

Construction AI: Practical Case Studies in Site Safety & Construction for IT Leaders

Dr. Will F. Ikerd II, PhD, PE

2025 AGC Technology Conference





Proposal Contents

Title

Construction AI: Practical Case Studies in Site Safety & Construction for IT Leaders

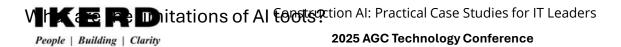
Session Description

This session will focus on practical AI case studies and AI use cases construction teams use on projects. It will help those construction industry cut through the fake hype of AI-washing marketing and look at practical examples of real projects the construction. It will include case studies of AI used in site safety and modular steel construction.

The session will briefly introduce key AI and data analytics concepts relevant to construction technology leaders. Reference citations will be provided for attendees to dive deep into the material later.

Case studies will look at construction project specification analysis and detailed Request For Information (RFI) creation. He thought, 'Wouldn't it be great if there was some way to improve this tedious process specification review and RFI creation? is! The session will provide clear examples of practical case studies of using AI tools on building projects for specifications generating RFIs on design documents reviewed. This session is designed to cut beyond the hype and provide clear, practic real projects using AI for construction. Key actionable takeaways that attendees will be able to answer.

What are the most used AI tools in business today that are relevant to the construction professional?









- Began in 2013
- IKERD is internationally recognized consulting group in buildings, civil and industrial construction markets.
- Aid structural Engineering Firms in Technology, Value and Process Improvement
- Using our knowledge of engineering, team dynamics, communication and technology, we have built an extensive breadth of experience on a wide variety of integrated construction project types with BIM.
- Engineering and Construction grade modeling.
- 3D Laser Scanning







Washington University in St. Louis



UNIVERSITY of DENVER

Mid-90's Graduate Work in Parametric Structural Engineering of Buildings with EDU. Pre-Netscape /Pre-email

2018-2021 PhD in Real State and Construction with BIM, Reality Capture & Machine Learning







The University of Texas at Austin
Texas Executive Education





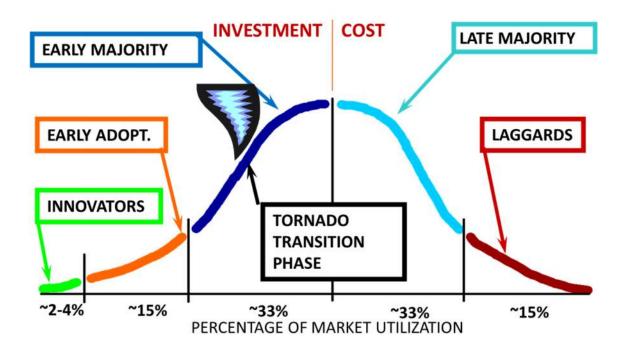
Some material from this presentation was developed with input from Dr. Kumar Muthuraman PhD, Dr. Gaylen Paulson PhD, Dr. Dan Mitchell PhD at UT Austin post-graduate programs in Artificial Intelligence, Full Stack Programming and Machine Learning.







TECHNOLOGY ADOPTION LIFE CYCLE (1950'S MODEL), ADAPTED FROM MOORE'S BOOK, "INSIDE THE TORNADO"

