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AI and New Technological Developments Applied to Hospital Design

Innovative Hospital Planning – “Looking back, moving forward, shaping the future“

June 24-25, 2025

Francisco Ortega. CEO ENERO

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Introduction

Patient management

Clinical practice

Facility management

Questions

Smart rooms

Liquid hospital

Clinical engineering

Case study

Conclusions

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Introduction

4th Industrial revolution
Evolution of AI/ML
Technology Adoption
Transversal technology

- John McCarthy introduced term “Artificial Intelligence” (1956)
- Klaus M. Schwab introduced term “4th Industrial revolution” Davos forum 2020
- Revolutions: Mechanization, Mass production, Automation, Digitalization
- New paradigm: speed vs acceleration
- Convergence of digital, biological and physical realities

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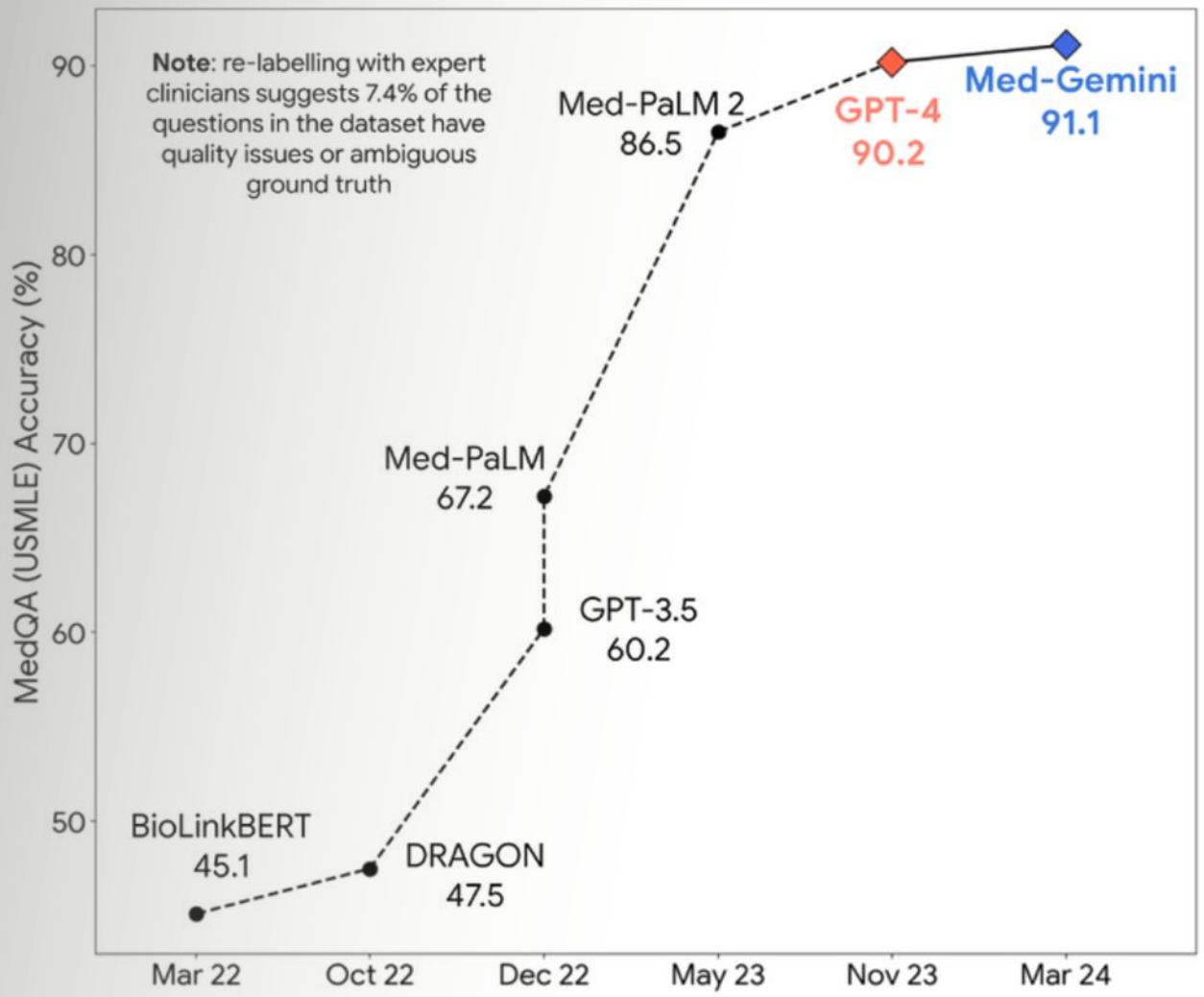
Introduction

4th Industrial revolution
Evolution of AI/ML
Technology Adoption
Transversal technology

- Integrate language, imaging and data (genomics)
- USMLE: from 2022 BioLinkBERT 45% to 2024 Med-Gemini 91%, humans 80%
- Accessible: They can be run by desktop computers



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Introduction

4th Industrial revolution
Evolution of AI/ML
Technology Adoption
Transversal technology

- ChatGPT 50 million users in 1 month
- FDA approved +1,000 apps for healthcare (2025)
- Adoption +85% healthcare players McKinsey (Q4,2024)
- VC Investment 50bm$ (2023) to 1tm (2030)

