Data thinking for high-performance projects

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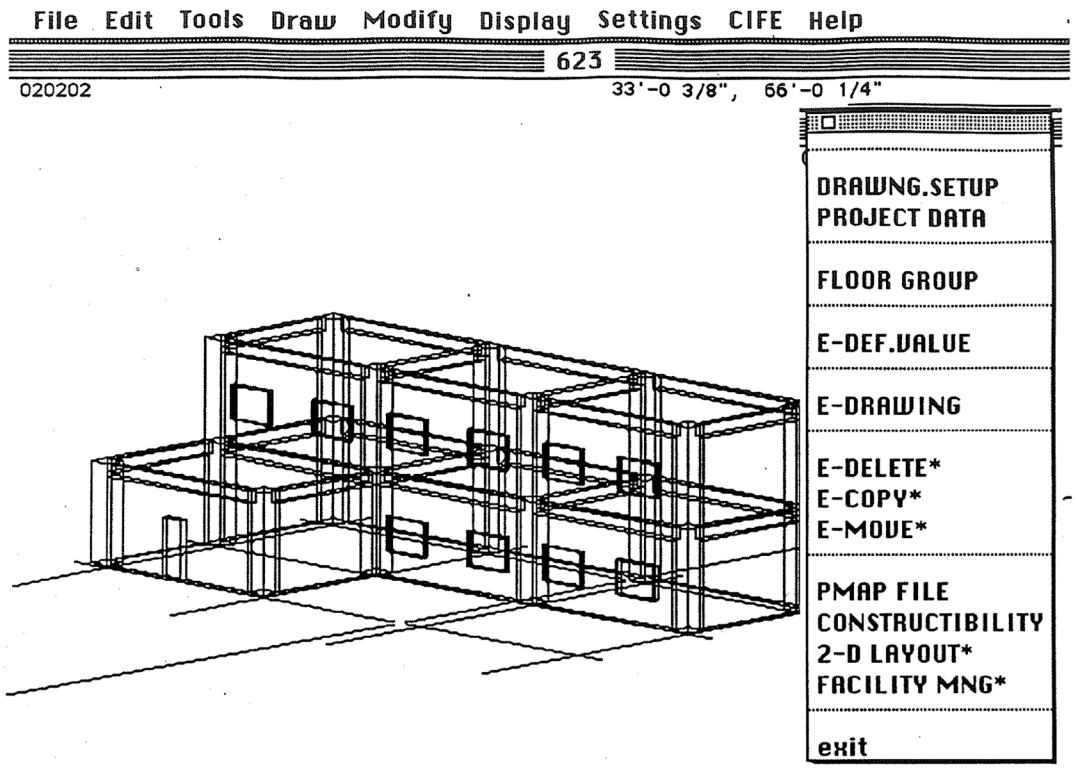
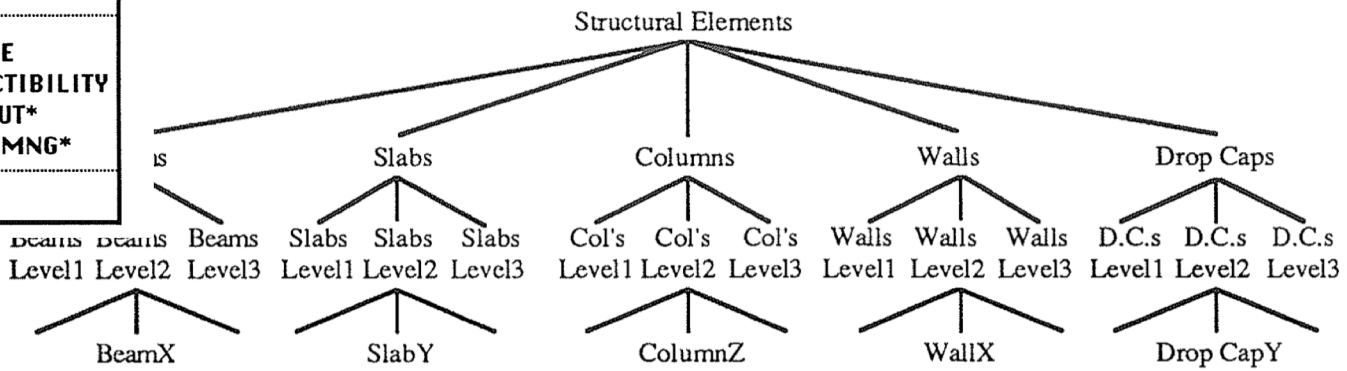
Expert Systems

- Apply existing knowledge broadly and consistently
  - Guide
  - Check
  - Critique

- Bidding advisor
- Bridge type advisor
- …





Slots representing attributes of structural elements (from CAD database):

Bottom Width=16"	Area=400000sqin	Angles of Beams	Beam-Above=0	Column=12
Clear Span= 256"	ID=Y	Supported=10°, 100°	Beam-Below=0	Concr. Str.=4000psi
Column-Left=12	IDs of Supporting	Angles of Boundary	Column-Left=18	ID=Y
Column-Right=15	Beams=26, 29	Slabs Supported=50°,	Column-Right=23	Level=2
Slab-Left=0	IDs of Supporting	140°	Concr. Str.=3000psi	Phi=45°
Slab-Right=5	Columns=6, 8, 10, 14	Angles of Walls	Height=120"	SideX=45"
Concr. Str.=4000psi	IDs of Supporting	Supported=0	ID=X	SideY=45"
Depth=24"	Walls=0	Column-Above=42	IDs of Doors in	Thickness=8"

Model-based reasoning

- Connect knowledge across project phases and disciplines
- Expanding from 3D to 4D models
- Considering more and more criteria

