

Artificial Intelligence in Construction

Introduction

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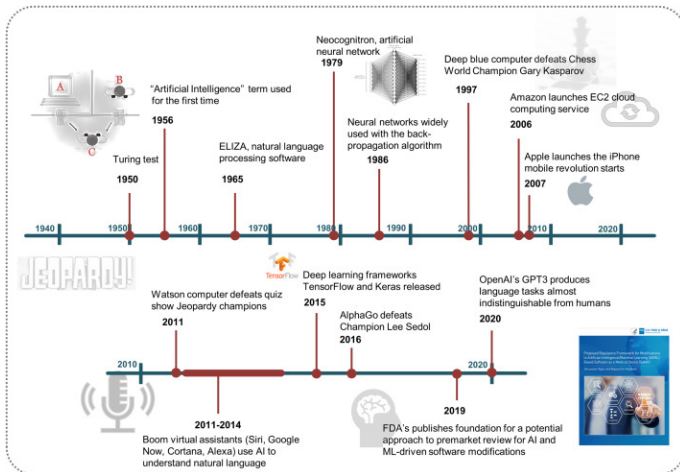
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Outline

- 1 Applications to safety and occupational risks
- 2 Applications for optimization, efficiency, management of uses
- 3 Applications to construction planning and cost control
- 4 Other applications
- 5 Bibliography and reference material

Timeline of artificial intelligence



<https://doi.org/10.1016/B978-0-12-820239-5.0000>

1. Applications to safety and occupational risks

AI to increase job safety

- The construction industry is one of the most *traumatic*. Goal: Reducing the likelihood of **accidents** (both human and equipment related).
- Open source libraries exist that analyze **images and videos from security cameras** in real time (e.g., automatic monitoring of work seen from above, cleaning, stagnant water, workers without personal protective equipment, . . .).



Vídeo: *Optimizando procesos en la construcción con Machine Learning* (see

<https://www.tensorflow.org/>),

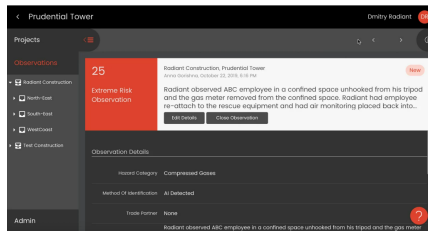
<https://www.youtube.com/watch?v=VvbTcPx5QP4>.

Use of images to improve safety and production.

Sustainability (e.g. use of concrete).

AI to increase job safety

- Risk analysis (physical, commercial), problem prediction: tools that detect abnormal behavior and alert the construction company.
- Programming of project risk indicators in the areas of safety, productivity and quality.
- For example, SmartVid (Vinnie, AI engine) combines pre-engineered security with construction systems such as Autodesk BIM 360, Procore, Oracle Aconex, OxBBlue site cameras, StructionSite and Box.
<https://www.tavco.net/smartvid.io-construction-safety-software>



2. Applications for optimization, efficiency, management of uses

AI in construction

Applications: optimization, efficiency, management of uses

- AI in renewable energies: <https://scur.cat/X0HKYP>: **optimal placement** of solar panels and wind turbines, production control, programming and power flow management, cost-reduction information for the customer, demand forecasting, combination of energy sources (solar, batteries, . . .), combination with other data (atmospheric, historical, images, . . .).
- Management of heating, ventilation and air conditioning (**HVAC**). Applications to **intelligent homes** or certain constructions (e.g., data centers, hotels) that, in order to be competitive, depend on complex HVAC systems with high **energy efficiency**.

AI in construction

Applications: optimization, efficiency, management of uses

- How to increase usage by reducing space? Occupancy and movement controls using sensors (*embedded deep learning*), reassignment of spaces, cleaning protocols (e.g., use of toilets),...

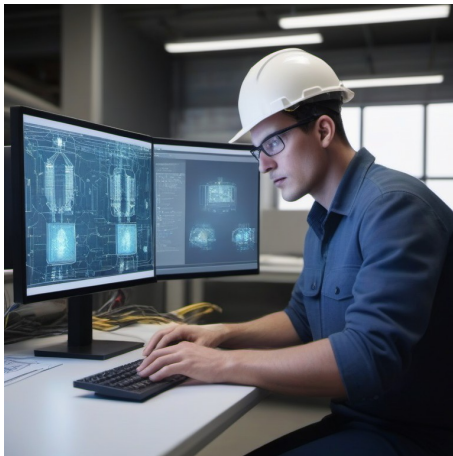


Vegeu <https://www.youtube.com/watch?v=TyogAAPI2oA> (*PointGrab's CogniPoint*).

- **Report writing** support tools (automatic translators, Chat GPT,...) and other more specialized ones: SWAPP, Spacio (payment), Midjourney (generative AI), Stable diffusion (generative AI),...

AI in construction

Exemple of image with *Stable Diffusion*



Building engineer using a computer at work using AI

AI in construction

Applications: efficiency, aesthetics,...

- New materials, efficiency, sustainability, robotics.



Vídeo (4'): *Building the architectural future with new technologies*, <https://youtu.be/35DjNZFCCI0>.

- Robotics, 3D printing.



Construction of a bridge in Amsterdam, *Joris Laarman lab*, see *TEDtalk* de M. Conti,

<https://www.youtube.com/watch?v=aR5N2Jl8k14>
(10'10-10'41").

AI in construction I

A paradigmatic example: wood treatment

Project *The Living lab* to create a sustainable building using wood recycled from scaffolding structures and expand the uses of wood as building material (video *Embodied Computation Lab*).