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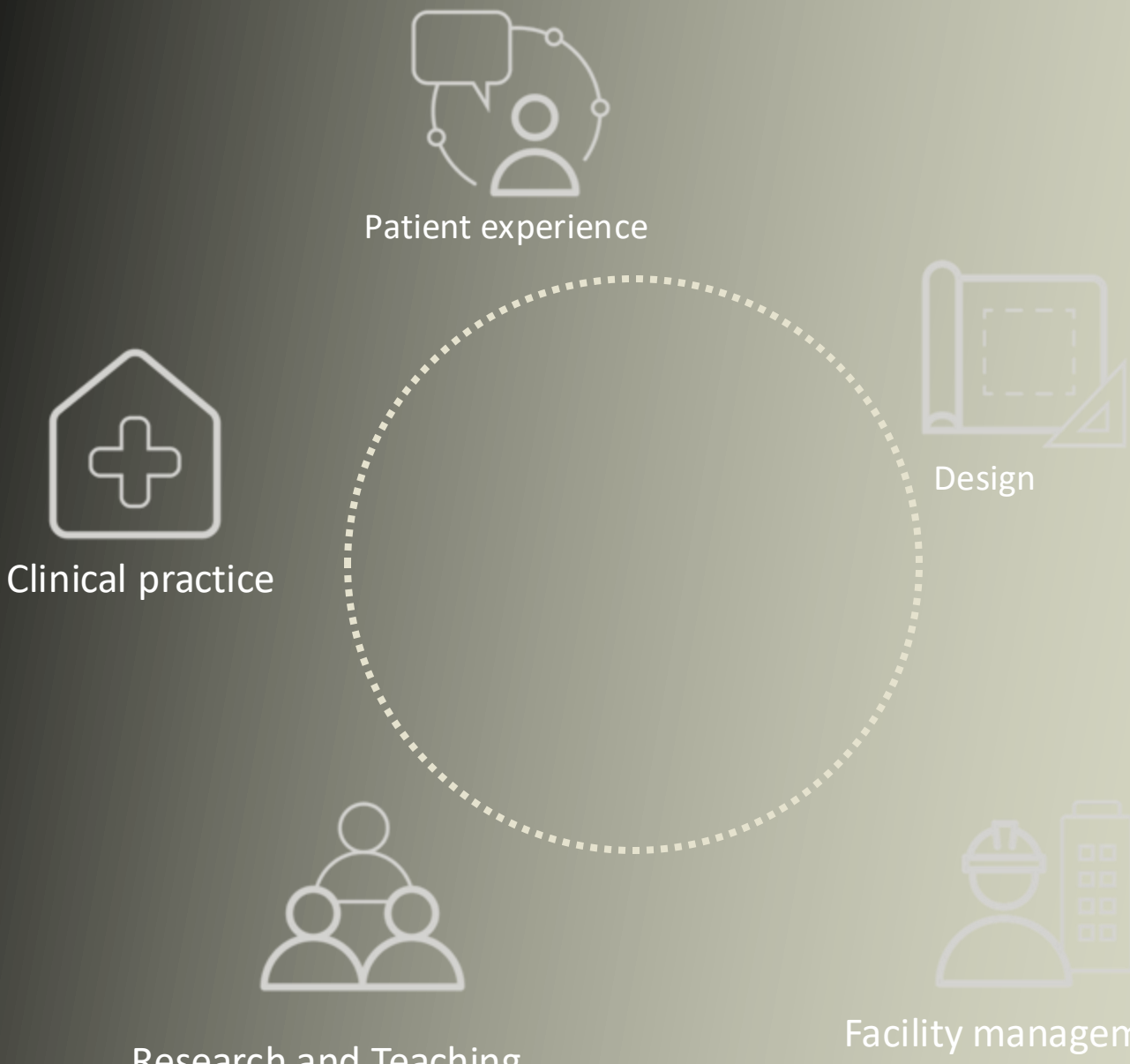
Introduction

- # 4th Industrial revolution
- # Evolution of AI/ML
- # Technology Adoption
- # Transversal technology



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Patient management

Predictive algorithms
Clinical information
Patient personalization

- “Customer” journey: Starbucks, Amazon, Spotify, etc.
- Optimize resources based on patient demand
- Real time decision making
- Personalize service

Patient management

Predictive algorithms
Clinical information
Patient personalization

- Electronic Health Record (EHR)
- Organize, structure and unify information
- Quick access to specific patient information
- Accuracy in treatment and diagnosis
- Better coordination among different departments
- Personalized treatment based on genetic info

Patient management

Predictive algorithms
Clinical information (EHR)
Patient personalization

- Sensors: Temperature, humidity, Co, Co2, noise…
- Patient monitoring: falls, heart rate, respiratory rate
- Communication: patient-staff
- Patches: vital signs, temperature, O2 saturation, blood pressure, pulse, ECG
- Environmental control: light, nurse call, blinds
- Entertainment: TV, music, games
- Others: Access control, alarms, tracker, presence sensor, etc.