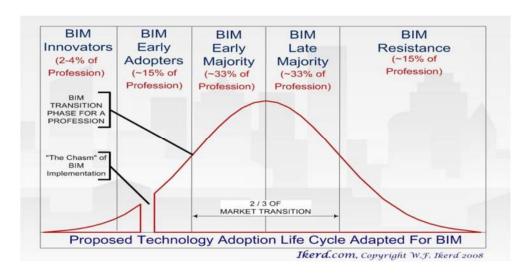


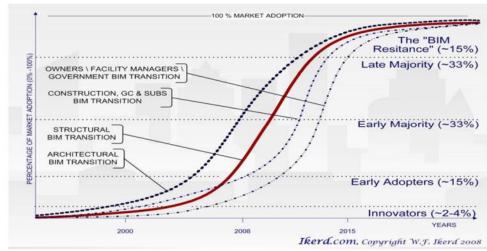






TECHNOLOGY ADOPTION LIFE CYCLE HOW PEOPLE, FIRMS & INDUSTRIES ADOPT TECHNOLOGY









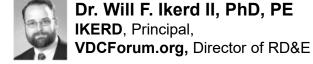




Artificial Intelligence

- Artificial Intelligence
- Not Real Intelligence
- Fake Intelligence









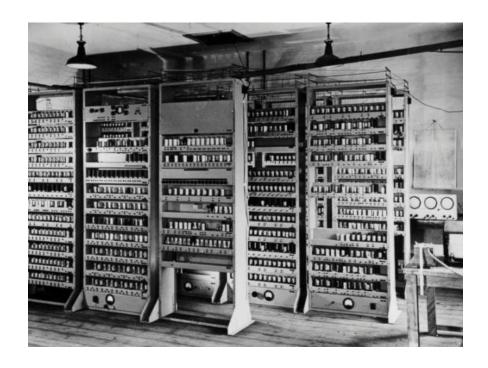
Evolution of Data Science

- Inferential/Mathematical
 - Central Tendency
 - Expected Values
 - Probability Theory
- Computational
 - Telegraph
 - Difference Engine
 - Audio Tapes









History 1940

- McCulloch-Pitts Neuron, 1940
- "The embryo of an electronic computer that (the Navy) expects will be able to walk, talk, see, write, reproduce itself and can be conscious of its existence." Rosenblatt, 1958









On June 14, 1951, we dedicated UNIVAC I, the nation's first commercial computer built for a civilian government agency at the Eckert-Mauchly Laboratory in Philadelphia, PA. https://en.wikipedia.org/wiki/UNIVAC_I#/media/File:Univac_I_Census_dedication.jpg

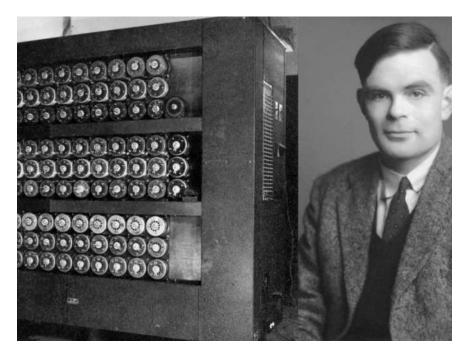
Evolution of Data Science 1940's-1950's

- Inferential Mathematical
 - Industrial Statistics
 - Sampling Theory
 - ANOVA
- Computational
 - Digital Computers
 - Monte Carlo Methods
 - Programming Languages









lustration of Alan Turing & Turing Machine. By pivotal.digital

Artificial Intelligence 1940's-1950's

- AI, has been with us for a long time. Since 1940 we have been obsessed with AI. One of the biggest reasons for the AI boom, especially in the 2010s, is that we now have the hardware power particularly GPUs—to support the development and training of complex AI models.
- In 1950 Alan Turing already published: "Computer Machinery and Intelligence" which proposed a test of machine intelligence, later this test was named after his name: The Turing Test.









Evolution of Data Science 1980's-1990's

- Inferential Mathematical
 - Resampling Methods
 - Generalized Linear Models
 - Model Selection
- Computational
 - Personal Computers
 - Object Oriented Programming
 - Adv. Programming









Evolution of Data Science 2000s-2010s

- Inferential Mathematical
 - Bayesian Networks
 - Causal Interference
 - Open Science Movement
- Computational
 - Artificial Intelligence Revi
 - Big Data
 - Cloud Computing









Evolution of Data Science 2020s+

- Inferential Mathematical
 - Interdisciplinary
 - Newer Causal Interference
 - Natural Experiments
- Computational
 - Blockchain
 - Edge Computing
 - Quantum Computing







Kasparov vs IBM Deep Blue (1996-1997)









Deep Blue in IBM's headquarters om Armonk, NY. Photo by: YVONNE HEMSEY.

Photo by: Sakkmesterke



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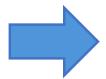


Hardware Evolution

We started replicating mechanical aspects of ourselves with mechanisms then robots that could do at first, the physical movements that a human could do.







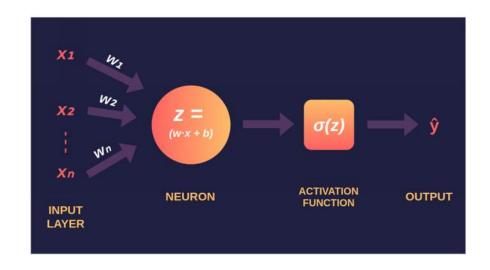


Picture by Josh Reynolds, AP.









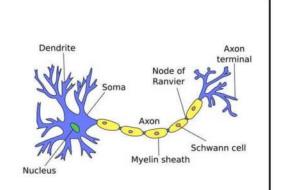
Neuron – Mathematical Representation

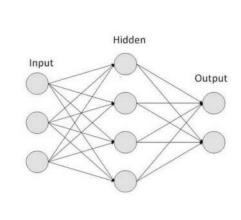
 We started to work on replicating intelligence, in some cases replicating the human brain itself.
 By our efforts, it seems more complicated than replicating the physical part of ourselves. We began to represent the neurons as a mathematical function with inputs and outputs.











