

Using Technology to Facilitate Learning Abstract Concepts

- Volumetric Visualization
- Time Sequencing Considerations
- Interpretive Behavioral Analysis
- Subjective Thinking Concepts in Construction Cost Estimating

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Construction Cost Estimating and Analysis
UC Davis Estimating Analysis Augmented Reality Lab

Civil and Environmental Engineering
University of California, Davis

The background of the slide is a blue-tinted photograph of a construction site. It shows a complex network of metal scaffolding and rebar structures, likely for a large-scale building project. The perspective is looking upwards, creating a sense of height and scale.

ECI 181

Construction Cost Estimating and Analysis

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CIVIL AND ENVIRONMENTAL
ENGINEERING

The background of the slide features several rolled-up blueprints or technical drawings, showing various engineering diagrams and text. A yellow pencil with a pink eraser and a sharpened lead tip is positioned diagonally across the center of the image, resting on one of the blueprints. The overall color scheme is a cool blue, with the yellow of the pencil providing a strong contrast.

Challenges when teaching engineering rigor while introducing students to applied abstract thinking and visualization skills

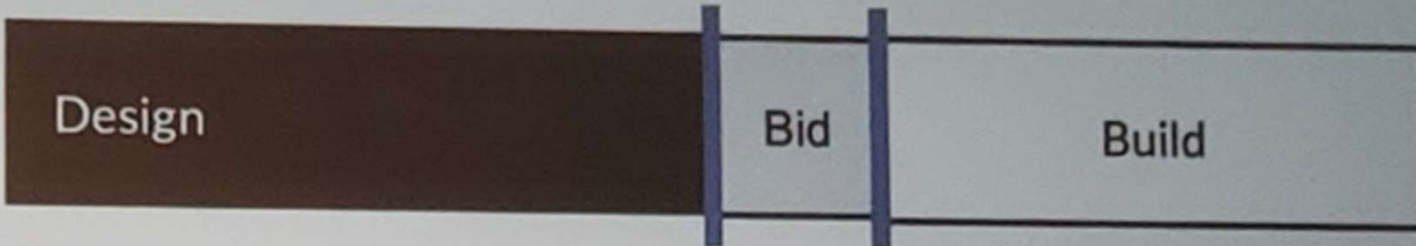
- Difficult to grasp
- Necessary in technical disciplines related to predictive analysis

Engineering undergraduate students are trained in objective analysis based on prescribed values and closed-ended solutions.

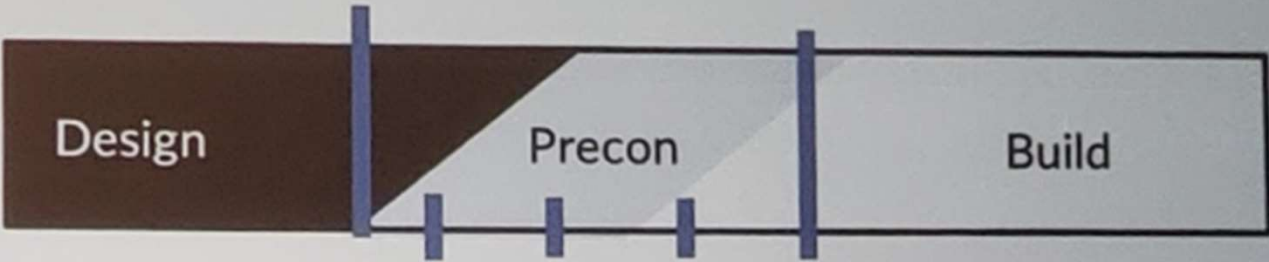
- Open-ended and subjective considerations analysis is likely required.
- Challenging to teach analysis which depend on visualization of a future multi-dimensional state.

The Future of Precon is More Precon

Past



Current



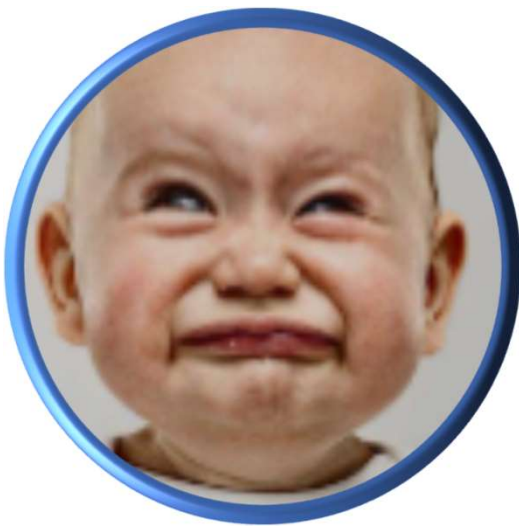
Future



■ = Iteration

Owner Cost Awareness Measurement:

