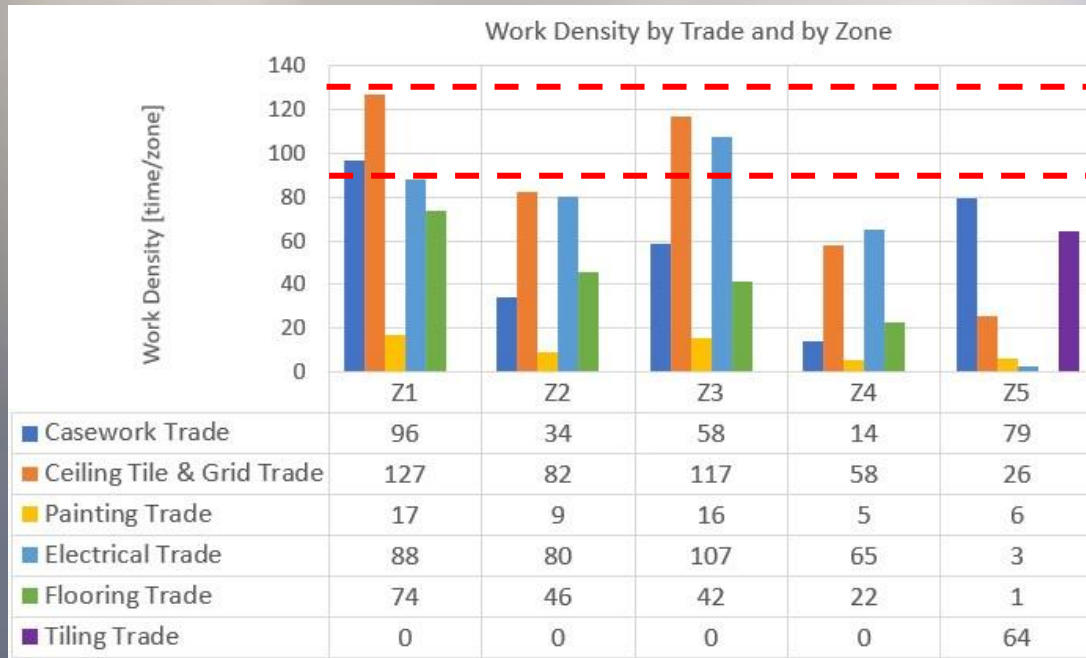
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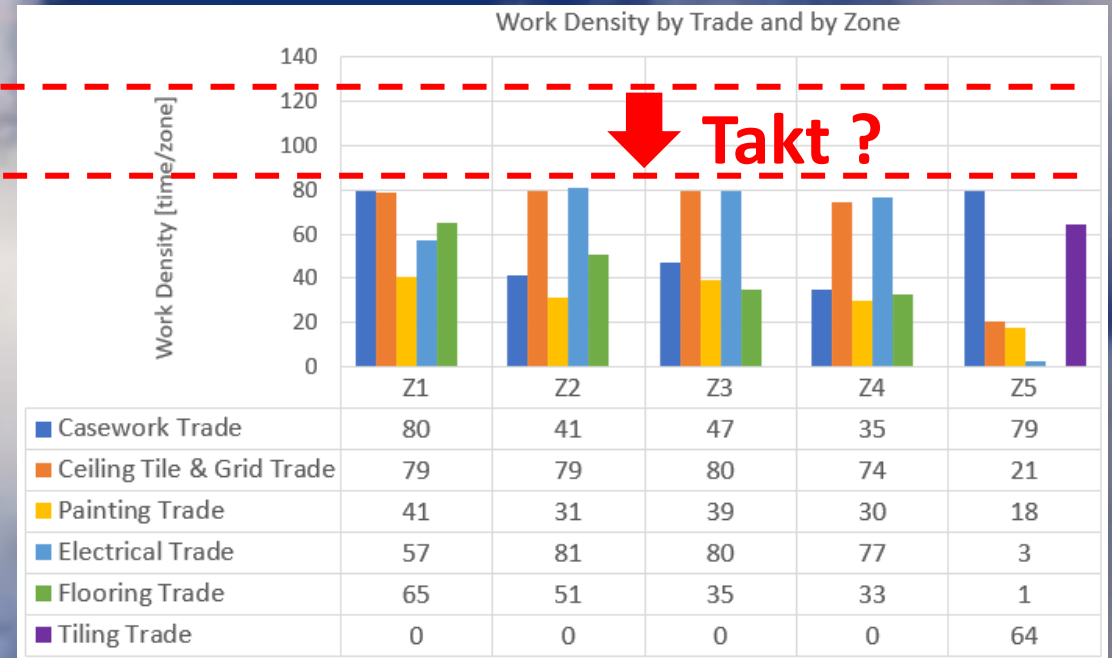
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Before



After

Next Steps



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- Project team must collaborate early on to define execution strategy and work processes
- Team must own the takt planning effort
- Data collection must be streamlined and established as databases
- Further study needed on work structuring and crew process capabilities
- BIM tool needed collect work quantities (by element and space)
- Automate workload leveling and zoning using optimization algorithms

Conclusion



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- Visually represent work density maps
- Visually explore alternative scenarios of zoning and workload leveling, by varying crew sizes and production rates for multiple trades
- Support what-if analyses to set takt



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Thank You

Singh, V.V., Tommelein, I.D., and Bardaweel, L. (2020) “Visual Tool for Workload Leveling using the Work Density Method for Takt Planning.” In: Tommelein, I.D. and Daniel, E. (eds.) *Proc. 28th Annual Conference of the International Group for Lean Construction (IGLC28), Berkeley, California, USA*, doi.org/10.24928/2020/0061.

visheshvs@berkeley.edu | tommelein@berkeley.edu | lian.bar@pihome.ca