Neural Networks

 Neural Networks: AI model that makes decisions in a similar matter as the human brain, it uses mathematical and statistical techniques to achieve this.







Key AI Technologies

- Machine Learning (ML) Subfield of AI that uses statistical and algorithmic systems with the ability to "learn" from and make decision based on data.
- Deep Learning A subset of machine learning that uses neural networks with three or more layers to analyze data in detail and learn from it.
- Natural Language Processing (NLP) AI that can understand sentiment, intent, insights, etc. From text.
- Physical AI Integration of AI systems with physical technologies like robotics, machine and smart devices enabling for the AI to interact and learn from the real world.
- Generative AI Deep learning models that combine different techniques like Deep Learning, Natural Language Processing, and Large Language Models to generate text, images, 3D design, video and other content.









Al Concepts

- Al training: Process in which the model it's feed with data sets, this sets can be structured or unstructured. This data helps the model to recognize patterns or correlations and eventually the models learn to make inferences based on the inputs.
- **Example**: Feed the model with the last three years of contracts data to determine the best job to work on.









Graphic by: VERA SOLOVYOVA

Al Concepts

- Computer vision: Al field that uses that enables to derive meaningful information from videos, photos, and live feed videos and then take proper action.
- Use examples: Photo tagging on social media, radiology imaging in healthcare, self-driving cars in the automotive industry, safety measure checking in sites.







Relationship between data science and AI

- Data is the basis of AI models, AI models rely on large, clean, well prepared data sets. And data science studies the cleaning and preparation of this data, as well as methods like ML models to analyze it.
- Garage In Garage Out. You need quality data to do AI.









Data Science Tools Ecosystem

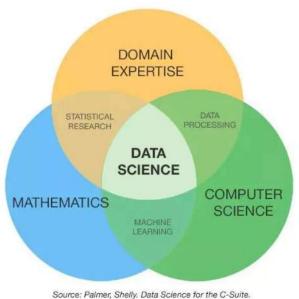








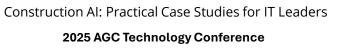
Roles and Skills



ource: Palmer,	Shelly.	Data Science for the C-Suite.
New York:	Digital	Living Press, 2015, Print.

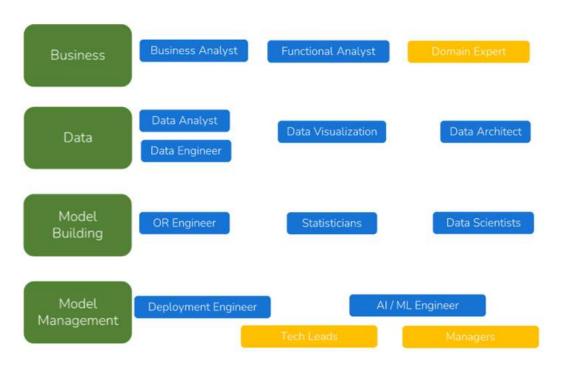
Skills	Tools & Technologies	Must- have/Preferred
Coding	Python, R,C/C++,Java, SQL, MATLAB, Scala	Must-have
Statistics and mathematics	Probability, regression analysis, hypothesis testing, identifying patterns and data uncertainties	Must-have
Analytics	SAS/R,Apache Spark, Tableau, Pig, Hadoop, MySQL	Must-have
Databases	MySQL,Cassandra, Google BigQuery, MongoDB, CouchDB	Must-have
AI & ML	Decision trees, neural networks, clustering methods	Preferred
Big data processing	Spark, Flink, Hadoop	Preferred
Algorithms and models	Support vector machines, regression models, hidden Markov models, ensemble algorithms	Must-have
Frameworks and libraries	NumPy, Scikit-learn, Keras, PyTorch, Plotly, TensorFlow, NLTK, SciPy	Preferred
Domain knowledge	Understanding the company's industry or domain,the industry fundamentals, new opportunities, and business problems	Preferred
Data handling	Data cleaning, pre-processing,feature engineering, data analysis	Must-have











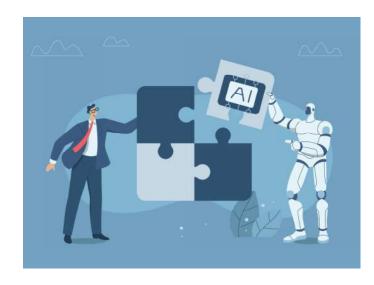
Data Science Roles

 All these skills are required at some level for every project









Industry related use case: GPT's

What is a GPT?