Adding simulation

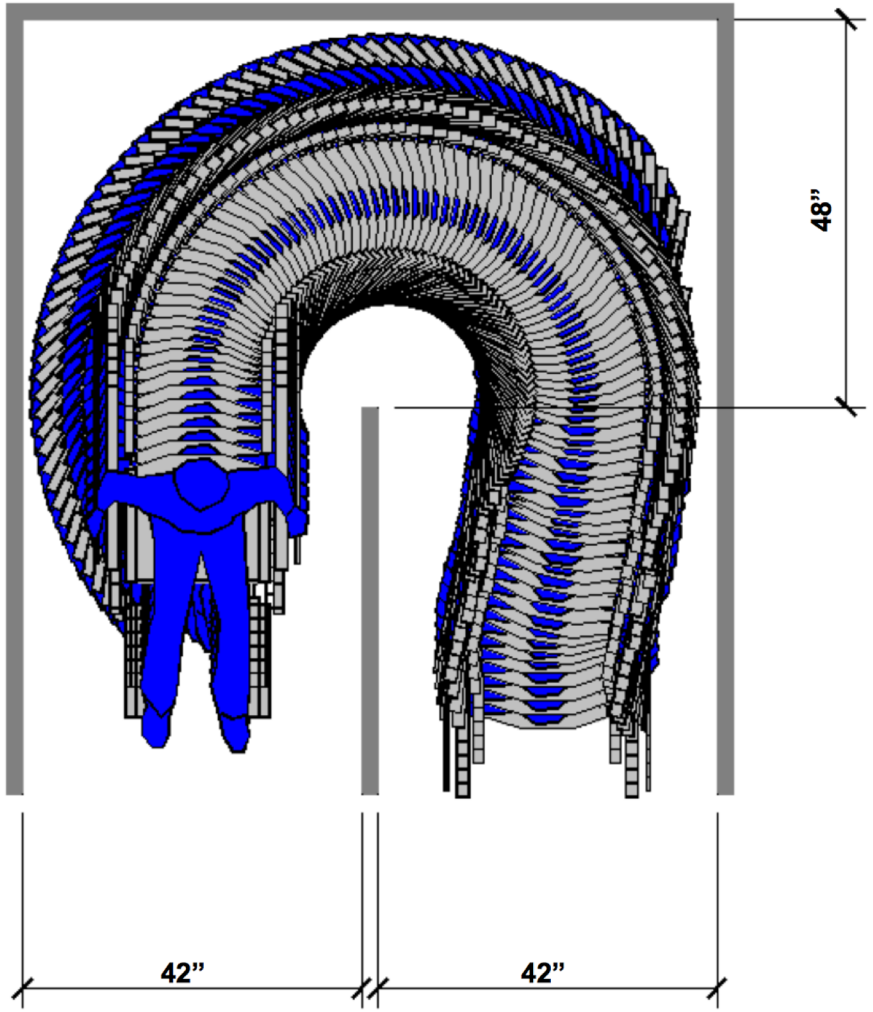


Figure 4.22: Motion-planning results for the second ADAAG 4.3.3 exception, $r_1 = 24$”.

Han, Charles S. and Law, Kincho H. and Kunz, John. (2000). TR123: Computer Models & Methods for a Disabled Access Analysis Design Environment. Stanford Digital Repository. Available at: http://purl.stanford.edu/hs087cr7645

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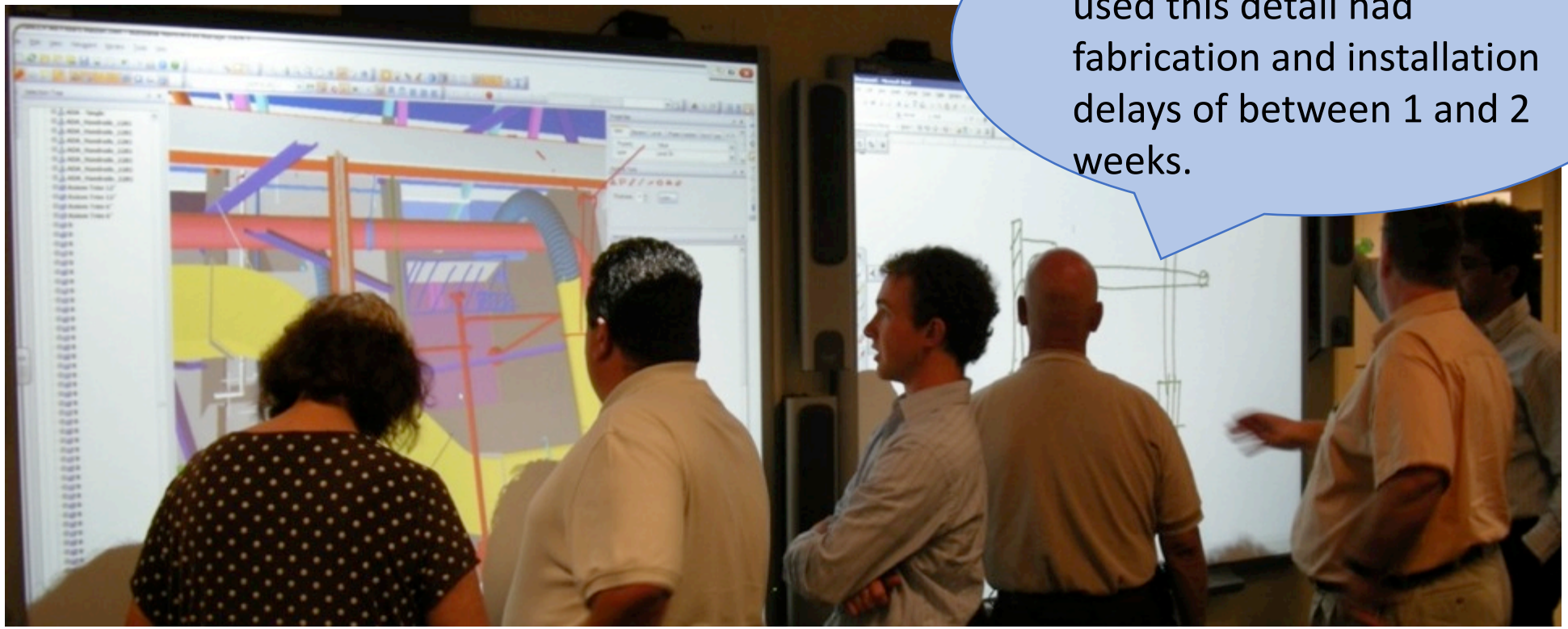
Today: Finding new insights and knowledge

- We now have data!

Does your integrated project information environment give you insights like these?