Clinical practice

Digital patient twin
Diagnosis and treatment
Telemedicine
Robotics

- First heart digital twin presented in the WMC 2024. + 270 patient treated in Johns Hopkins
- Marenostrum 5 billions of variables (humans will take 57 billion years to complete)
- Sources include electrocardiographs and MRI with contrast
- Complete digital human twin by 2030
- Customize treatment plans based on the digital twin's simulations, orientation of fibers
- Predict patient responses to new drugs, treatments or surgery

Clinical practice

Digital patient twin
Diagnosis and treatment
Telemedicine
Robotics

- Diagnosis by imaging: repetitive tasks, pattern prediction
- Genetic and omics diagnosis: ability to process large amounts of data in real time

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Clinical practice

Digital patient twin
Diagnosis and treatment
Telemedicine
Robotics

- Increase in remote consultations: 74.0 % of professionals used telemedicine
- Time efficiency: 64% of telemedicine consultations lasted 11-30 min
- Reduce patient referral rates: 92.5% have acknowledged it
- FJD: Diagnostic check + survey 90% of the cases
- Khealth: AI chatbot for primary care, urgent care, mental healthcare

August, 2022
National Engineering Laboratory for Internet Medical Systems and Applications, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, China

Clinical practice

Digital patient twin
Diagnosis and treatment
Telemedicine
Robotics

- Surgery: Autonomy level 0 (DaVinci)-3 (Smart tissue AI) involve humans, 4-5 do not involve humans
- Rehabilitation: wearable robots, intelligent prosthetics, soft exosuits

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Facility management

Smart buildings

Logistic Robotics

- Integrate sensing devices, data processing modules, optimization algorithms and control systems
- Digital twin provide building performance simulation, design review
- Optimize and predict consumption based on time, weather, asset type, occupancy, usage, etc.
- Manage in real time adaptive control of (HVAC) systems, dynamic lighting and integration with renewable energy sources
- Predictive maintenance based on data

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Facility management

Smart buildings

Logistic Robotics

- Pharmacy robot drug dispensing
- Logistics automate warehouse storage
- Delivery of goods
- Surveillance of patients
- Cognitive assistants
- Entertainment
- Autonomous disinfection
- Drones: Commercial drone operations in Europe by 2026

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Questions

Can my building accommodate all these technologies?
Are we prepared for those changes?
Does it make sense to continue designing hospitals without taking this into account?
Timeframe: 1-3 years project, 2-6 years construction
Where do we have to start from?
What are the challenges we are facing?

Compliance warning!

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Smart rooms

Definition

Simplify patient journey

Optimization of circulations

Increase in space

- Integration of patient treatment and recovery
- Patient centered design: Patient doesn´t move, staff and equipment does
- Modular: units containing most procedures
- Plug and play: MEP and Equipment
- Interdisciplinary: All types of procedures: from echography to surgery

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Smart rooms

Definition

Simplify patient journey

Optimization of circulations

Increase in space

REGISTRATION

TREATMENT/RECOVERY

DISCHARGE

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Smart rooms

Definition

Simplify patient journey

Optimization of circulations

Increase in space

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Smart rooms

Definition

Simplify patient journey

Optimization of circulations

Increase in space

TRADITIONAL WARD ROOM

HOSPITAL ROOM : 25 m^2

- LOW TECHNOLOGY
- PASSIVE TREATMENT
- STAFF-CENTERED DESIGN

FUTURE SMART ROOM

SMART ROOM : 37.5 m^2 (+50%)

- INTEGRATED TECHNOLOGY
- ACTIVE TREATMENT
- USER-CENTERED DESIGN
- HIGH INCREASE IN COSTS

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Liquid hospital

Definition

Online and smart clinics

Virtual reality

Augmented reality

- Remote monitoring: Delocalization of medical staff-patient interaction
- Based on multimedia technologies
- Closer contact with patients
- Optimization of staff and infrastructures
- Telehealth: conference rooms, remote patient monitoring systems, telemedicine platforms

Chatbot/Avatar

Telemedicine with wearables

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Liquid hospital

Definition

Online and smart clinics

TRADITIONAL CLINICS

- CLINIC : 20 m^2
- WAITING AREA : 10 m^2 / OFFICE
- USERS : PATIENTS, MEDICAL STAFF
- BASIC EQUIPMENT DEPENDING ON SPECIALTY
- FACE TO FACE INTERACTIONS
- MORE TIME PER CONSULTATION

SMART CLINICS

ONLINE CLINIC: 10 m^2

- USERS : MEDICAL STAFF ONLY
- MULTIPLE SPECIALISTS
- LESS TIME PER CONSULTATION

SMART CLINIC: 20 -30 m^2

- NO WAITING AREA
- INTEGRATED TECHNOLOGY (MRI, XRAY, CT)

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Clinical Engineering

Integration of technology

Dissemination of Image devices

Proton therapy

- Sensors: biometric, movement, pressure, chemical, electrical, environmental
- New areas: robots, data centers, innumerous devices, supercomputers, etc.
- Increase equipment dimensions: Hybrid ORs, MRI 11,7 Teslas, 180 tons

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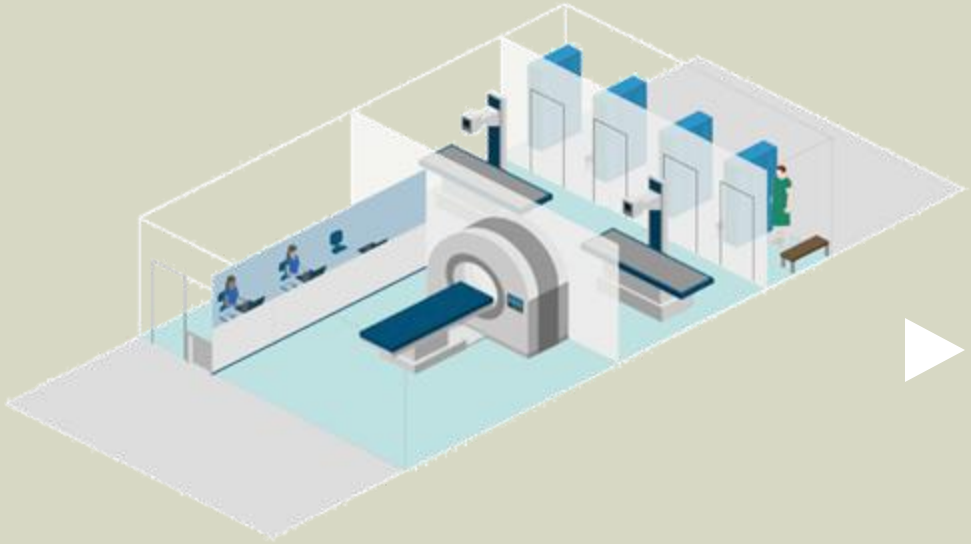
Clinical Engineering