A GPT (Generative Pre-Trained Transformer) is a family of neutral network models that uses AI Architecture to generate AI applications such as Chat-GPT.

For this specific use case, we chose to use the OpenAI platform for GPTs. This platform allows specific no-code model training, which helps users customize versions of the Chat GPT AI model for specific tasks or topics by combining instructions, knowledge, and capabilities.







Industry related use case: Legal Case

This is a part of litigation that sorts and analyzes relevant data and documents. This AI application focuses on two purposes: first, to determine if a document is relevant to the prompt asked, and second, to request specific information from legal documents.

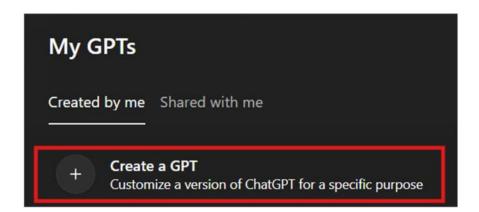
Examples of possible prompts and questions to ask the trained GPT:

- On what day did Dr. IKERD sign the first contract?
- What position did Dr. IKERD have in the first deposition about LOD 200?
- In what part of the deposition did the defendant's lawyer ask, "When did you first start noticing communication problems?"
- On what date was the first task order for the new building requested?









Industry related use case: GPT Training

- Steps
- For better GPT management, it is suggested to have an enterprise plan with OpenAI.
- 2. Turn off the "Improve model for everyone" setting because we do not want OpenAI to have access to our legal documents.
- 3. Go into: My GPTs > Create a GPT. To start working on training the model.

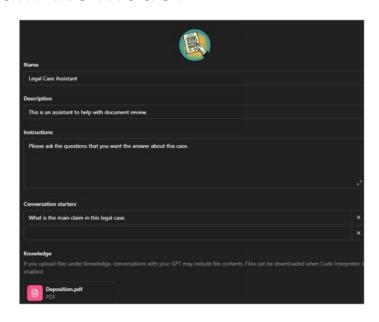


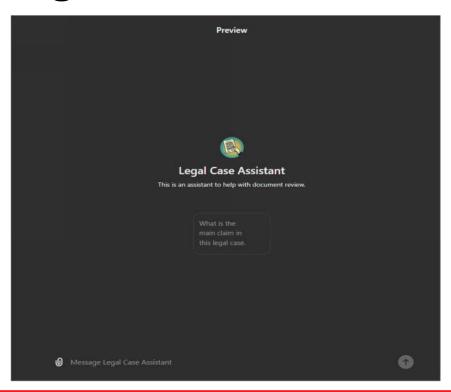




Industry related use case: Legal Case

4. Train the model





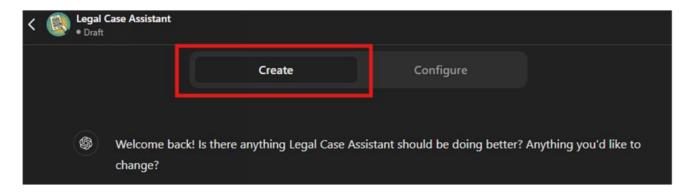






Industry related use case: Legal Case

5. Test the GPT and start adjusting for mistakes on the create tab



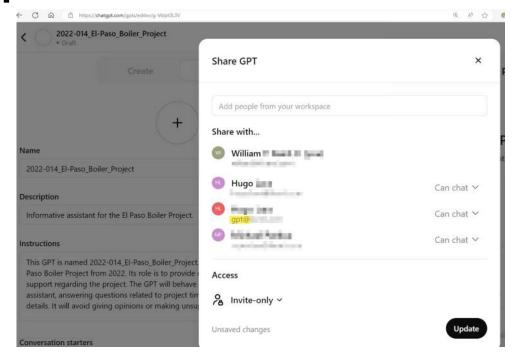
6. Corroborate the answers of the GPT when you are asking about sensitive matters.