The BABY-O-Meter



The Future of Precon is More Precon

Owner Business Case \$

Owner Confirmed Cost

Past

Design

Bid

Build



Current

Design

Precon

Build



Future

Design

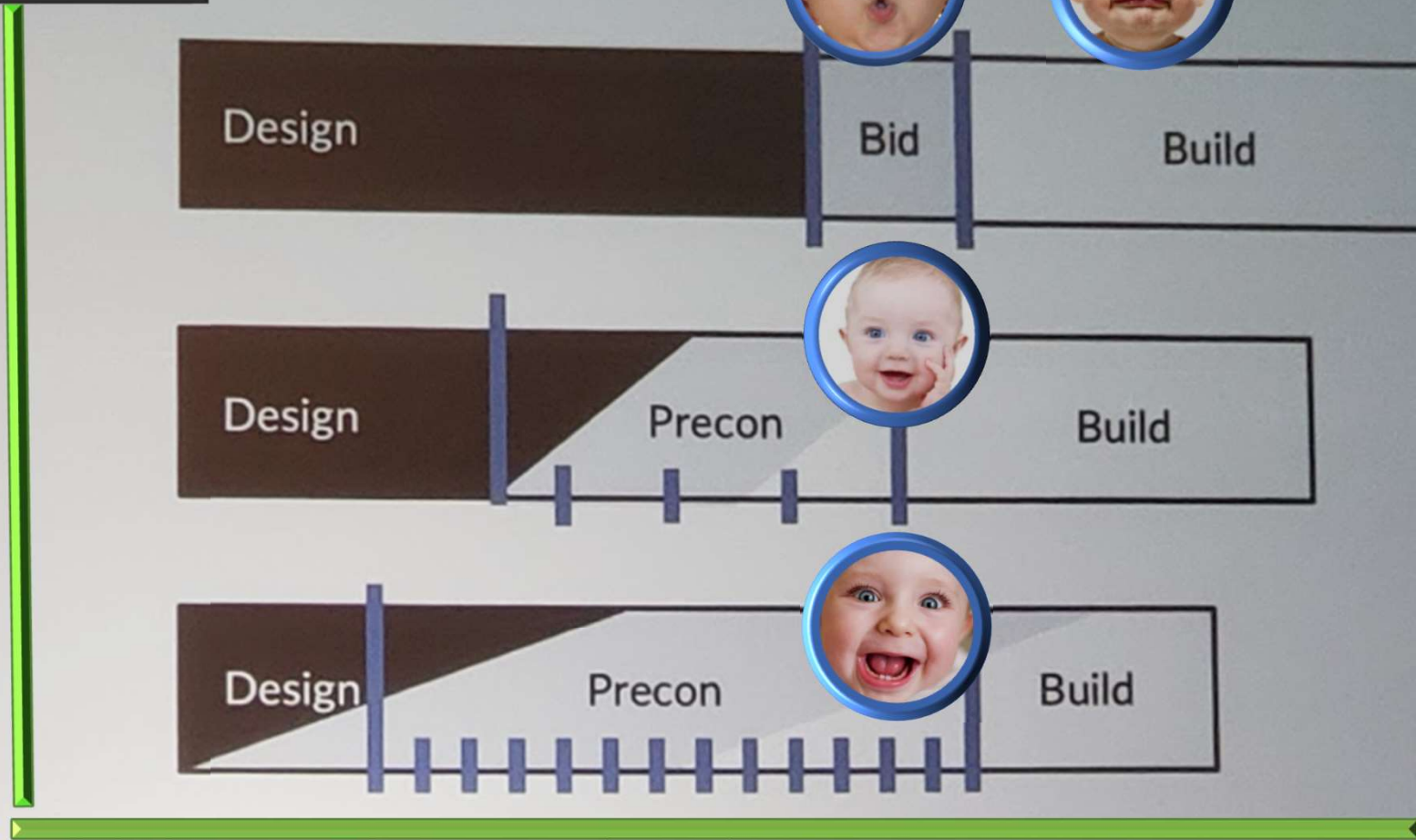
Precon

Build

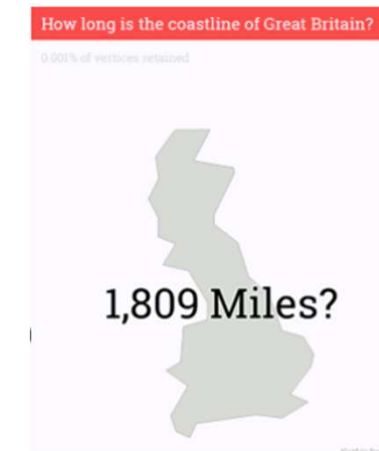


▮ = Iteration

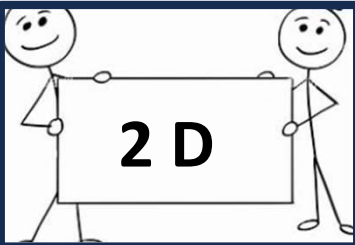
TIME



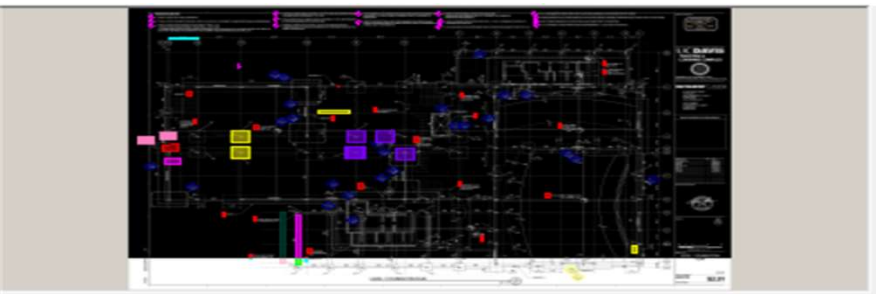
How long is the coastline of Great Britain?



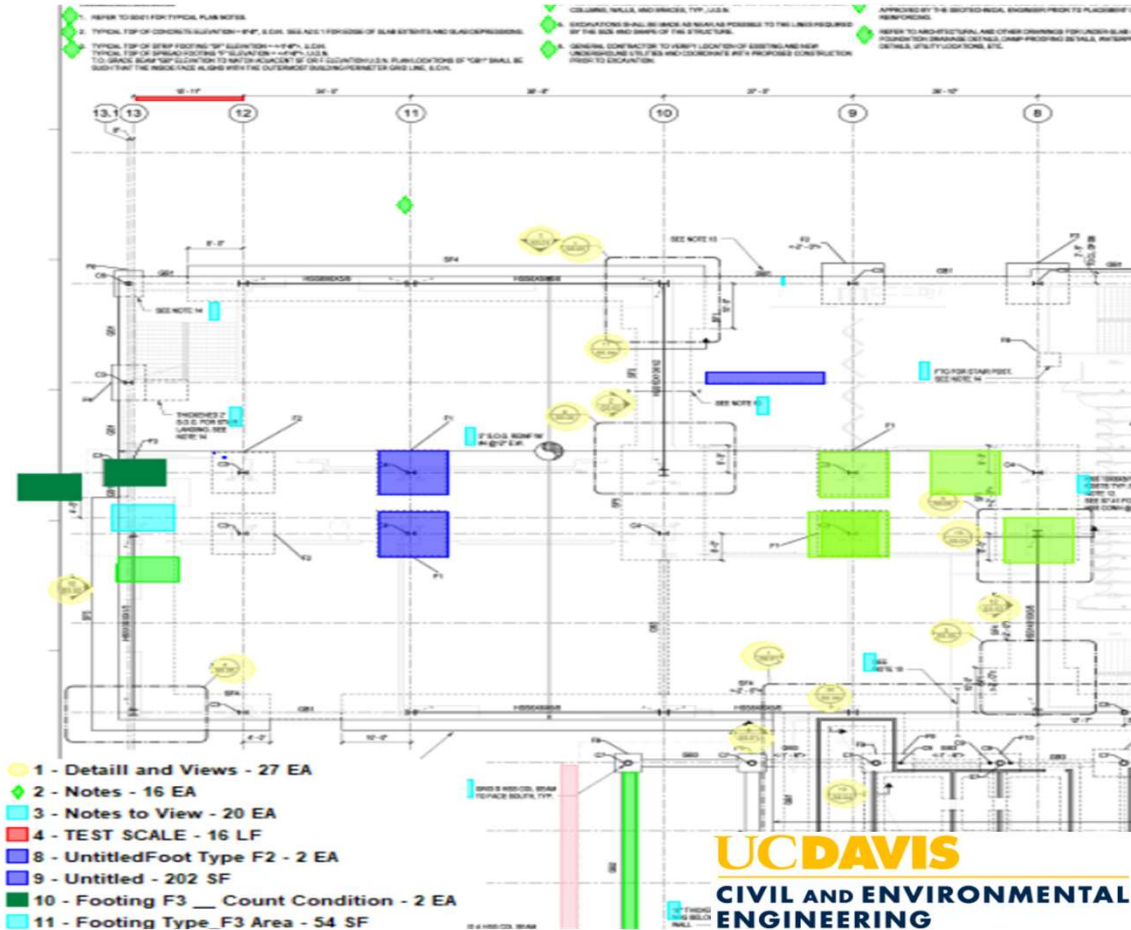
- Credit: Alastair Rae 2016



STRUCTURAL FOUNDATION PLAN



| No. | Name | Qty1 | Qty2 | Qty3 |
|----------------------|--------|--------|--------|------|
| Untitled | 202 SF | 19 CY | 80 LF | |
| Untitled | 0 EA | | | |
| Untitled | 0 EA | | | |
| TEST SCALE | 16 LF | | | |
| Take Notice | 0 EA | | | |
| Notes to View | 20 EA | | | |
| Notes | 16 EA | | | |
| GB2 LF | 43 LF | 172 SF | 6 CY | |
| GB2 | 100 SF | 90 LF | 7 CY | |
| GB | 0 SF | | | |
| Footing Type_F3 ... | 54 SF | 5 CY | 30 LF | |
| Footing type F1 | 5 EA | 28 CY | 200 LF | |
| Footing F3 TEST A | 52 SF | 30 LF | 5 CY | |
| Footing F3 __ Cou... | 2 EA | 60 LF | 10 CY | |
| Detail and Views | 27 EA | | | |
| BG LF TEST | 24 LF | | | |

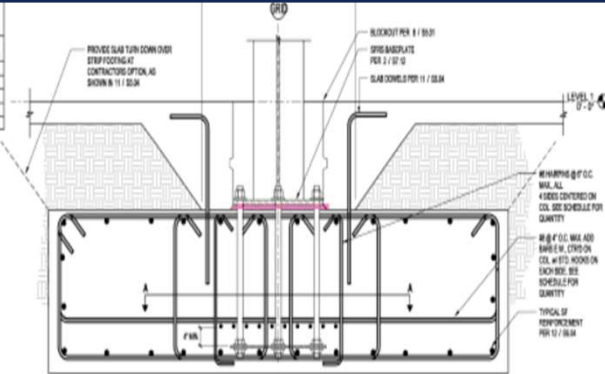


STRUCTURAL FOUNDATION DETAILS

REINFORCING SCHEDULE PER SP TYPE

| MARK | HARPN QUANTITY (PER SIDE) | HORIZONTAL ADD BAR QUANTITY (E.W.) |
|------|---------------------------|------------------------------------|
| SP1 | 6 | 6 |
| SP2 | 6 | 12 |
| SP3 | 6 | 12 |

REFER TO 2 / 18 IN 3 / 16 IN FOR TOP REIN. SEE NOTES.
REFER TO 4 / 11 / 12 FOR COLUMN. SEE PLAN DETAIL NOTES.