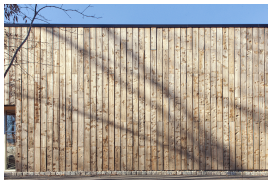
Process:

- Human identification of knots in wood. A learning algorithm analyzes the data to be able to detect and identify knots in future images.
- Development of a special machine to clean with sand and thus expose the microcontours of the knots.
- Sorting of 900 recovered planks, according to color tone and knots.
- Solar analysis of the facade.

AI in construction II

A paradigmatic example: wood treatment

- Arrangement of planks with the aim of making **match the solar analysis with the specific thermal insulation** based on the microcontours (additionally: sensors near the wood to collect data on the useful life of the building).
- The aesthetic revolves around knots, with changing shades during the day. “Wearing” over time creates a dynamic surface.



<https://www.wtin.com/article/2018/july/090718/artificial-intelligence-through-the-lens-of-biomimicry>

3. Applications to construction planning and cost control

Construction planning and cost control

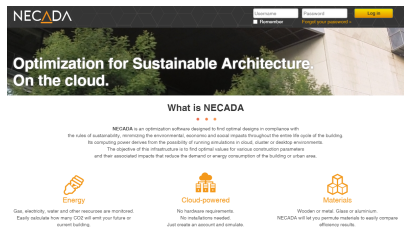
- Working with **low margins**. How to evaluate (build time, costs, competition capacity) how good an option is? If errors are not anticipated, profit margins fall.
- Need ability to **simulate design options** in the construction process (e.g., cost and schedule modification when adding a crane, a work crew, a drying process, or the influence of the weather) .

AI to measure progress in real time

- Connecting the digital world with the real world. AI-based solutions exist that scrutinize the **progress of construction projects** and provide **real-time** feedback on progress and quality.
- Robot equipped with a camera that wanders autonomously around the construction site to capture three-dimensional point clouds of construction projects, with the aim of creating a **digital twin** of the workplace.
- A neural network automatically processes all data, compares it with BIM and with a list of materials to inform project managers of the cost of executing the work, whether or not we deviate from the schedule and if there are errors of quality. It provides an **immediate reaction capability** to inefficiencies and errors.

Simulation and planning

- Comparative (combinatorial) between *numerous* options. Example: NEVADA, <https://inlab.fib.upc.edu/projecte/necada-3/>, <https://necada.com/>.



NECADA

Optimization for Sustainable Architecture.
On the cloud.

What is NECADA

NECADA is an optimization software designed to find optimal designs in compliance with the rules of sustainability, minimizing the environmental, economic and social impacts throughout the entire life cycle of the building. Its computing power derives from the possibility of running simulations in cloud, cluster or desktop environments. The objective of the infrastructure is to find optimal values for various construction parameters, and their associated impacts that reduce the demand or energy consumption of the building or urban area.

Energy
Gas, electricity, water and other resources are monitored. Easily retrocure how many CO2 will emit your future or current building.

Cloud-powered
No hardware requirements. No installation needed. Just create an account and simulate.

Materials
Wooden or metal. Glass or aluminum. NECADA will let you generate materials to easily compare different results.

Simulation and planning

- Comparative between *numerous* options. Assessment of **thermal comfort** versus **cost**.

Description

The study aims to provide the necessary management to be able to set the minimum criteria for energy rehabilitation, ensuring optimal levels from an energy and economic point of view, and propose solutions adapted to the particular building characteristics of Catalonia (climate and construction). Thereby, the overall objective of the project is to conduct a technical study of optimizing the energy rehabilitation of housing in Catalonia. The results will allow to use the knowledge gained to propose the minimum requirements for the energy efficiency of homes and assess how to gradually achieve near-zero energy buildings (NZEB).

Author

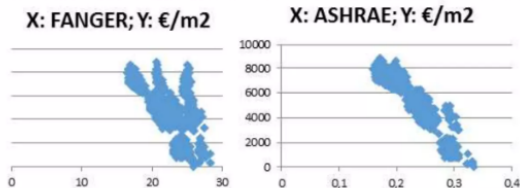
UPC

Visibility

Publicly available

Latest modification

14/01/2015 16:18:03



<https://inlab.fib.upc.edu/projecte/necada-3/>

4. Other applications

AI for earthmoving



Vegeu <https://www.builtrobotics.com/>.

- The earthmoving industry uses **robotics for infrastructure projects**, such as the construction of wind farms, gas pipelines and new housing developments.
- Upgrade of **heavy equipment** with GPS, sensors, cameras and AI guidance systems that allows them to operate autonomously; achieve long periods of operation without safety incidents.
- Allows to mitigate the **labor shortage** in construction.

Ethical aspects

- General EU guidelines.
- Opinion article. [Carly Kind, *Venture beat*].

Conclusion: AI and technical architecture

- Observe and decide on the **appropriate parameters/variables**.
- Have abundant and good quality **data** available. Create a **unified platform** to store, access and manipulate data.
- **Interact between experts**. **Data engineer speakers** are needed in each discipline: *«toward a new type of construction worker that uses AI to predict the likelihood of personal injury, plan actions, etc.»* [Autodesk journal]. Also see this **video with expert experiences and opinions on the future of AI**.
- AI requires **human help/approval**, especially in the construction industry (uncontrollable external factors *a priori*). **Human-robot interaction**, as in the *Bishop* project, see **TEDtalk** by M. Conti (8'45"-9'20") on **increased creativity**.
- We must not forget the **ethical aspects**.

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