GPT Team Account Setup – Make GPT@YOUR-DOMAIN.COM

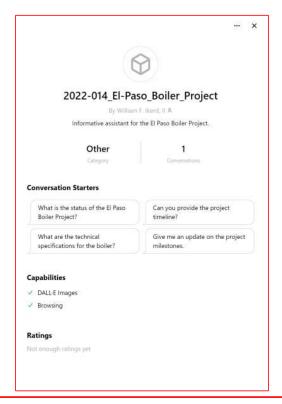


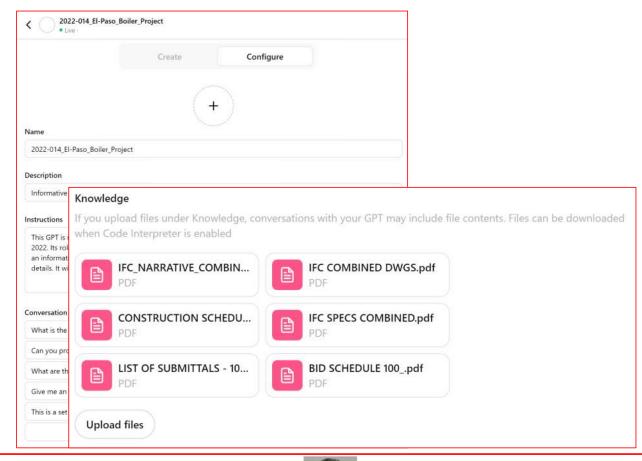






GPT Creation















The force protection requirements for the project include evaluation based on the building's "Mission Critical" status and the required protections for blast, force, and standoff distance. This evaluation is to be conducted by The Contractor's Manufactured Metal Building (MMB) engineer. The proposed foundation is intended to receive these forces, which will be detailed by The Contractor's MMB Engineer. Relevant standards and codes include:

- VA Physical Security Design Manual for Life-Safety Protected Facilities (January 2015)
- VA Physical Security Design Standards Data Definitions (Restricted)
- Single Degree of Freedom Structural Response Limits for Antiterrorism Design, U.S. Army Corps
 of Engineers Protective Design Center Technical Report, PDC-TR 06-08, Revision 1 (January 2008)







The foundation for the new building is a combination of shallow spread footings and an isolated thickened slab-on-grade foundation system. The shallow spread footings are designed with a minimum embedment depth of 24 inches below finished grade and allowable bearing pressures of 2,500 psf for net dead plus sustained live load and 3,000 psf for net total load. The isolated thickened slab-on-grade has a minimum embedment depth of 18 inches and is supported on ground-prepared subgrade with an allowable bearing pressure of 1,500 psf.









Who are the desiers who designed the project?

- The designers for the El Paso Boiler Project include:
 - 1. Engogy U.D (McDated):
 - Roger L. Naphore, 464.
 - Contact 254,700,0009
 - 2. Rent-Consulting, LDC FOHE Structured NOCE:
 - Will have US (DIL/NO)
 - Contact 254,780(657).
 - DM Masschille Consulting Degeneral Descharics, Electrical, Fluebongs.
 - Miles Schools, Pf.
 - Contact PERSONS













Develop a list of the drawings in the construction documents



































Study Case

• Trained model for security equipment detection:



Graphic by: VERA SOLOVYOVA



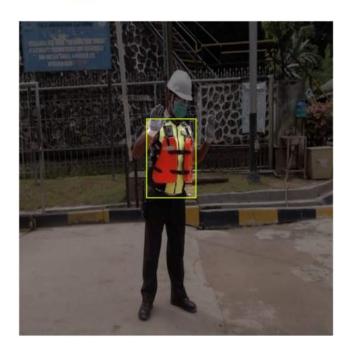




Data Set Labelling















Model training

Library	Common Use	Recommended Runtime	Notes
Pandas	Data Wrangling	СРИ	Optimal for single-threaded data manipulation.
Dask	Parallel Computing for Data	CPU/GPU	Scales well with CPU; GPU beneficial for very large datasets.
Scikit-Learn	Basic Machine Learning	СРИ	Most algorithms are CPU-optimized.
TensorFlow	Deep Learning	GPU (L4/A100) or TPU	Use TPU if the model is TPU-compatible.
PyTorch	Deep Learning	GPU (T4/L4/A100)	Works well with GPUs for intensive model training.
NumPy	Mathematical Operations	CPU (or GPU)	Primarily CPU; some benefits with GPU for large arrays.





Graphic by: DR. ERNESTO LEE



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Training information

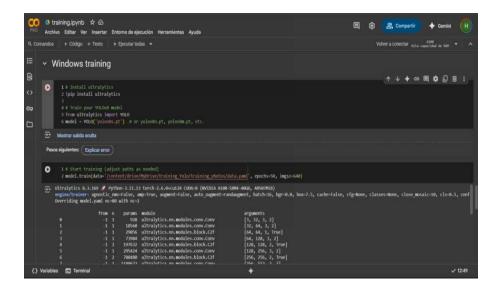
- Model trained with ~4000 images.
- GPU A100 used for training.
- Training time: 20 minutes.
- Cost: \$20 for the subscription for Google Colab Pro.