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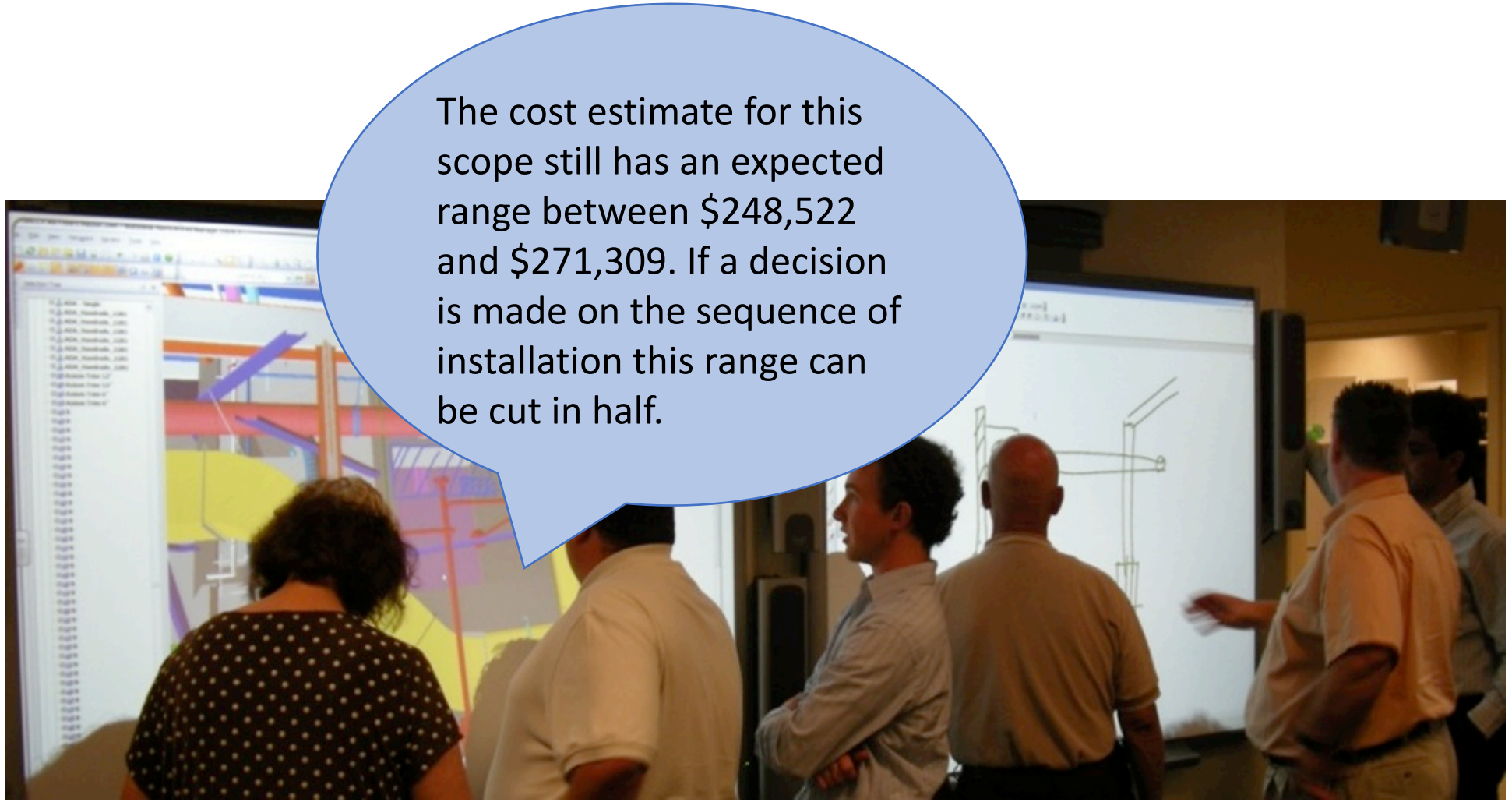

Does your integrated project information environment give you insights like these?

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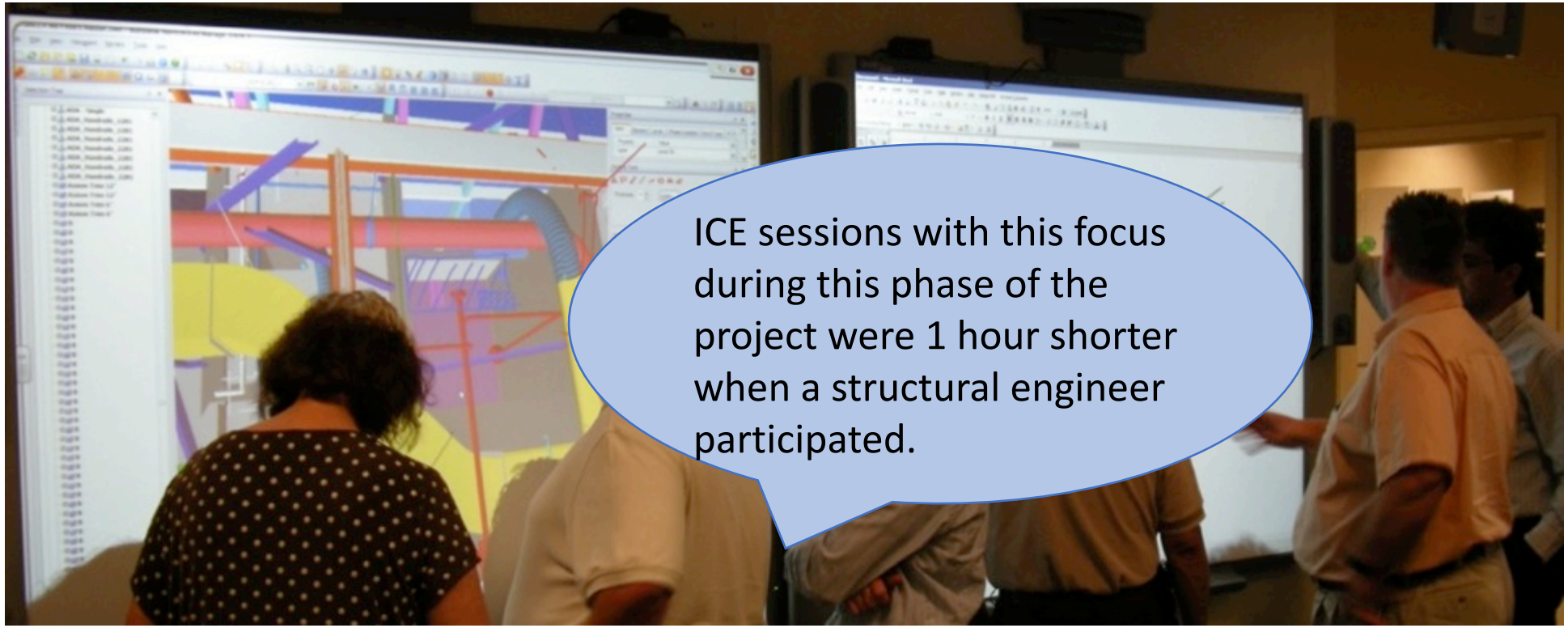