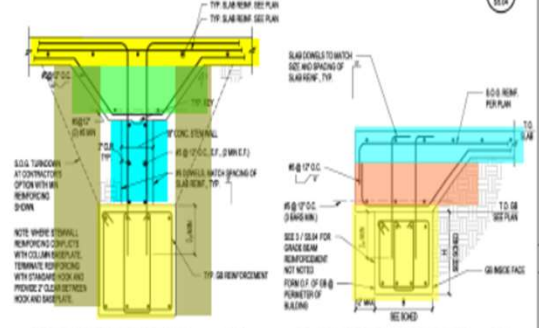


RECTANGULAR FOOTING REINFORCEMENT SCHEDULE

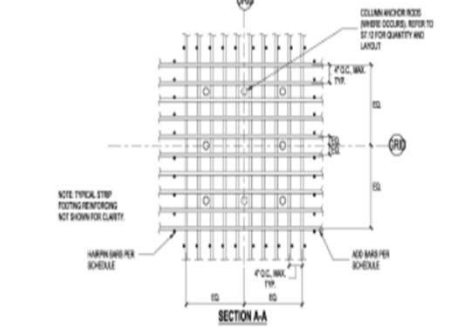
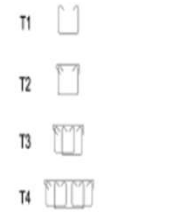
| MARK | WIDTH | HEIGHT | TOP REIN. TYPE | ADD. REIN. TYPE | BOTT. REIN. TYPE | CA. REIN. TYPE | REMARKS |
|------|--------|--------|----------------|-----------------|------------------|----------------|---------|
| F1 | 10'-0" | 10'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F2 | 8'-0" | 8'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F3 | 6'-0" | 6'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F4 | 4'-0" | 4'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F5 | 2'-0" | 2'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F6 | 4'-0" | 4'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F7 | 4'-0" | 4'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F8 | 3'-0" | 3'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F9 | 4'-0" | 4'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F10 | 4'-0" | 4'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F11 | 6'-0" | 6'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |
| F12 | 3'-0" | 3'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 |

- NOTES:**
- SEE FOUNDATION PLAN FOR FOOTING MARK LOCATIONS.
 - SEE BASE PLATE DETAILS FOR ANCHOR ROD DETAILS.
 - SEE SHEETS B14 FOR TYPICAL CONCRETE DETAILS AND ADDITIONAL FOUNDATION DETAILS.
 - ALL FOOTINGS AND GRADE BEAMS ARE CENTERED ON GRIDS UNLESS OTHERWISE SPECIFIED ON PLAN DETAILS.

TYPICAL COLUMN RECTANGULAR FOOTING WITH GRADE BEAMS 1 SLAB



SLAB ON GRADE TURN DOWN AND STEM WALL AT INTERIOR GB 6 SLAB
TYPICAL SLAB ON GRADE TURN DOWN AT EXTERIOR GB 2 SLAB



GRADE BEAM SCHEDULE - FULL VERSION

| MARK | WIDTH | HEIGHT | TOP REIN. | | | BOTT. REIN. | | | STIRRUPS | | | REMARKS |
|------|-------|--------|-----------|--------|--------|-------------|--------|-----|----------|------|---------|---------|
| | | | TYPE | ADD. | BAR | TYPE | ADD. | BAR | SIZE | TYPE | SPACING | |
| GB1 | 1'-0" | 1'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 | (1) #5 | #4 | 12 | 12 | | |
| GB2 | 2'-0" | 2'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 | (1) #5 | #4 | 12 | 12 | | |
| GB3 | 1'-0" | 1'-0" | (1) #5 | (1) #5 | (1) #5 | (1) #5 | (1) #5 | #4 | 12 | 12 | | |

SEE FOUNDATION PLAN FOR GRADE BEAM SIZES
GRADE BEAM SCHEDULE

ENGINEERED BY
DIV. OF THE STATE ARCHITECT
SERV. BY TISHKO, INC.
REGISTERED FOR
ARCH. PLAN. ARCH.
DATE: 03/20/2011

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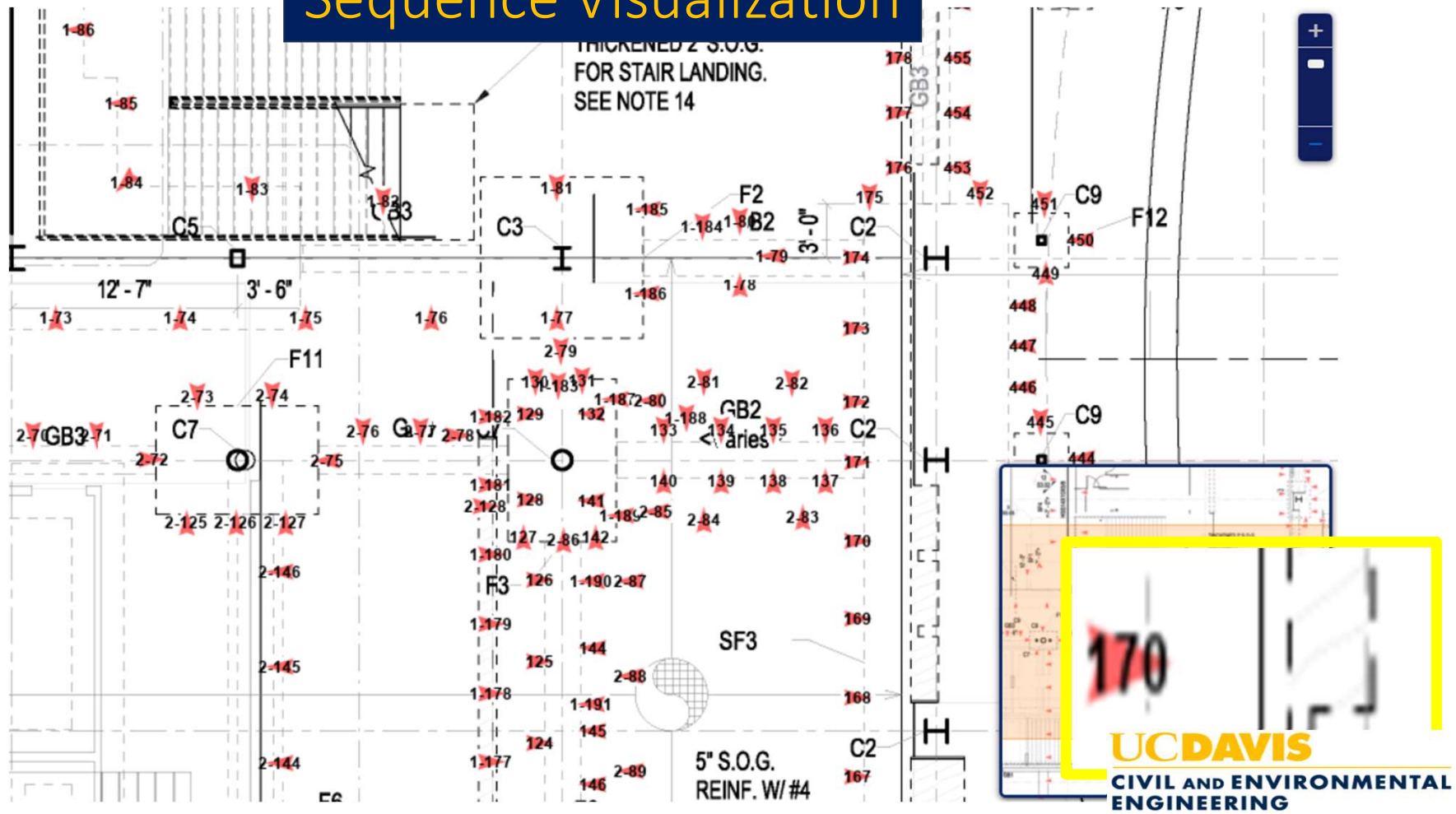
1001 J STREET
SACRAMENTO, CA 95811
916.946.8454
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SPACE RESERVED FOR FIRE MARSHAL