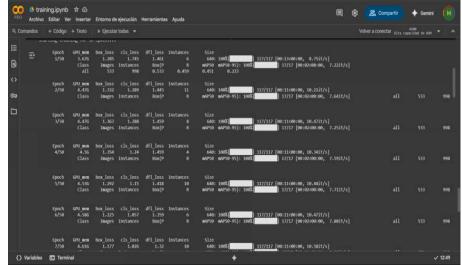






Model training



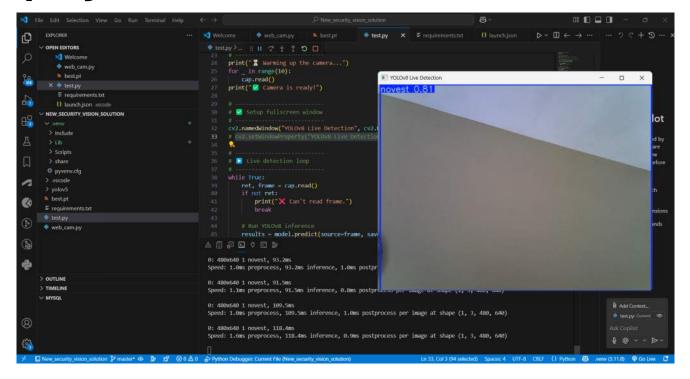








Model deployment









Results







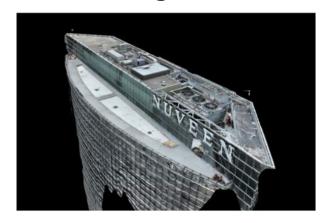


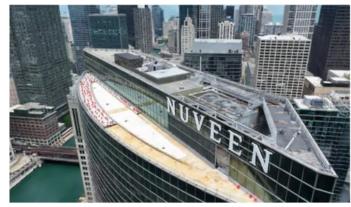


AI in Reality Capture

Background context generation







Photogrammetry captures the structure's meshes but misses the surroundings and background (left). Gaussian splatting includes the background, providing better visualization for developers and use cases that benefit from full context (right). Photos by: Ben Stocker, Skender



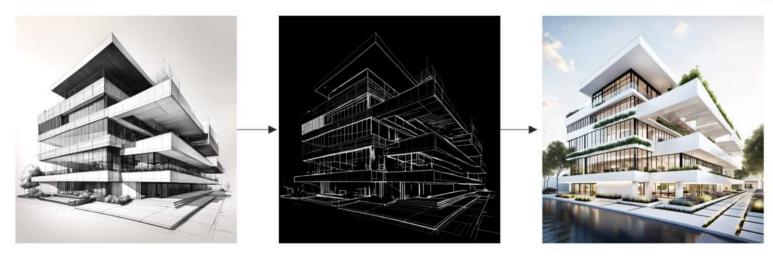




AI in AEC Design

Render Generation





ControlNet converts an architectural sketch into a detailed render



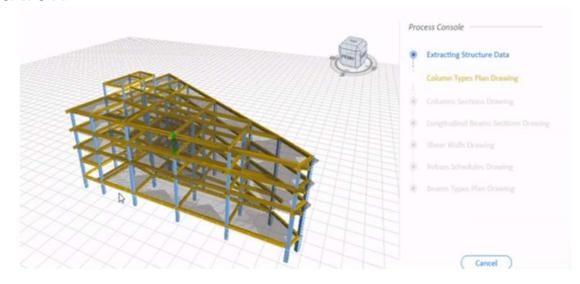




AI in Structural Design

Render Generation





Structure Plus is an AI tool that helps with Structural Design



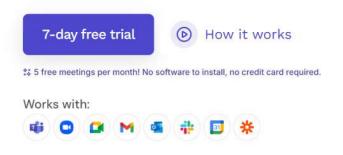


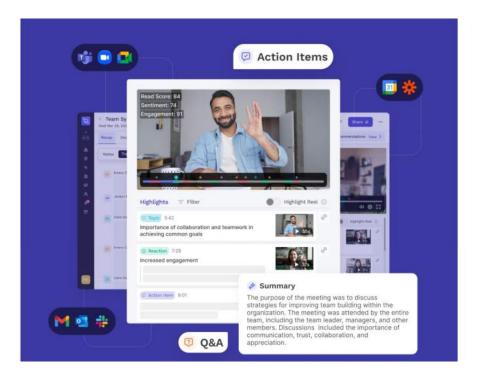


Al Tools for Meeting Recordings



Read AI makes your meetings, emails, and messages more efficient with AI-generated summaries, transcripts, playback, and highlights.