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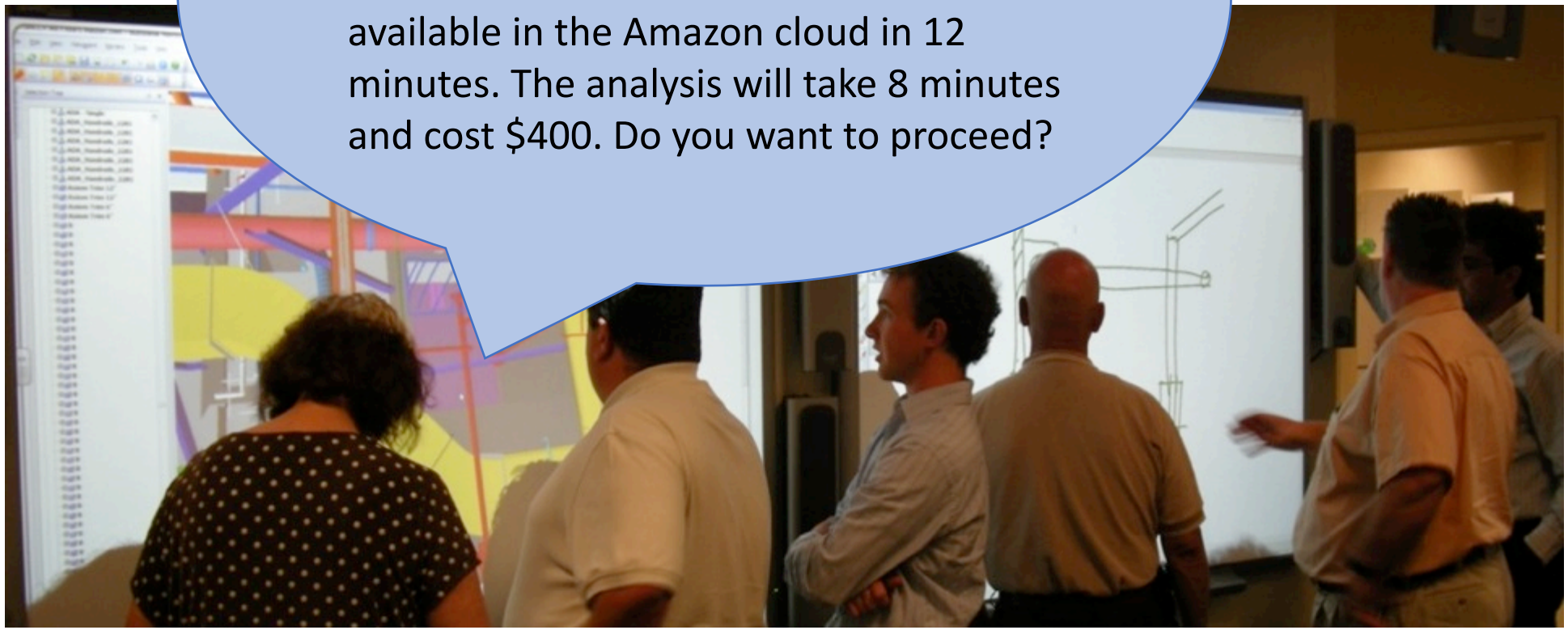
Does your integrated project information environment give you insights like these?

Do you want to run a full cost, schedule, and lifecycle calculation for the 100 best options considering your high-level decisions? There are 1,000 nodes available in the Amazon cloud in 12 minutes. The analysis will take 8 minutes and cost $400. Do you want to proceed?



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WHY is the client doing the project?

Client/Business Objectives

CLIENT PERFORMANCE

- Usable
- Operable
- Sustainable

WHAT does the project team need to achieve?

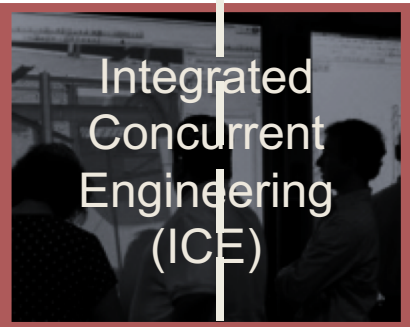
Project Objectives

PROJECT PERFORMANCE

- Buildable

Safety, Budget, Schedule, Quality

HOW is the project team accomplishing the project objectives?



PRODUCTION PERFORMANCE

CONTROLLABLE FACTORS OF PRODUCTION

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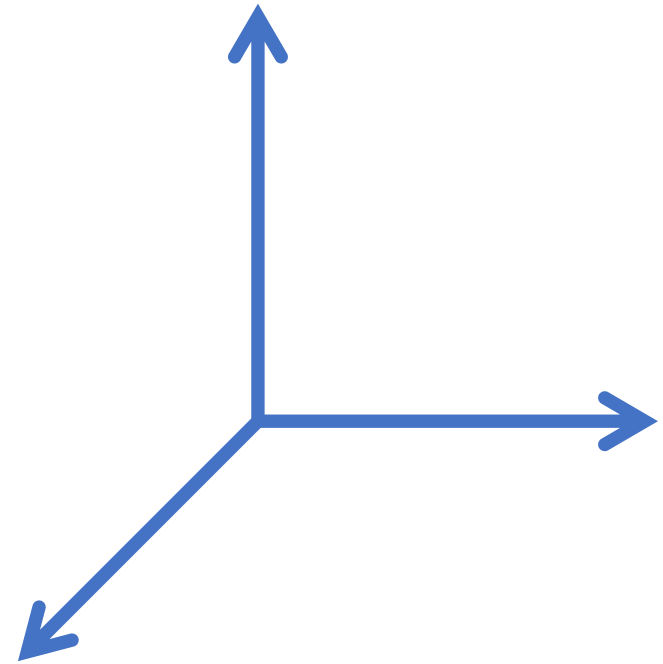
There are three ways to improve your predictions

Increase the number of **virtual** buildings or design options considered



Increase the number of **real** buildings considered

Improve the **quality** of analysis and simulation **models**

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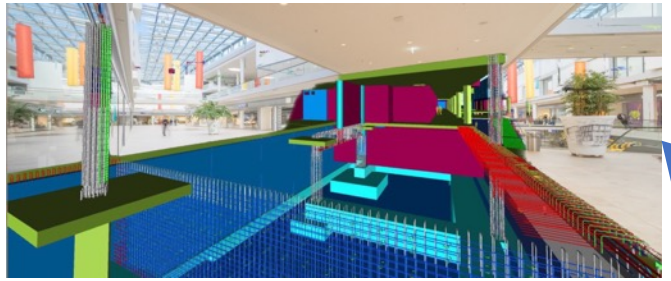
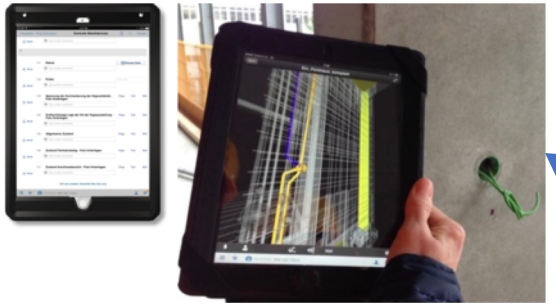
How will you leverage 3D and other data in 2019, etc.?

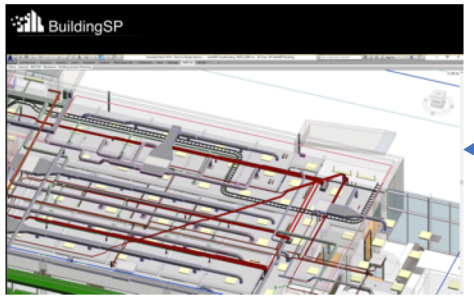
Visualization



Information Integration

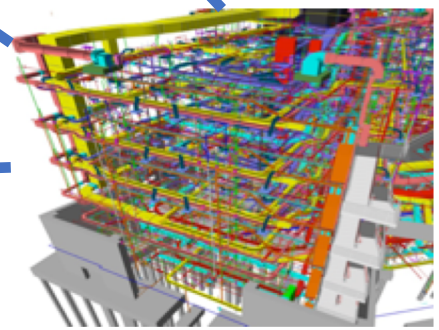


Automation



Open the whole Eden Valley Medical Center hospital on budget and 30% earlier than typical