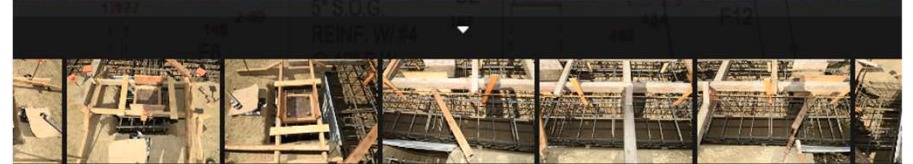
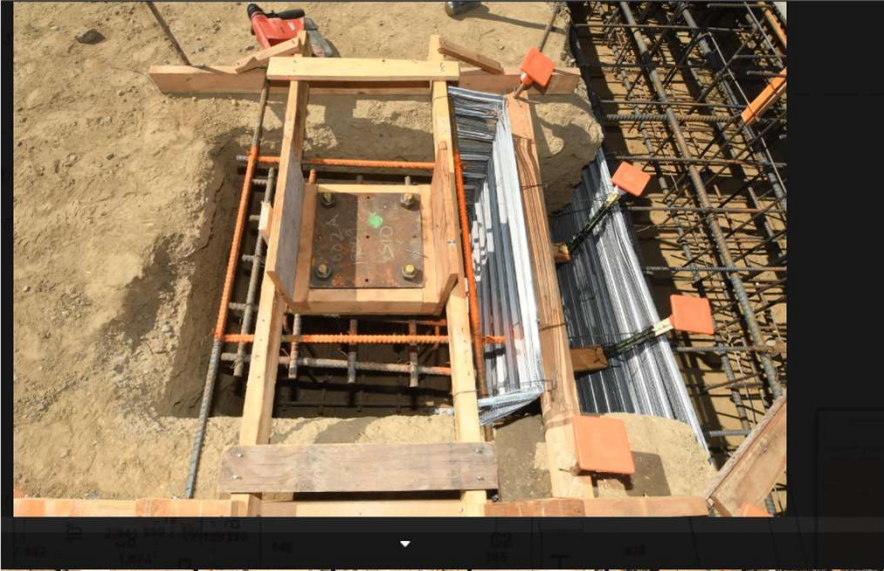
ISSUED FOR: REV. DATE:
BY: J. BENTLEY: DATE: 03/20/11
CHK: J. BENTLEY: DATE: 03/20/11
DLS: J. BENTLEY: DATE: 03/20/11

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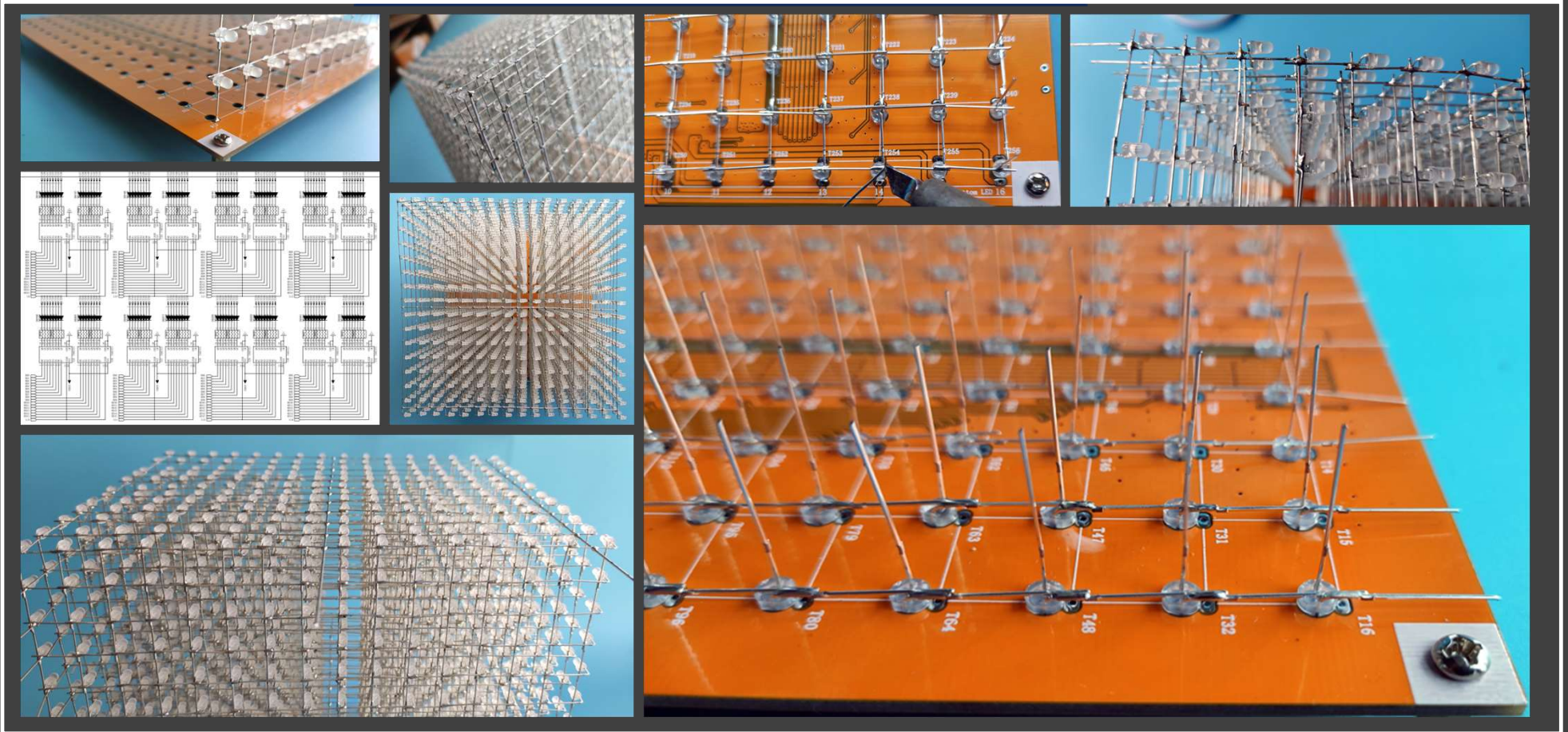
Sequence Visualization



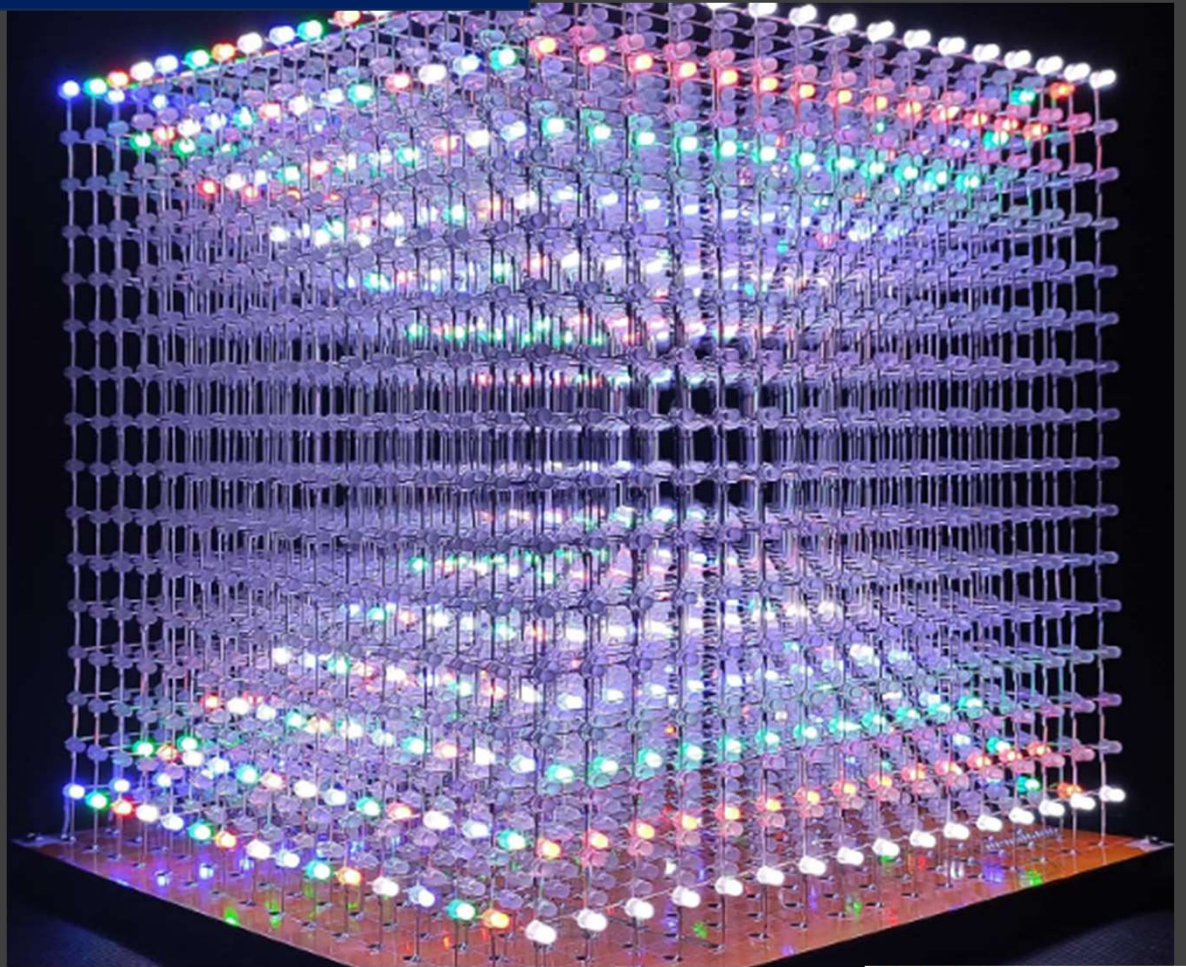
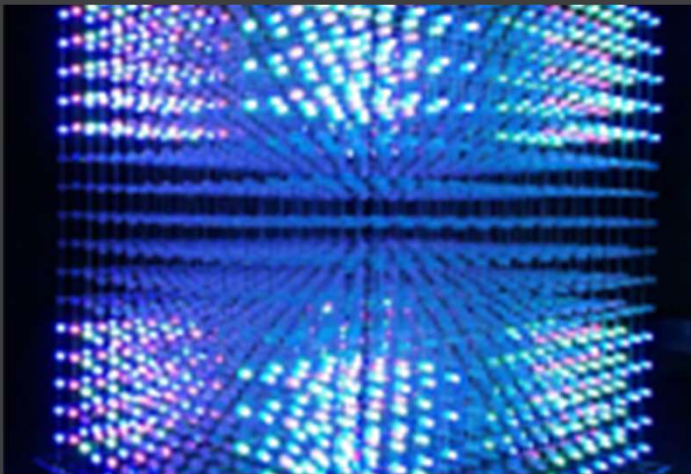
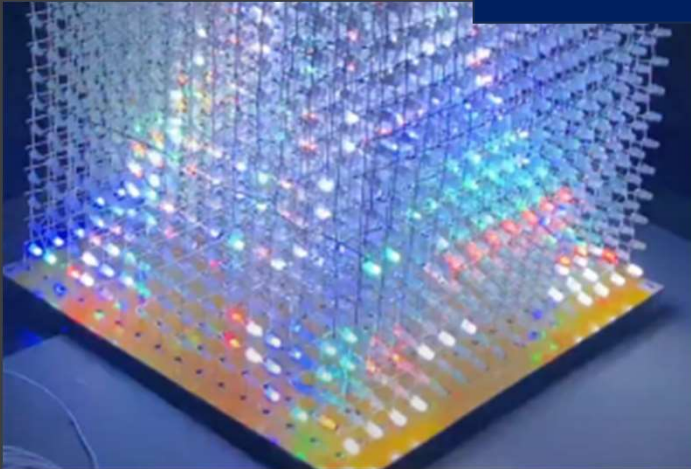
Sequence Visualization