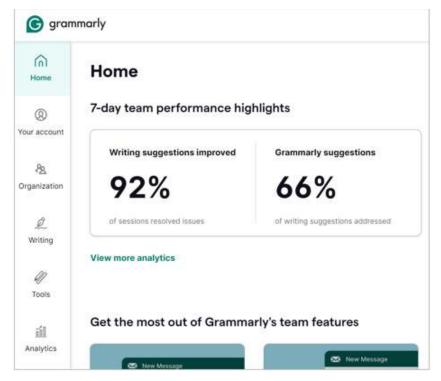


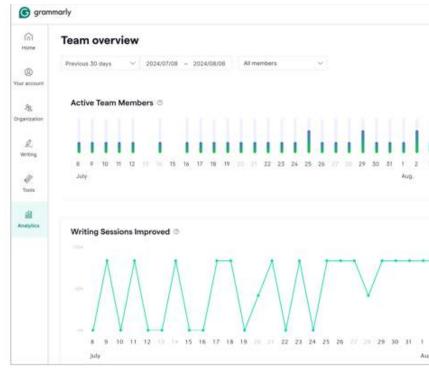






Team AI Writing Tools



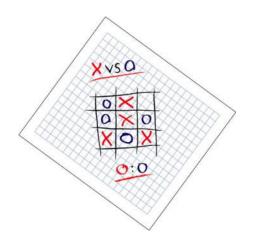








Think About Your Business Processes Requirements









Tik - Tak - Toe

Checkers

Chess

Poker











Challenges for Site Layout

- Time
- Rework
- Safety
- Cost



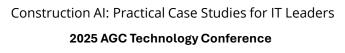




SETUP FOR SUCCESS: Set Control













Background

New automated layout technologies now enable direct translation of 3D models to field execution.

HP A2PS9A SitePrint Robot









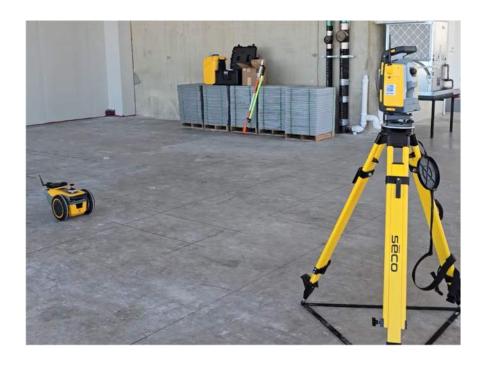
Limitations of Site Printing Robots

- Flat surfaces, less than 3% slope.
- 2. Firm surfaces.
- 3. 1/8" Tolerances.
- 4. Must have site control set prior to developing site print files.
- 5. \sim 300 x \sim 300-foot areas at a time.
- 6. It will typically be used for anything you would use chalk line on.









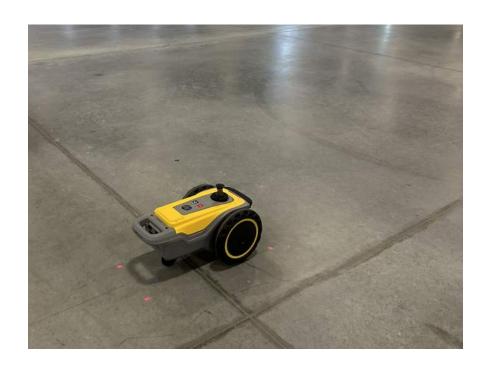
Field Setup

Setup Total Station









Field Printing

- Select and review file for printing.
- Supervise printing, process, times and issues that may arise.





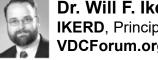




QA/QC Best Practices

 Print small test of lines at extreme location of print area.





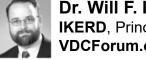




Clear Line of Sight

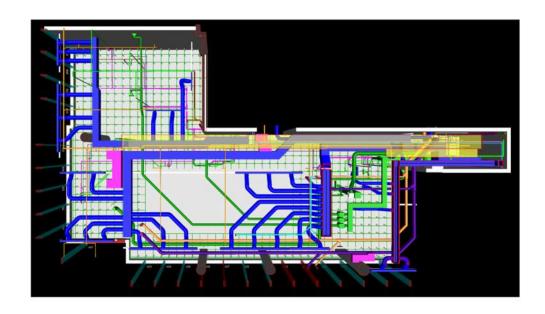
 The units must have line of site between the total station and site printer.