Highly reliable construction



Pictures courtesy DPR Construction

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Two main applications of AI

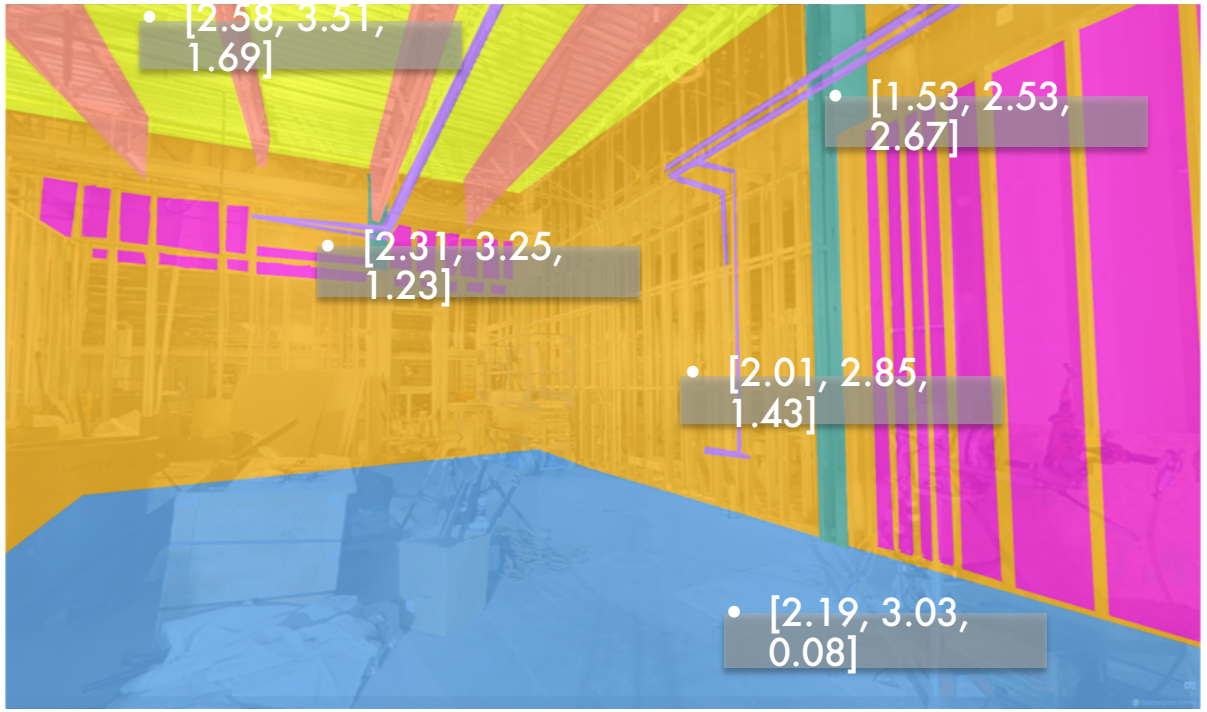
Do what you already know how to do automatically.

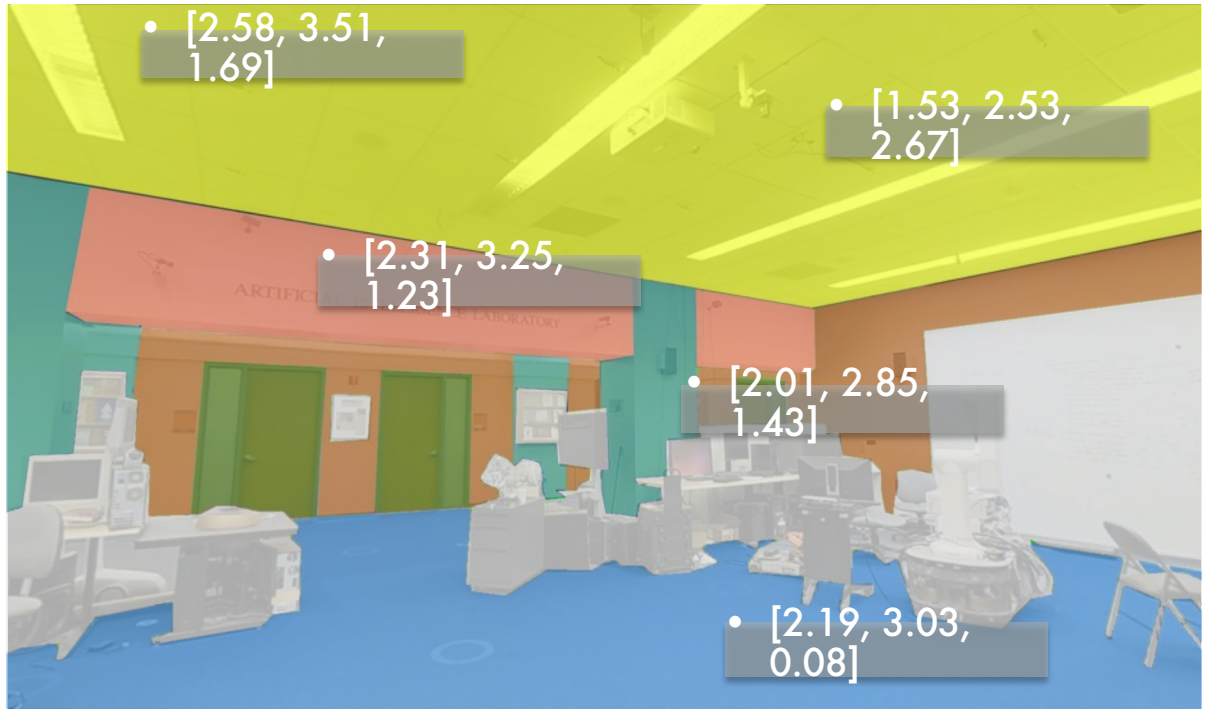
Do something new.

Automatically generating a BIM from a laser scan

Where is it?