The "CUBE"

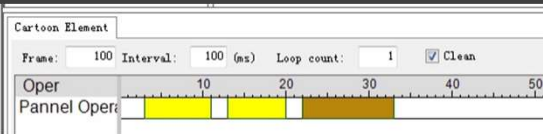
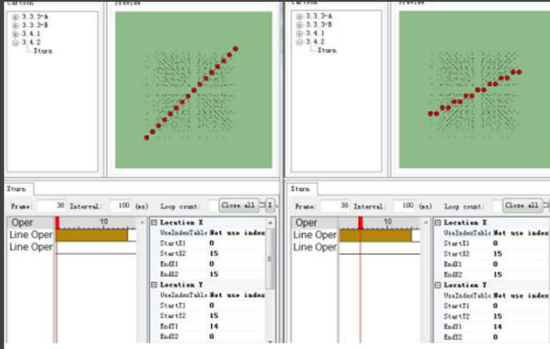
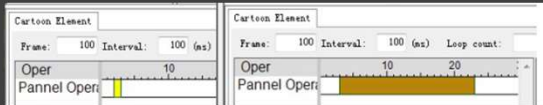
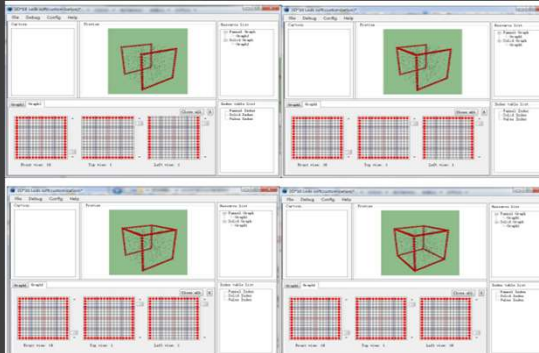
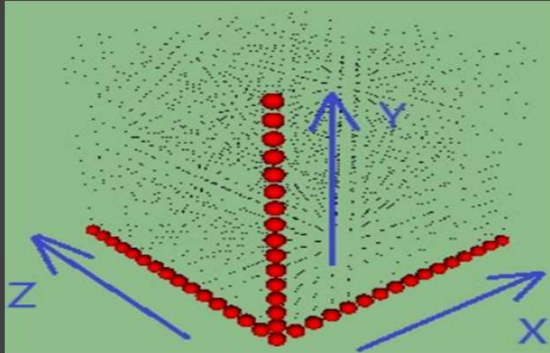
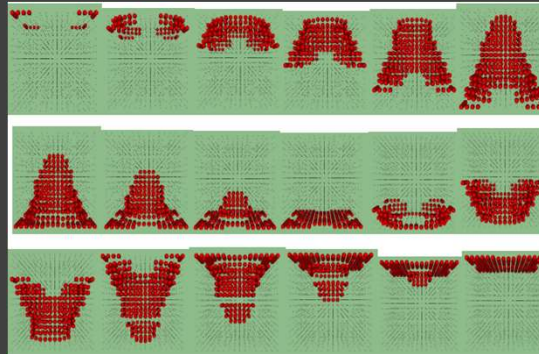
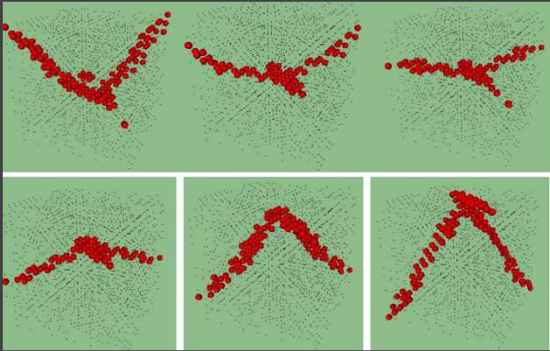


The "CUBE"

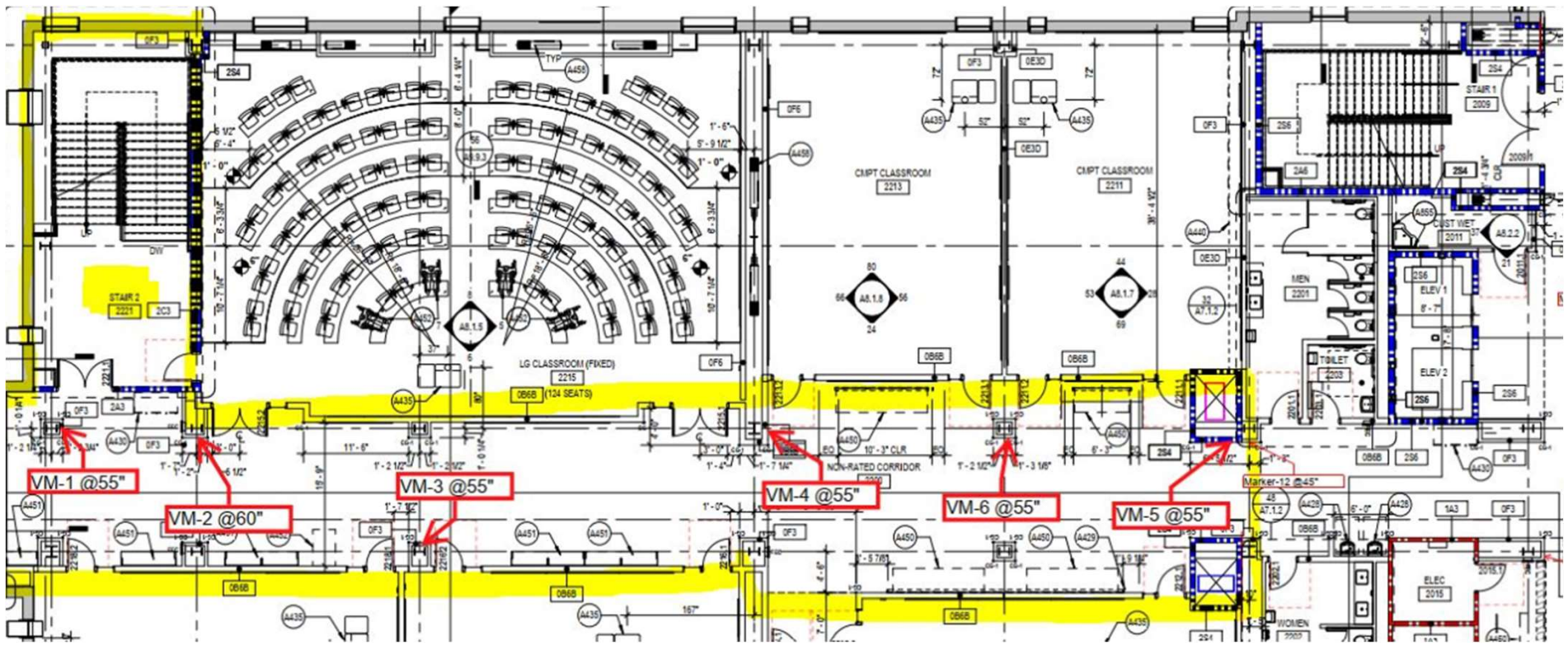


The "CUBE"