Case Study: Condo

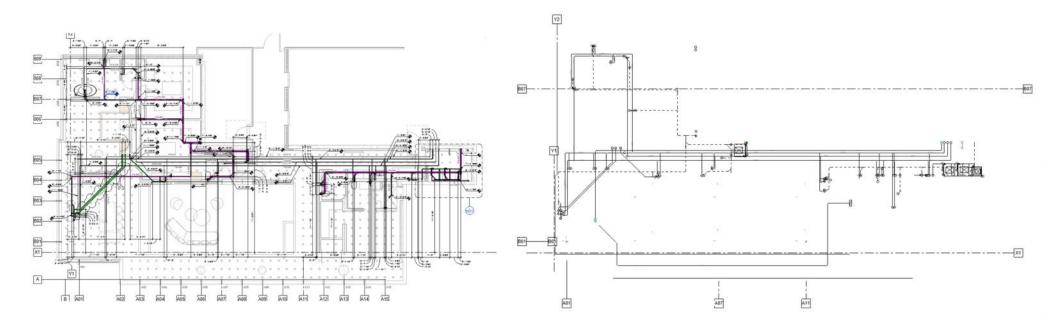
- The layout includes both linework and text.
- This condo took about 4~6
 hours to print the layout of
 the plumbing and ductwork
 lines.
- The GC felt like they might have spent a week laying this out manually.







Sub-Floor Plumbing





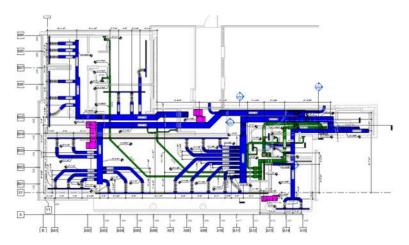


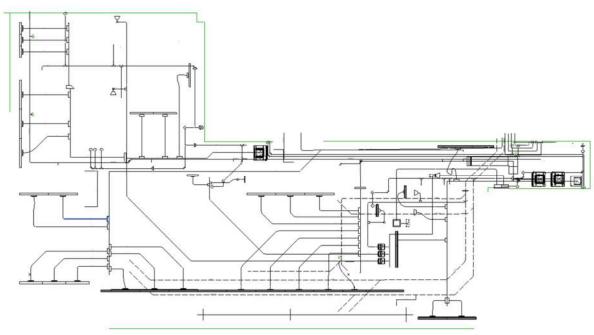


Dr. Will F. Ikerd II, PhD, PE IKERD, Principal, VDCForum.org, Director of RD&E



Above Ceiling MEP





Line work to send to printer



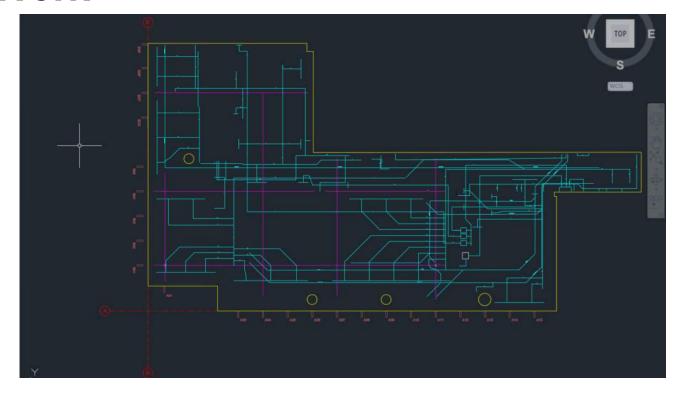






Print File of Line Work

 2D CAD EXPORT FOR CREATION OF PRINT FILE









SITE PRINTING





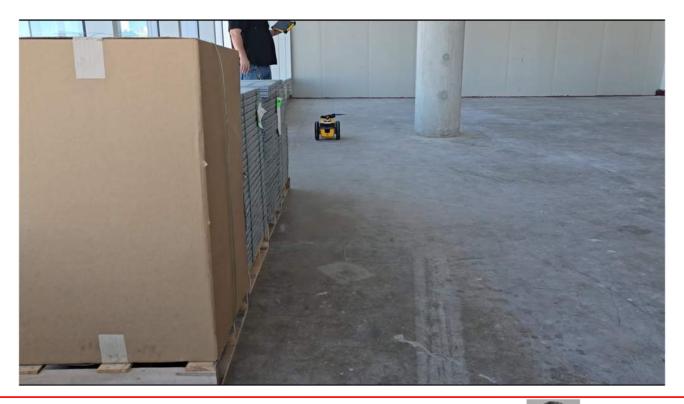
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TEMPORARY OBSTRUCTIONS





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SITE CONTROL OF ROBOT





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Case Study Results

- Results of ink on floor.
- Completed in 4-6 hours what would have taken a week's worth of manual layout work among different trades from the BIM Coordination Process.







Q/A



Contact Card



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