Integration of technology

Dissemination of Image devices

Proton therapy



SMART CLINICS

SMART ROOMS

HYBRID UNITS

TRADITIONAL MEDICAL IMAGING

- OR: 35 - 50 m^2

REAL-TIME MEDICAL IMAGING

- FEWER TRANSFERS AND REDUCED PATIENT JOURNEYS
- FASTER DIAGNOSIS AND TREATMENTS
- REDUCED PROCEDURE TIMES
- IMPROVED PATIENT SAFETY

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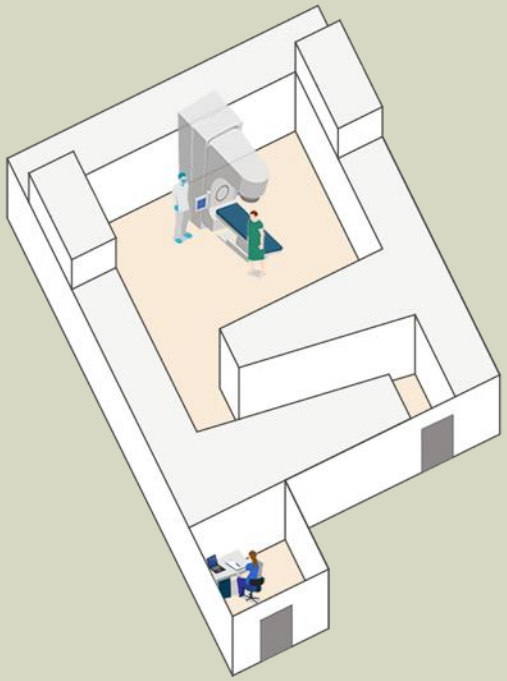
Clinical Engineering

Integration of technology

Dissemination of Image devices

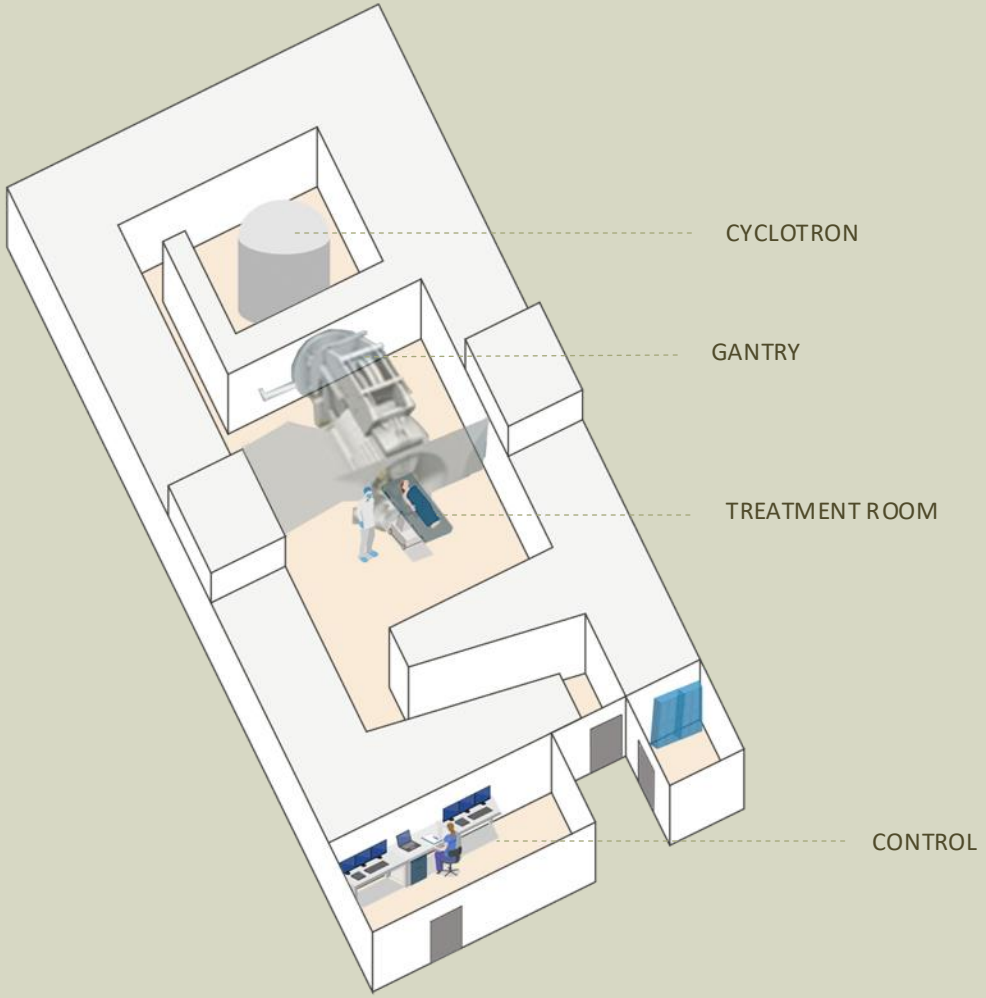
Proton therapy

PHOTON BUNKER



- DIMENSIONS : 13 x 12 x 7m

PROTON BUNKER



- DIMENSIONS : 30 x 15 x 15m

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CASE STUDY : Quironsalud Zaragoza Hospital