Multiple
Disciplinary
Opportunity
for Teaching



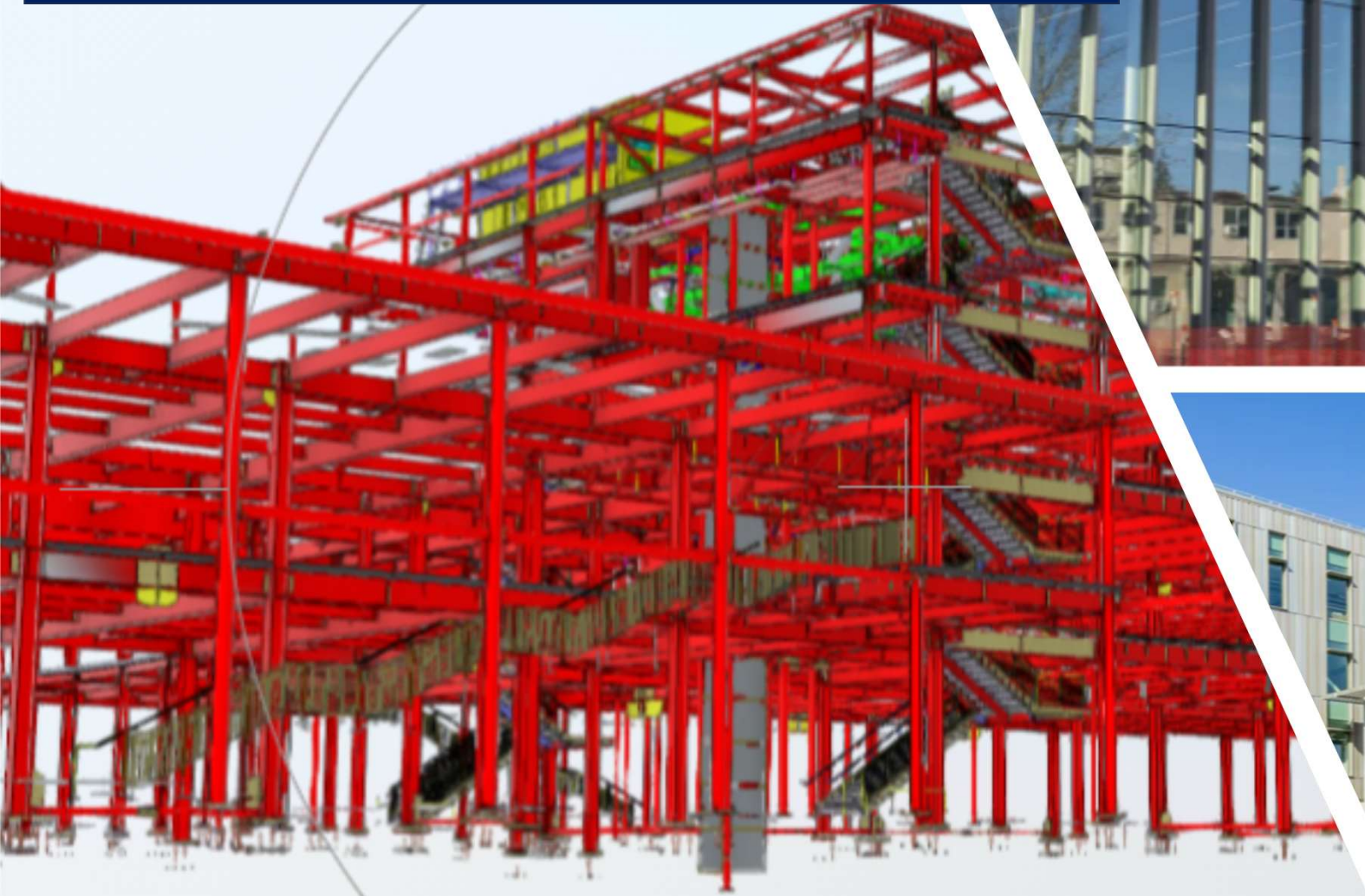
UCD TLC ESTIMATING ANALYSIS AR LAB



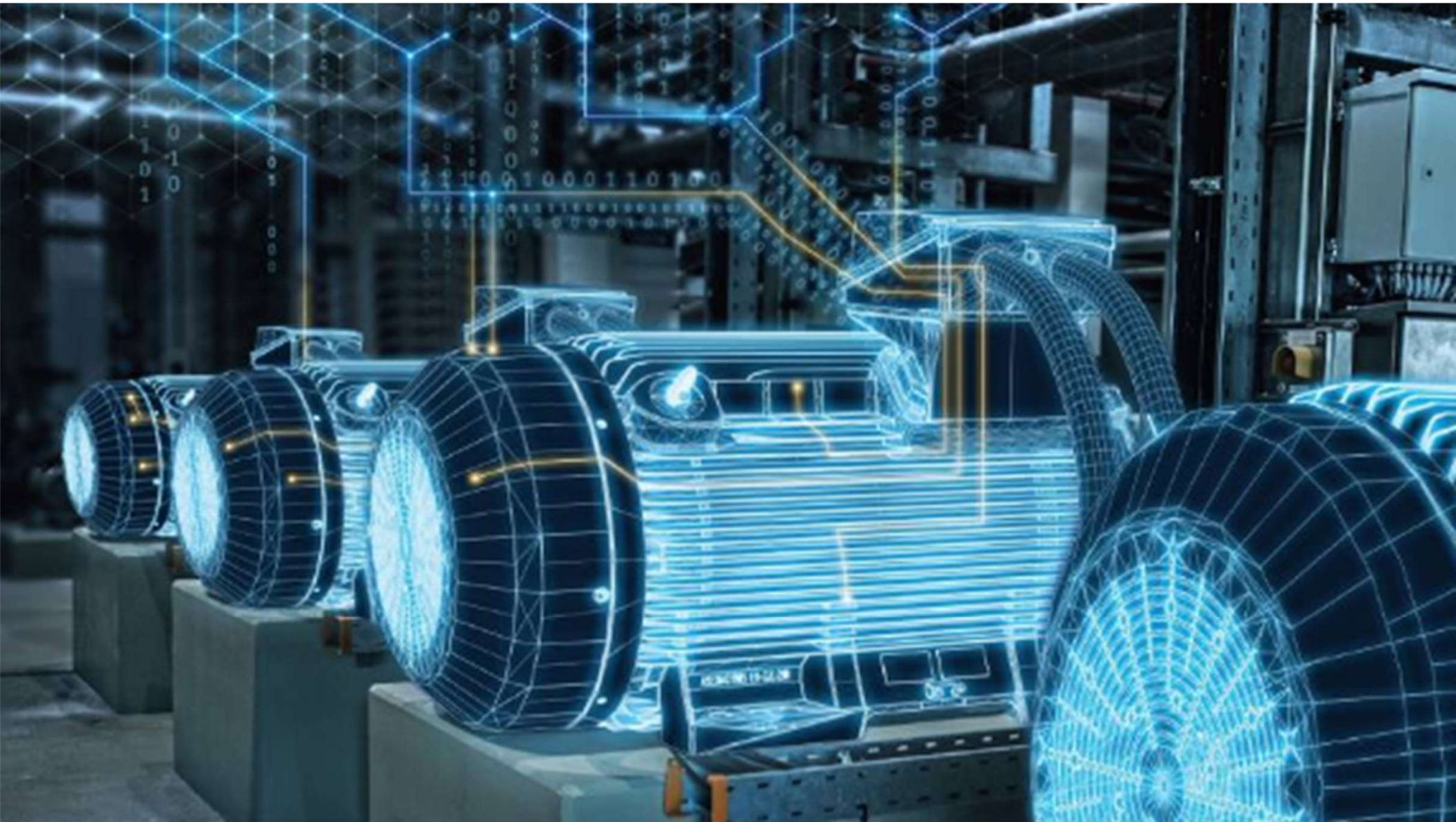
UCD TLC ESTIMATING ANALYSIS AR LAB



UCD TLC ESTIMATING ANALYSIS AR LAB

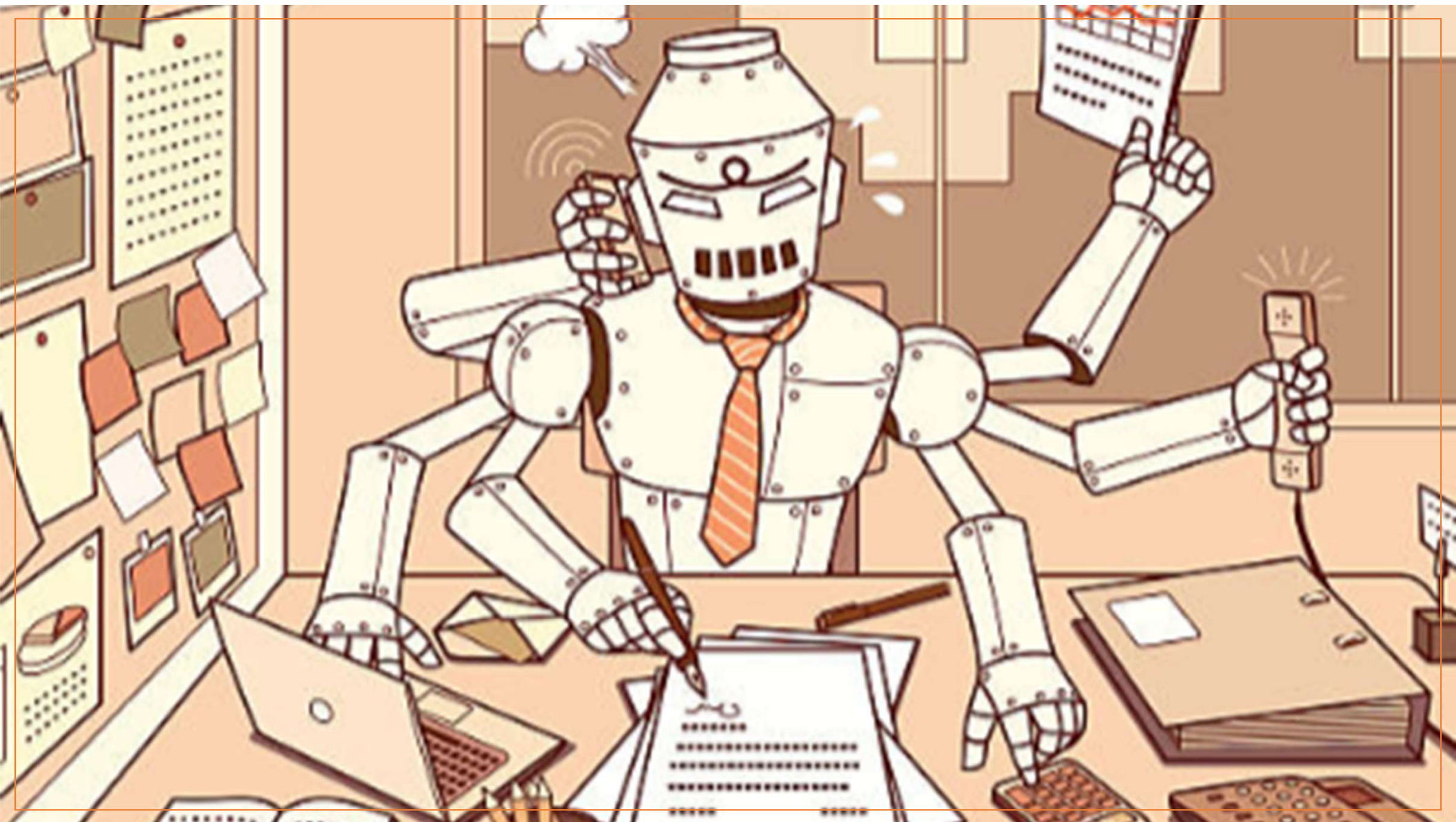


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AN
REVIEW





Behavioral Analysis



Pythagorean tuning

Article Talk

22 languages

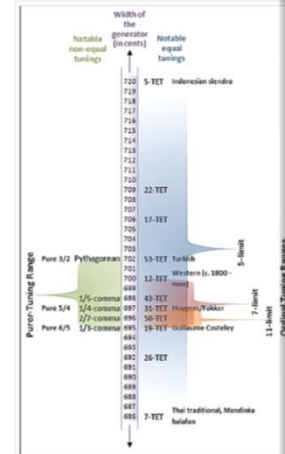
Read Edit View history Tools

From Wikipedia, the free encyclopedia

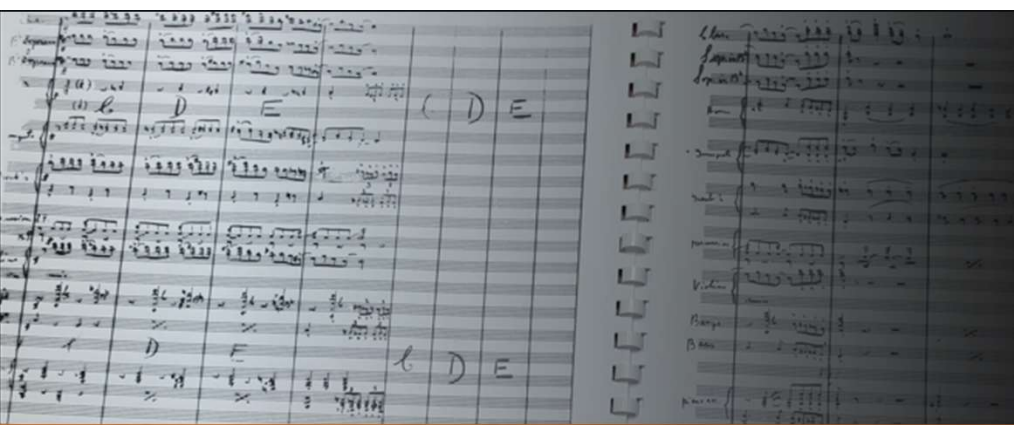
Pythagorean tuning is a system of *musical tuning* in which the *frequency ratios* of all *intervals* are based on the ratio 3:2.^[2] This ratio, also known as the "pure" perfect fifth, is chosen because it is one of the most *consonant* and easiest to tune by ear and because of importance attributed to the integer 3. As *Novalis* put it, "The musical proportions seem to me to be particularly correct natural proportions."^[3] Alternatively, it can be described as the tuning of the *syntonic temperament*^[1] in which the *generator* is the ratio 3:2 (i.e., the untempered perfect fifth), which is ≈ 702 cents wide.