What is it?





construction

post - occupancy

Semantic Building Parser Research

With Silvio Savarese, Iro Armeni, Amir Zamir, buildingparser.stanford.edu

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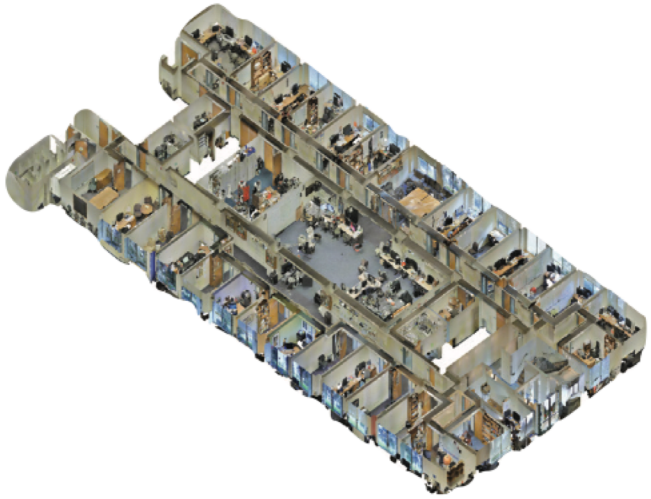
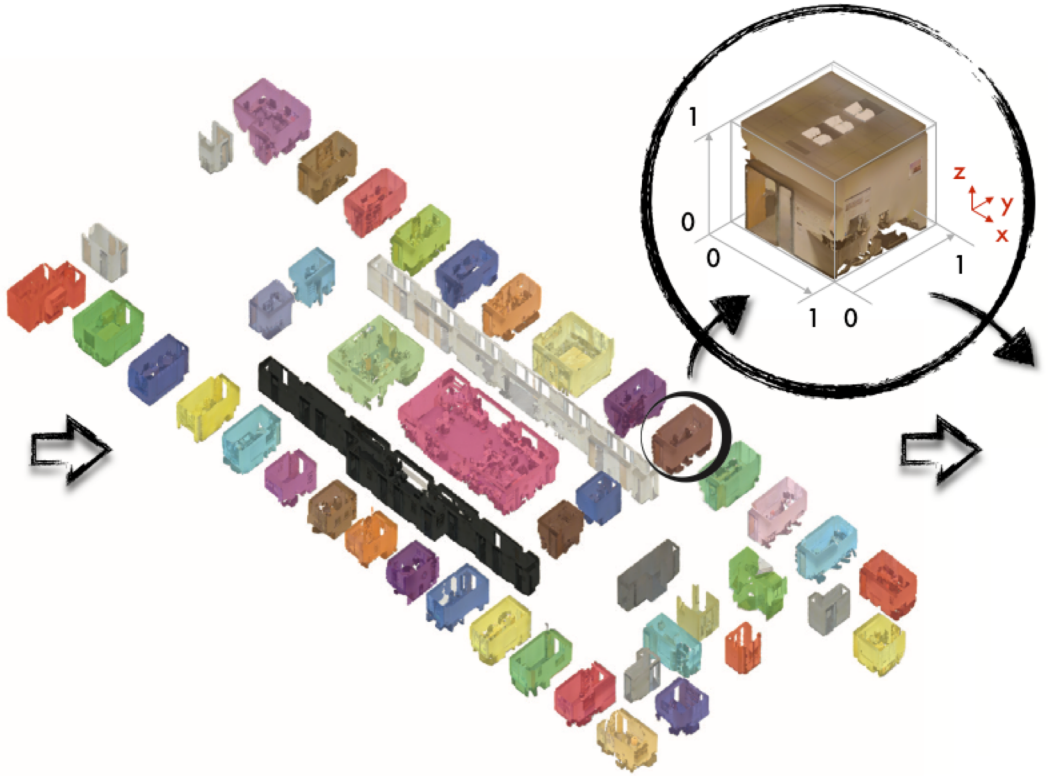
Making BIM for Existing Buildings Affordable

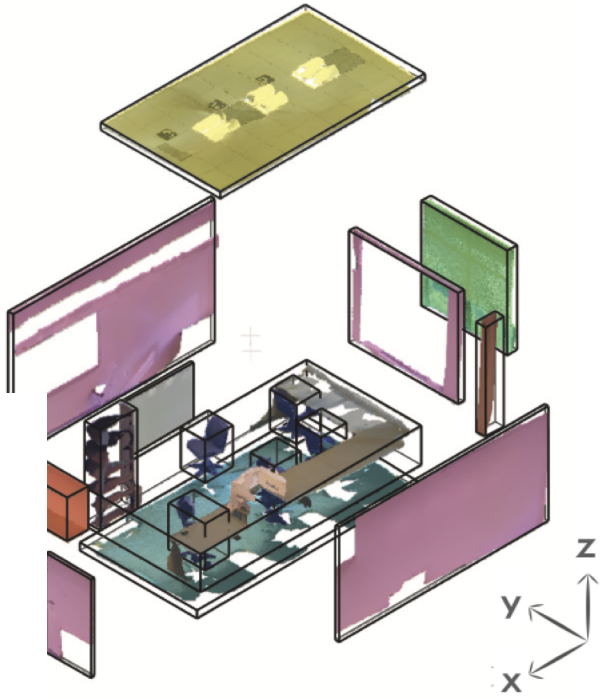
Raw Point Cloud



Disjoint Space Parsing



Building Element Detection



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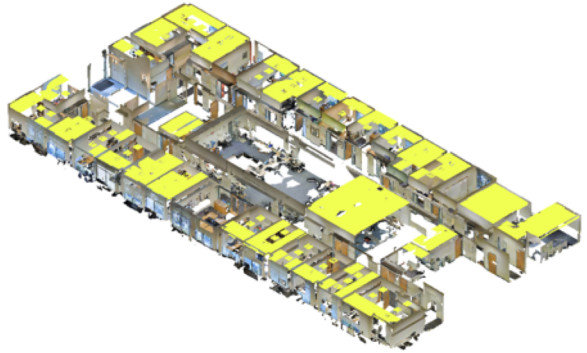
Automatically Generated Space Statistics