149 Rooms
14 +1H ORs
47 x 2 Clinics
10 + 4 ER
2RX, 1ORTP, 1 HT, 2MRI, 1CT, 2ECO, 1MAM, 1DENS
5 UTPR
11 NEO
12 ICU

25,400 sqm hospital
3,800 sqm parking

Construction finished August 2024

CASE STUDY: Hospiten Boadilla Hospital

158 Rooms
17 + 2H OTs
80 Clinics
25 ER
2RX, 1ORTP, 3MRI, 2CT, 6ECO, 2MAM, 1DENS
5 UTPR
6 NEO
13 ICU

36,000 sqm hospital
20,000 sqm parking

Construction due to finish by May 2026

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CASE STUDY: Quironsalud Valencia Hospital

116 Rooms
16 + 1H OTs
147 Clinics
8+5 ER
2RX, 1ORTP, 2MRI, 1CT, 1 PET CT, 5ECO, 2MAM, 1DENS
4 UTPR
10 NEO
10 ICU

25.900 sqm hospital
19.300 sqm parking

Construction starts in 2025

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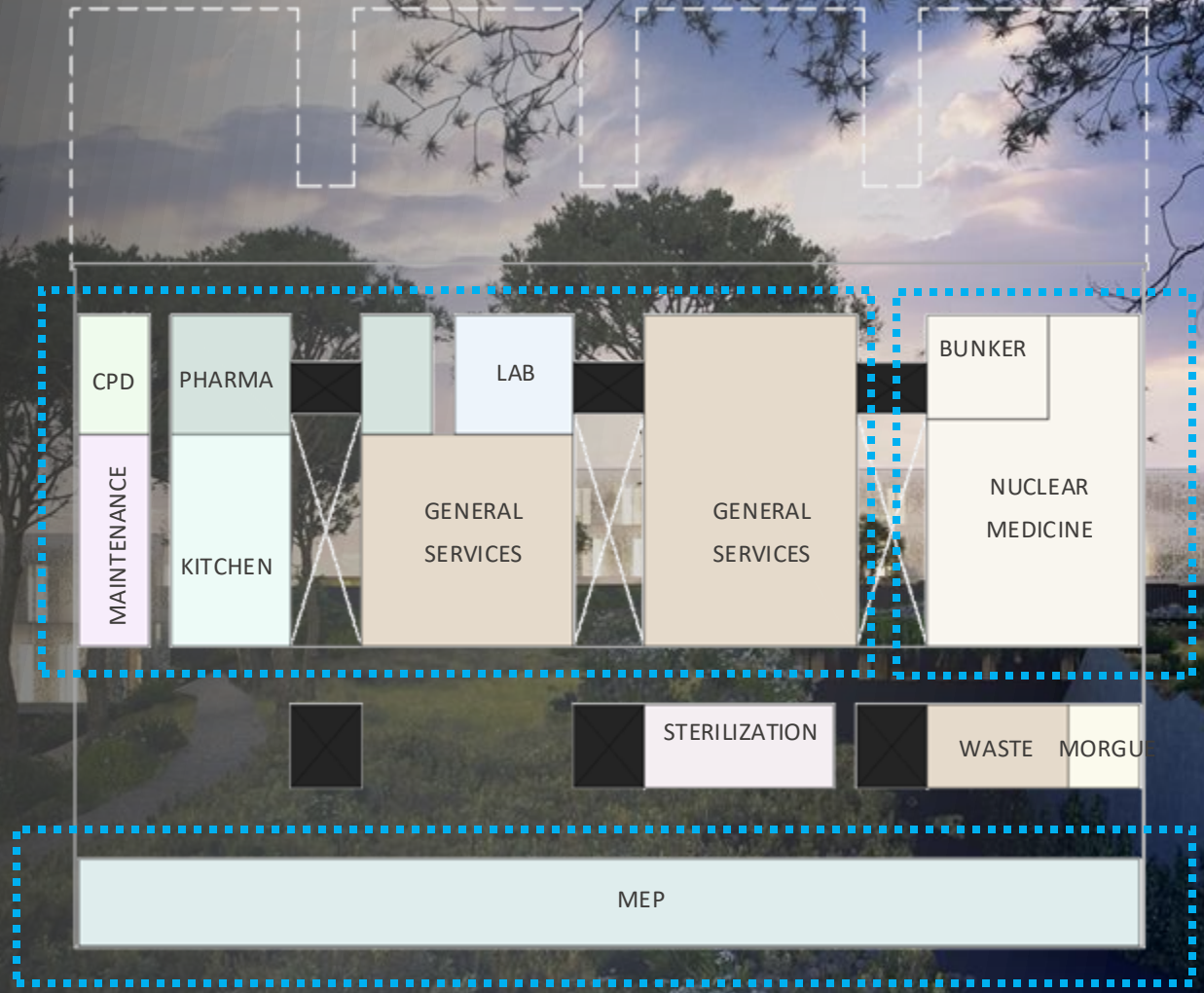
CASE STUDY

ROBOTICS, AUTOMATIC STORAGE, AUTOMATIC DELIVERY
...