The system dates to Ancient Mesopotamia;^[4] see *Music of Mesopotamia § Music theory*. The system is named, and has been widely misattributed, to *Ancient Greeks*, notably *Pythagoras* (sixth century BC) by modern authors of music theory, while *Ptolemy*, and later *Boethius*, ascribed the division of the *tetrachord* by only two intervals, called "semitonium", "tonus", "tonus" in Latin (256:243 × 9:8 × 9:8), to *Eratosthenes*. The so-called "Pythagorean tuning" was used by musicians up to the beginning of the 16th century. "The Pythagorean system would appear to be ideal because of the purity of the fifths, but some consider other intervals, particularly the major third, to be so badly out of tune that major chords [may be considered] a dissonance."^[2]

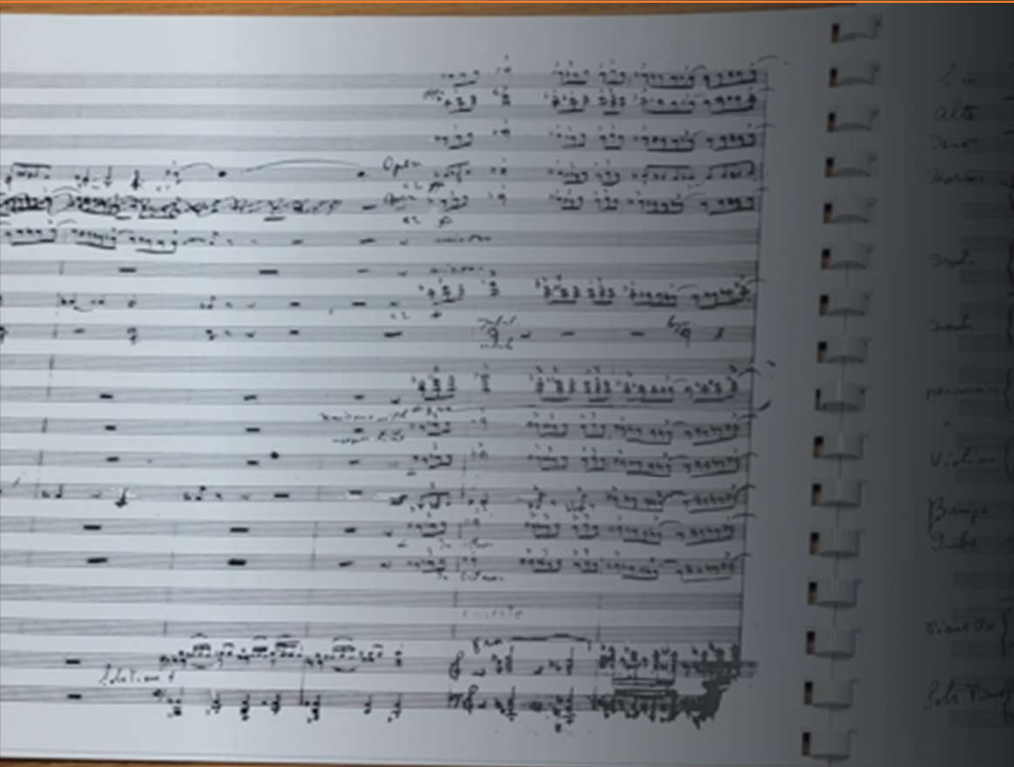
The **Pythagorean scale** is any *scale* which can be constructed from only pure perfect fifths (3:2) and octaves (2:1).^[5] In Greek music it was used to *tune tetrachords*, which were composed into scales spanning an octave.^[6] A distinction can be made between extended Pythagorean tuning and a 12-tone Pythagorean temperament. Extended Pythagorean tuning corresponds 1-on-1 with western music notation and there is no limit to the number of fifths. In 12-tone Pythagorean temperament however one is limited by 12-tones per



The syntonic tuning continuum, showing Pythagorean tuning at 702 cents^[1]



- An American In Paris
- George Gershwin
- 1928



New York Philharmonic

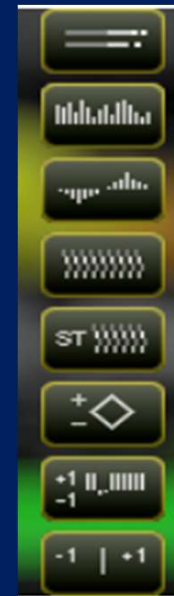
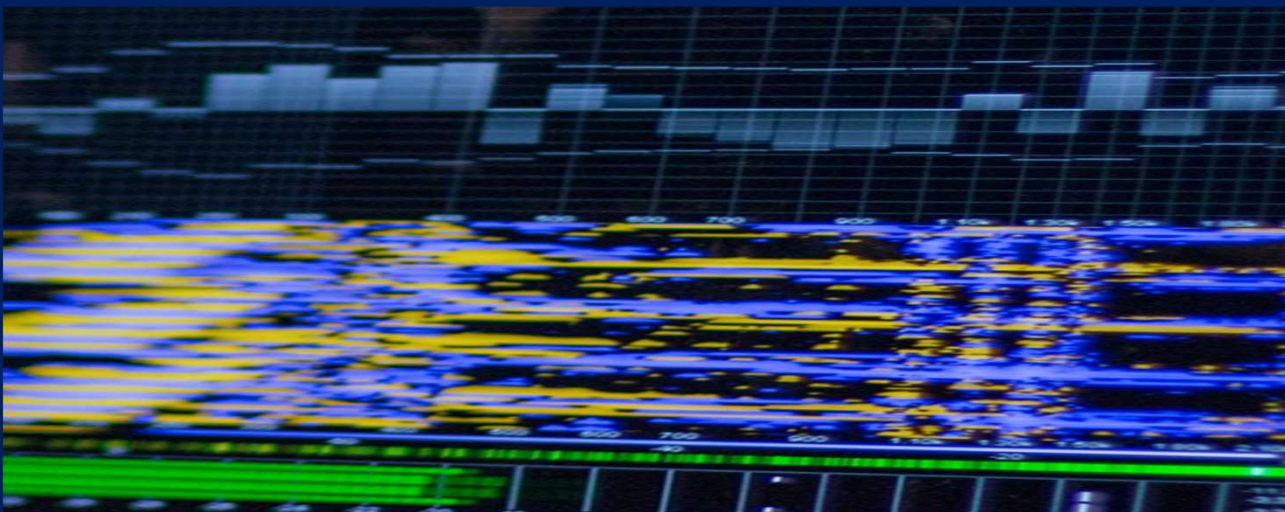


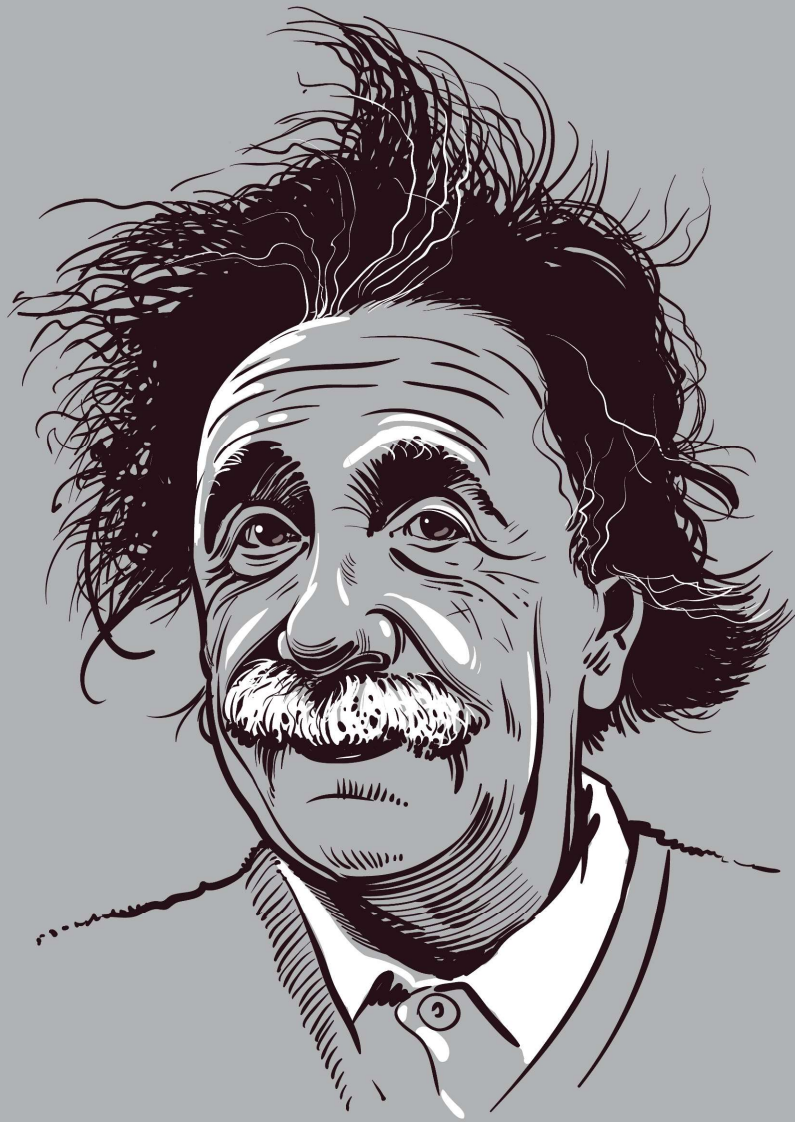
1928



1959

Behavioral Analysis





"Not everything that counts
can be counted, and not
everything that can be
counted counts."

A stage with red curtains and two people in costumes. The scene is lit with stage lights, and the floor is covered with gold balloons.

THANK YOU

Questions

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