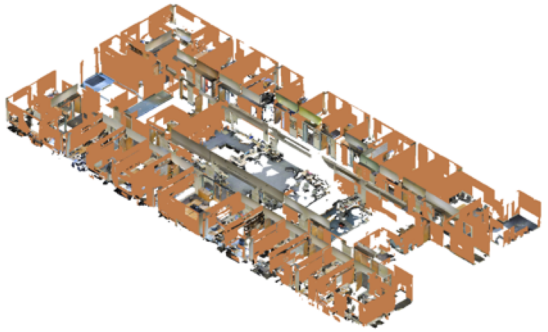


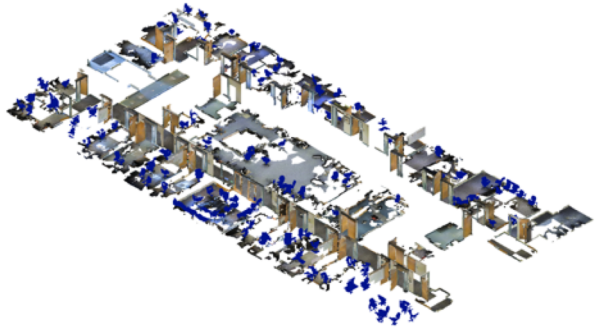
Ceiling

Total Area: 667.67 m2

Walls

Total Number: 42
Total Area: 479.5 m2



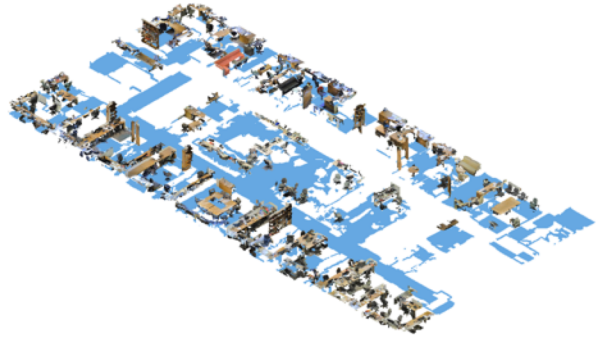


Chairs

Total Number: 106

Floor

Total Area: 639.36 m2

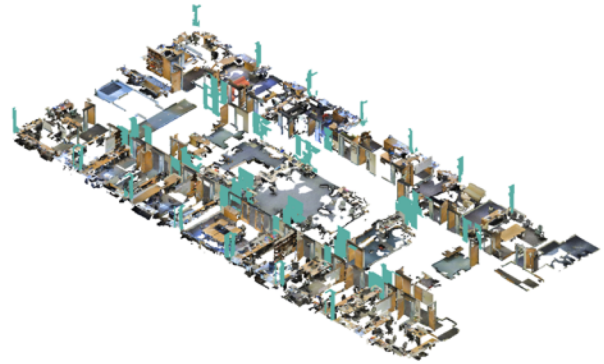


Table

Total Number: 45

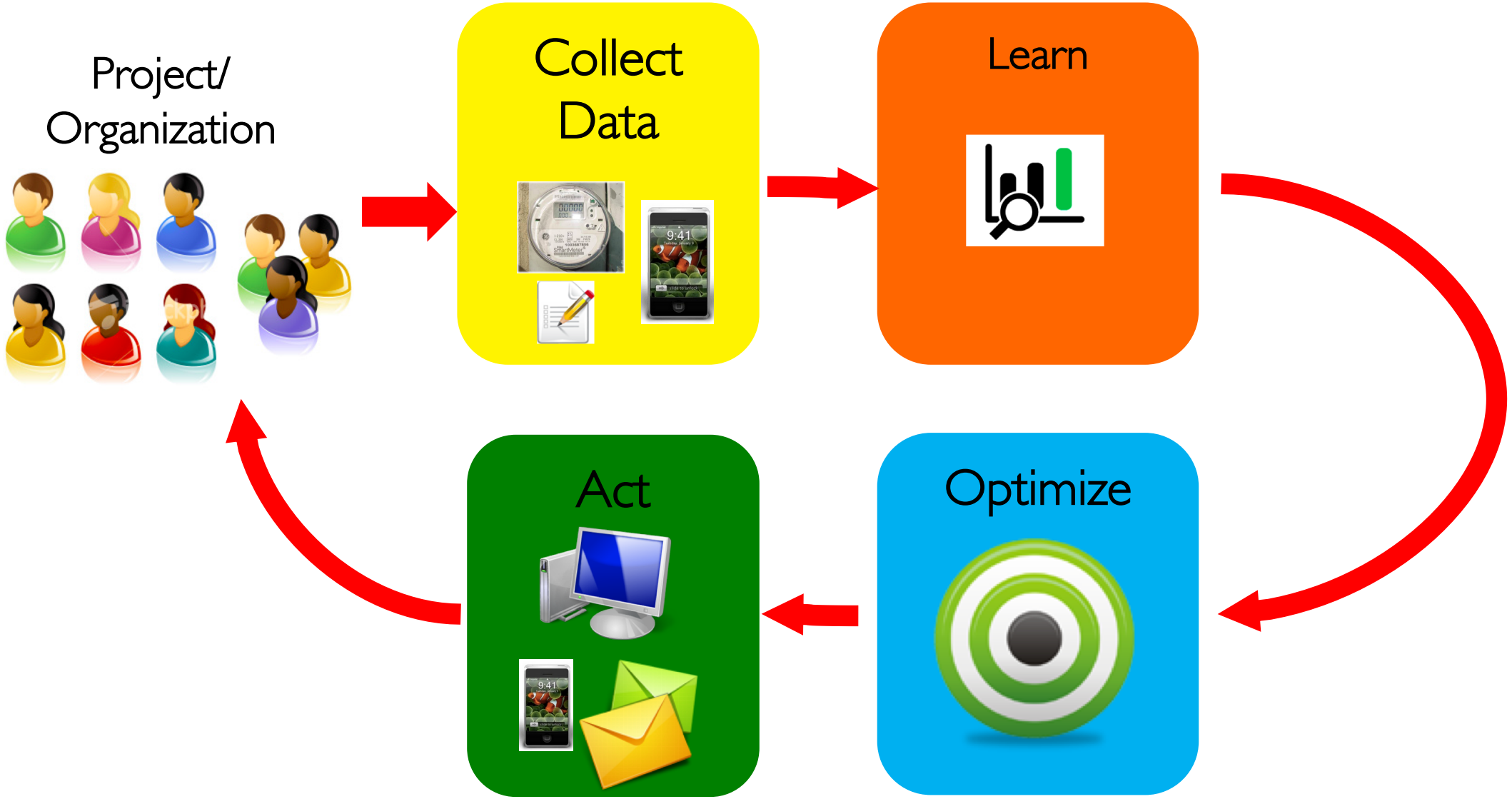
Columns

Total Number: 39

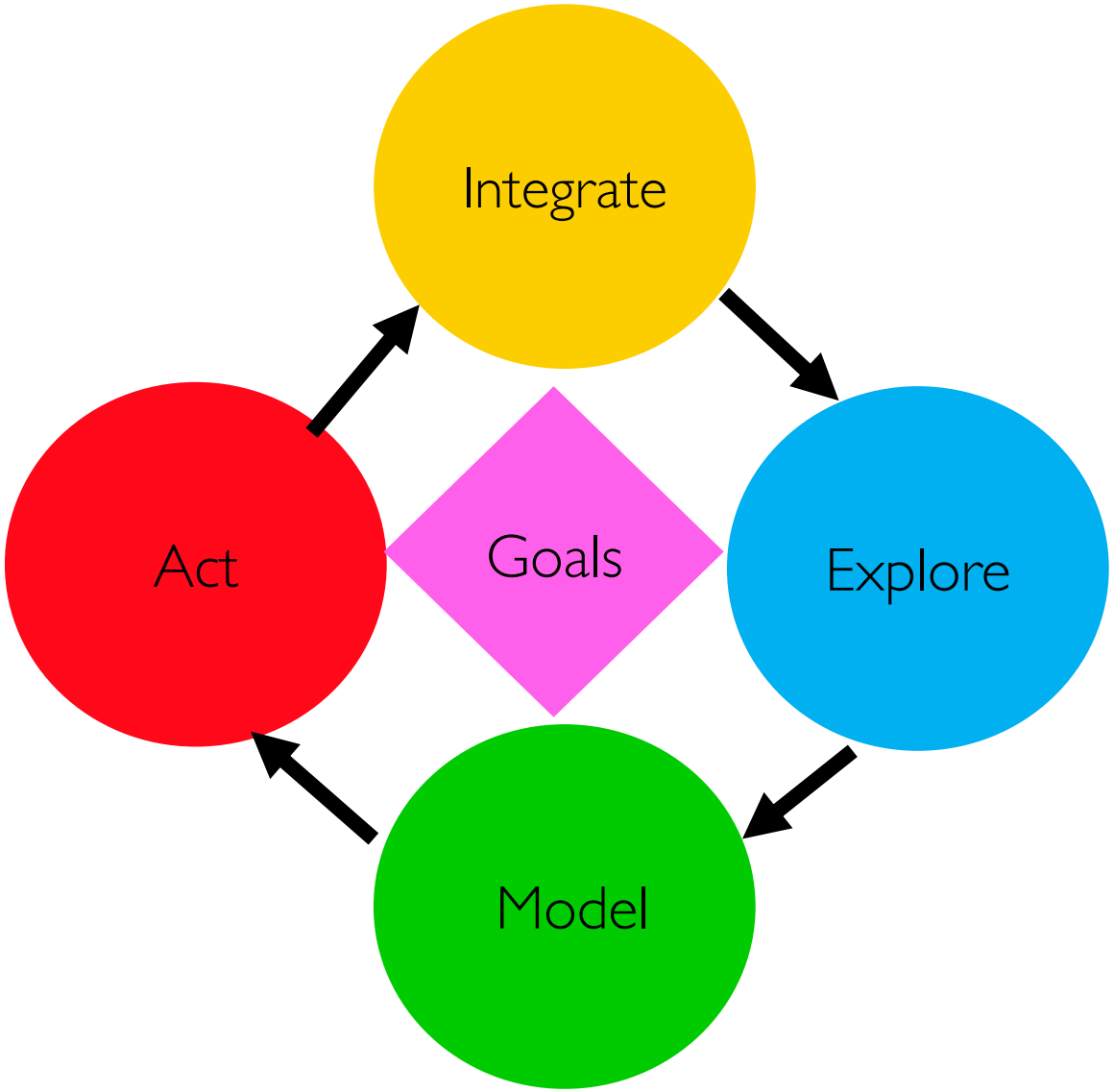


What are tasks you know how to do (or results you know how to get) that you would like to do (get) automatically and consistently?

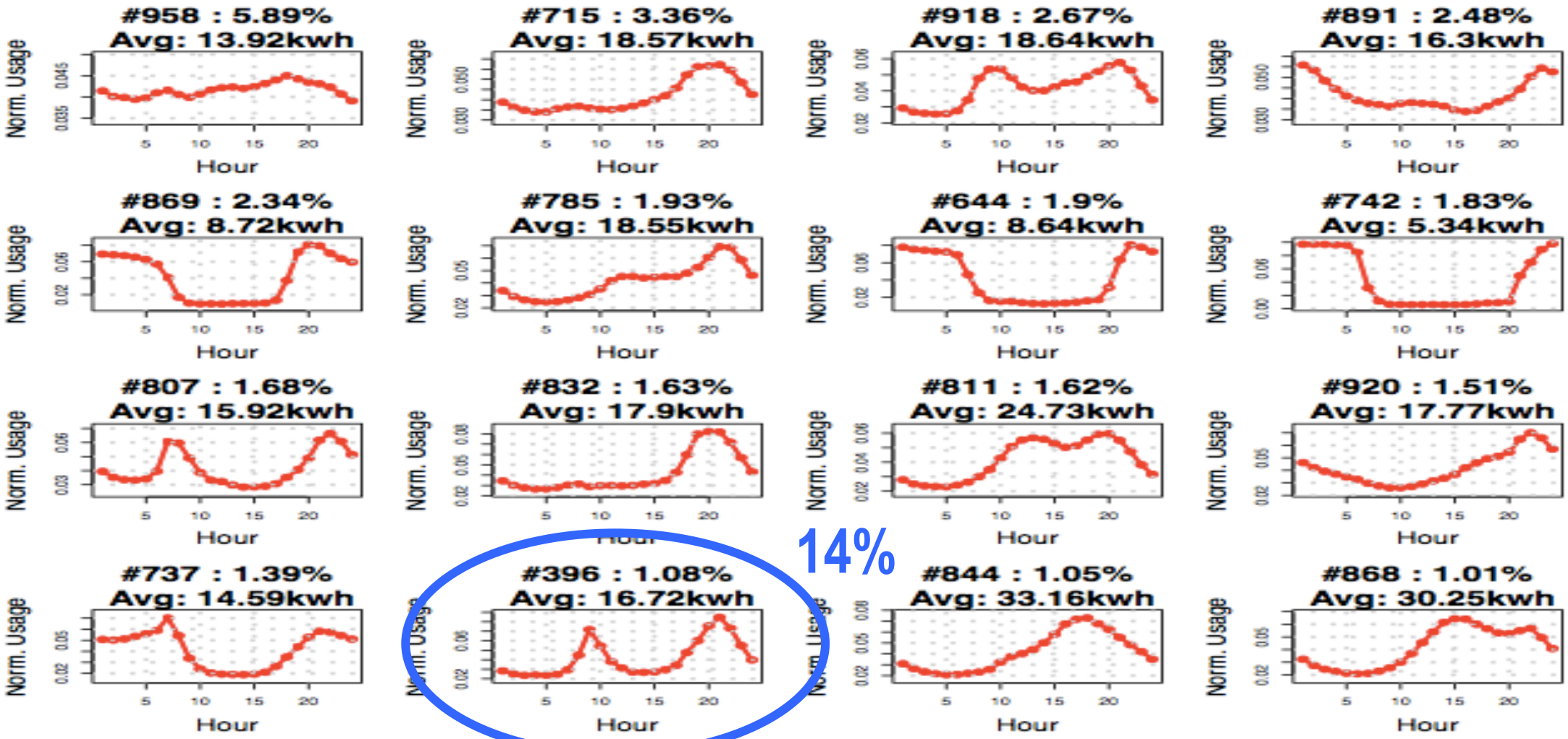
Data-driven Organizations



Data Thinking



Consumption Patterns



Household Energy Consumption Segmentation Using Hourly Data, J. Kwac, J. Flora and R. Rajagopal, IEEE Trans. Smart Grid, 5:1, pp 420-430, 2014.

Three key ingredients:

Machine learning methods

Good data

Good questions

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What are questions you can’t get answered today you would like to get answered?

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What data do you have or could you get?

Challenges in having good data?

In summary, use data science methods to

- Do what you know how to do (and still have to do) more quickly and more consistently

- Start doing things you can't do today

- Identify the most relevant questions for you
- → Collect necessary data and make sure that it's good data
- → Apply machine learning methods
- → Act

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The Business Perspective

"The automated execution of processes changes everything."

(Alan Perlis, 1961)

The Scientific Perspective

"Science is knowledge which we understand so well that we can teach it to a computer; and if we don't fully understand something, it is an art to deal with it. Since the notion of an algorithm or a computer program provides us with an extremely useful test for the depth of our knowledge about any given subject, the process of going from an art to a science means that we learn how to automate something."

(Donald Knuth, Computer Programming as an Art, CACM, Dec. 1974)

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