PROTON THERAPY
BIGGER EQUIPMENT
MORE UNITS
...

DIFFERENT TECHNOLOGIES, C02 NEUTRAL, MODULAR ...

Underground floor

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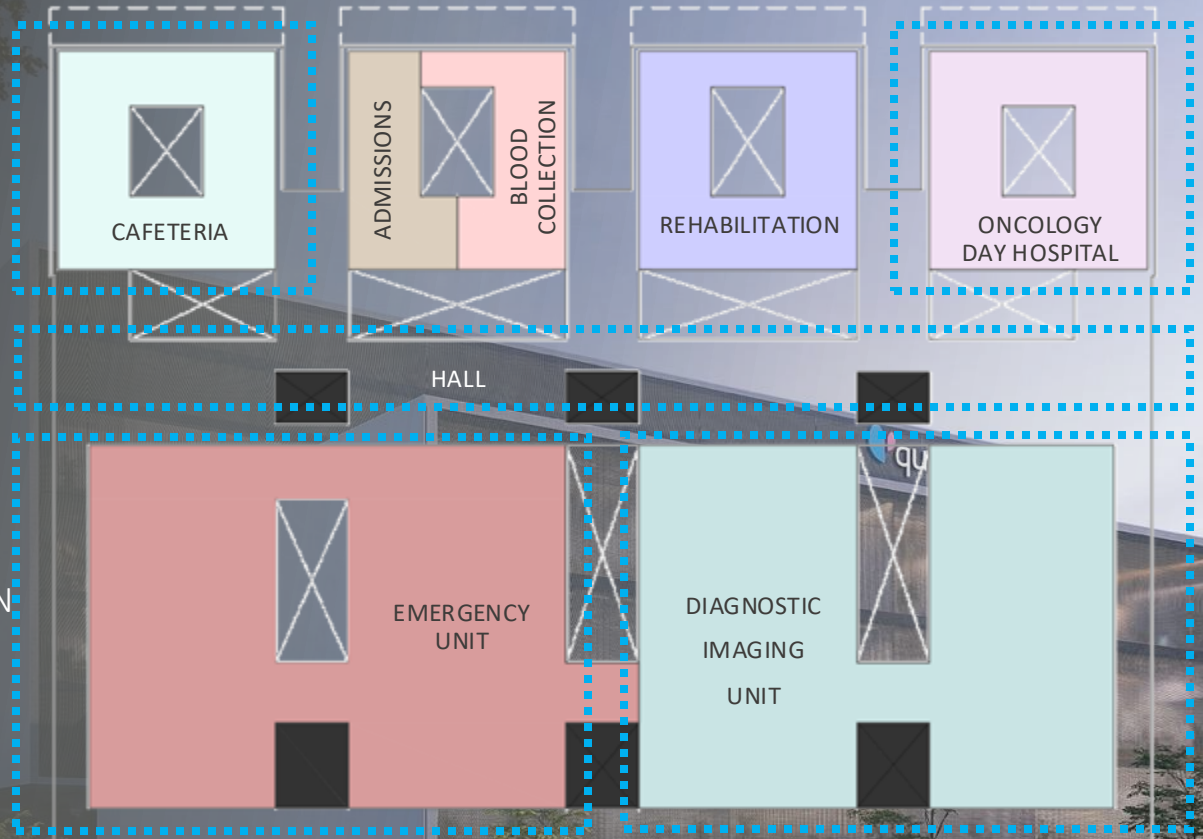
CASE STUDY

PERSONALIZED,
CUSTOMER ORIENTED,
…

PERSONALIZED,
CUSTOMER ORIENTED
….

PERSONALIZED,
CUSTOMER ORIENTED,
TECHNOLOGY INTEGRATION
…



REMOTE MONITORING

INTEGRATED,
BIGGER SIZES,
PERSONALIZED

Ground floor

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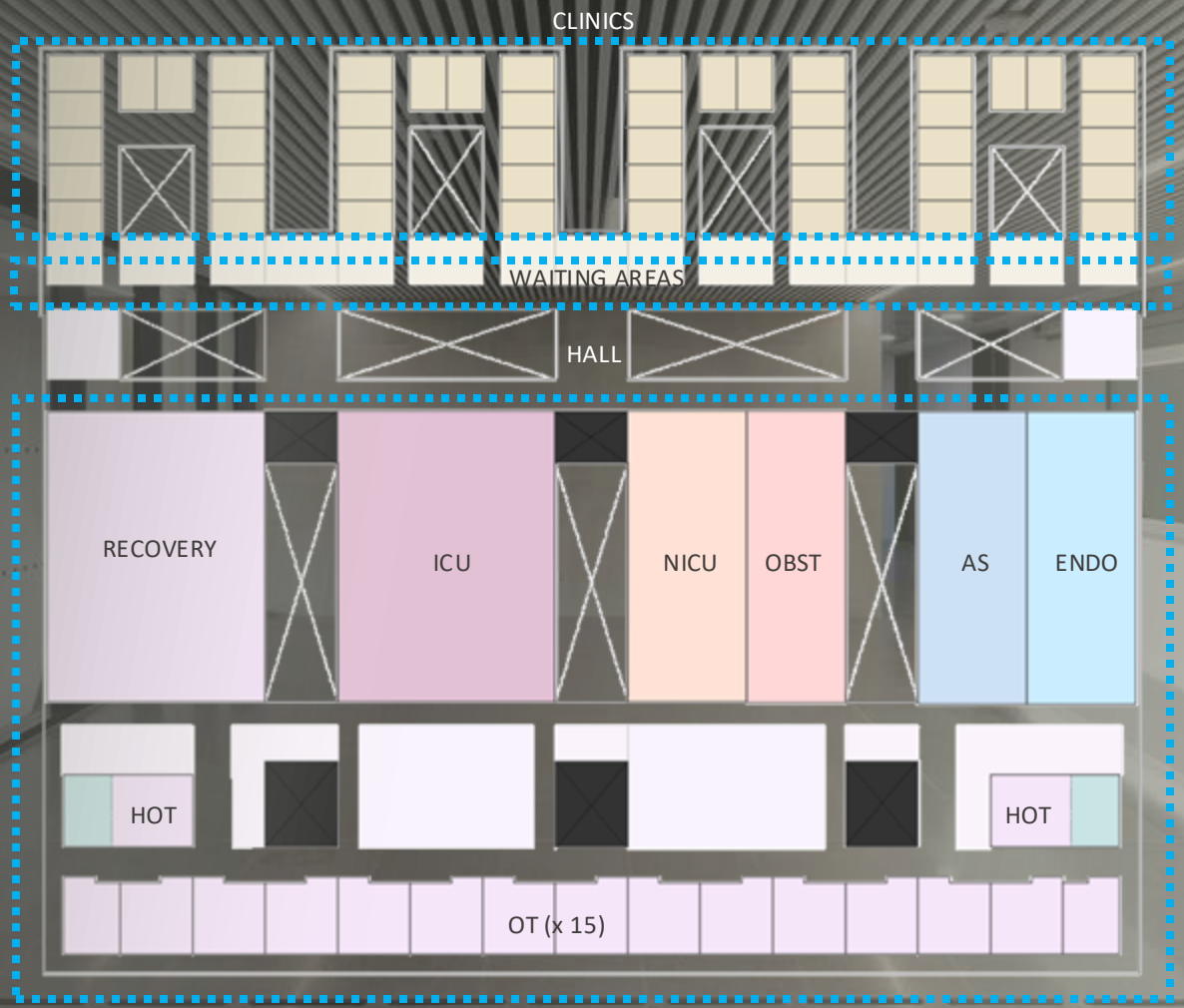
CASE STUDY

PERSONALIZED,
CUSTOMER ORIENTED,
TECHNOLOGY INTEGRATION,
TELEHEALTH
....

PERSONALIZED,
CUSTOMER ORIENTED,
TECHNOLOGY INTEGRATION,
SMART ROOMS
....



NO USE

First Floor

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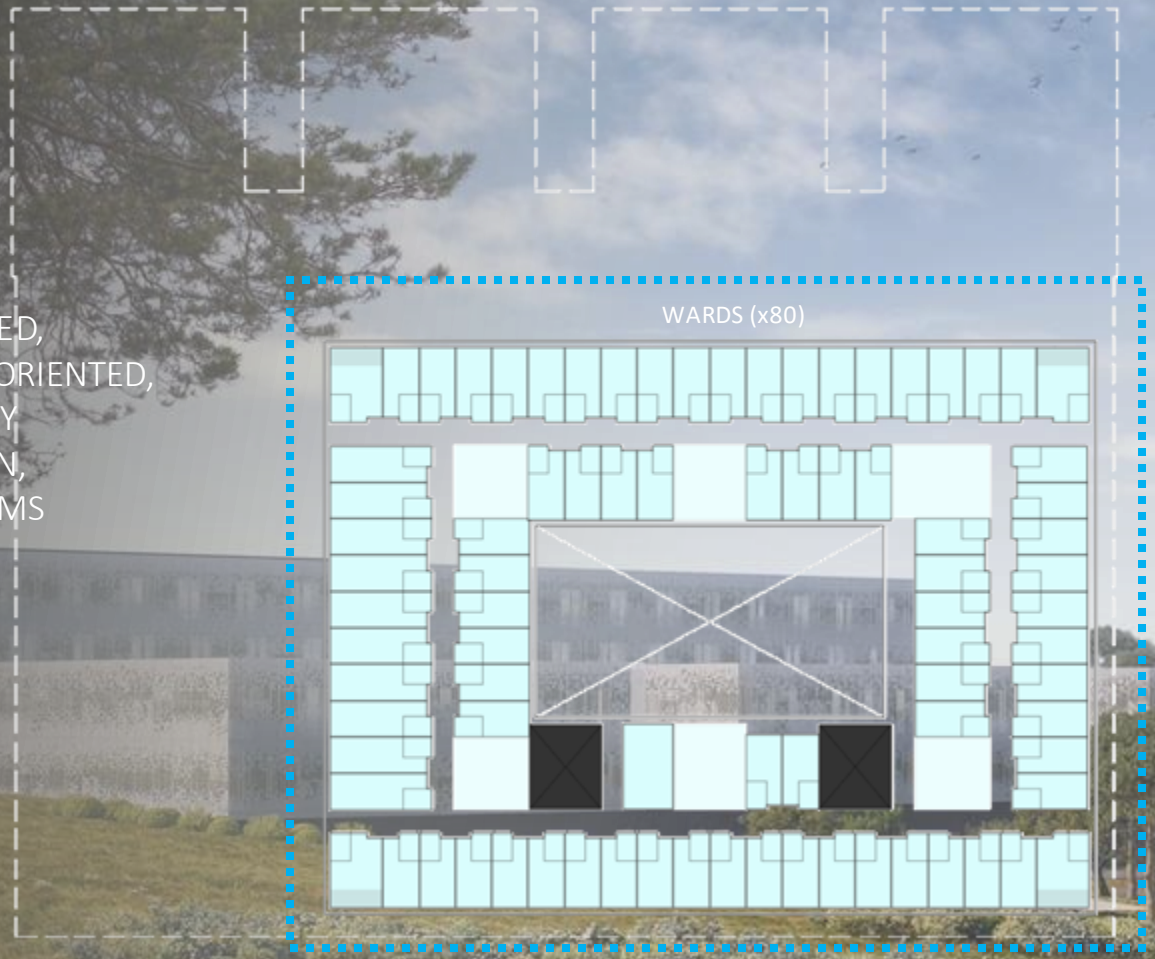
CASE STUDY

PERSONALIZED,
CUSTOMER ORIENTED,
TECHNOLOGY
INTEGRATION,
SMART ROOMS
....



Second and third floors

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Conclusions

- AI is a very disruptive technology
- Most healing processes will be led by technology
- These changes will arrive in less than 5 years
- Our designs are going to be obsolete before they are built
- We must change our mindset approaching design

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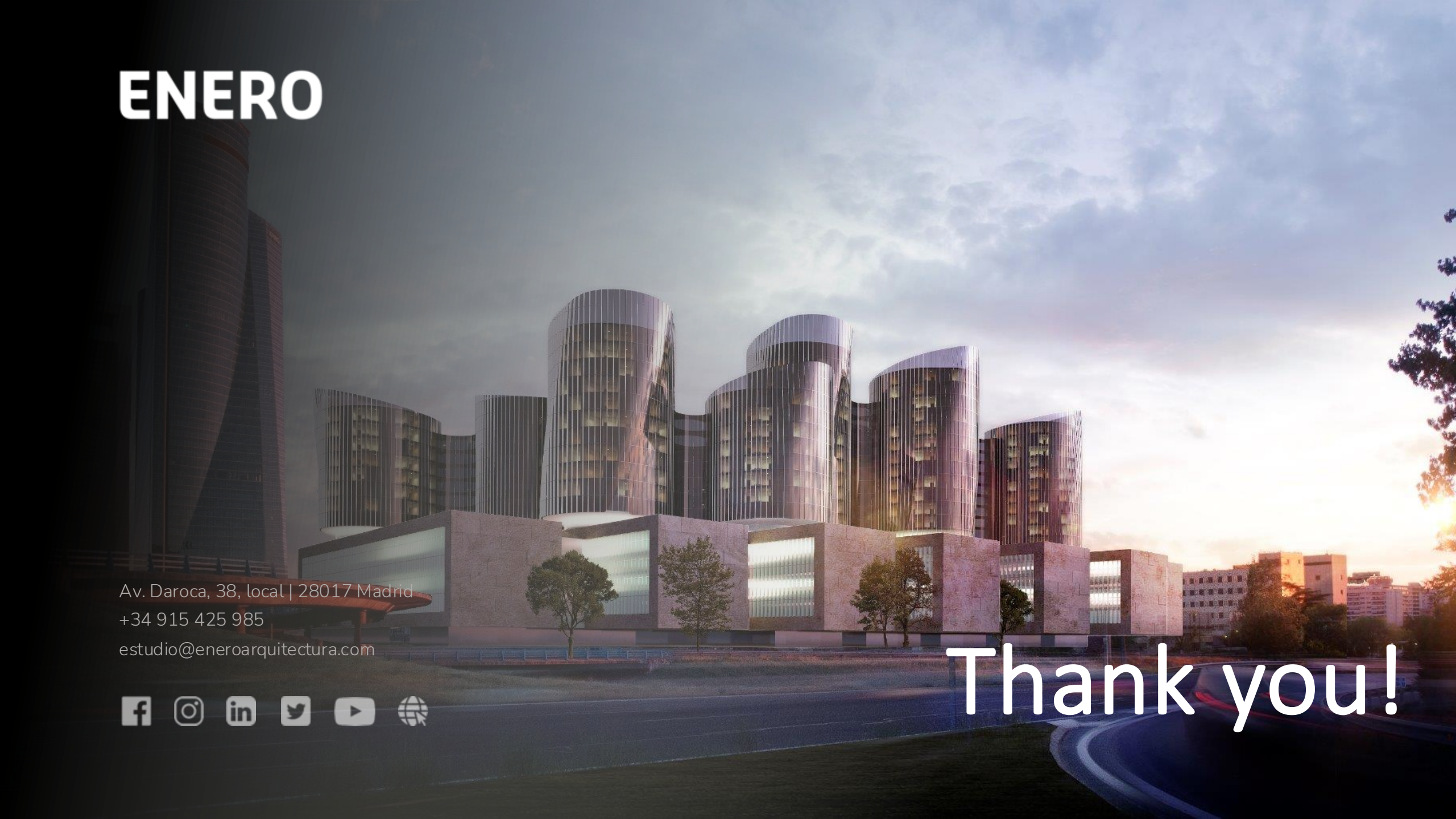

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Thank you!