

Under the patronage of **HRH Prince Khalid Al-Faisal**  
Advisor to the Custodian of the Two Holy Mosques & Governor of Makkah Region



المؤتمر الدولي الثاني والعشرون لإدارة الأصول والمرافق والصيانة  
The 22<sup>nd</sup> International Asset, Facility & Maintenance  
Management Conference

**Digitization - Excellence - Sustainability**

**ADVANCING PROSTHETICS: PERSONALIZATION WITH 3D  
PRINTING, AI, AND THE CRITICAL ROLE OF MAINTENANCE**

**26-28 January 2025**

The Ritz-Carlton Jeddah, Kingdom of Saudi Arabia

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Biomedical Engineer,  
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AI

3D printing

Training  
and  
integration



Let's Explore the Future of **Prosthetics** Beyond What We Know!

## **CAIRO TOE** earliest fake body bit!

The Cairo Toe: A 3000 year, the world's earliest functional prosthetic, highlighting Egypt's long history in medical innovation.



The "Cairo toe" appears to have been functional

## Introduction

- \$2.9 billion global market by 2025.
- Rising demand for affordable, personalized solutions.
- Challenges: Limited access in rural areas of Egypt and KSA.





## Upper Limb Prosthetics

**Price:** \$3,000 ~ \$100,000

**Lifespan:** 2–5 years.



## Lower Limb Prosthetics

**Price:** \$5000 to \$100,000

**Lifespan:** 3–7 years.



3D Printed (Avg.)

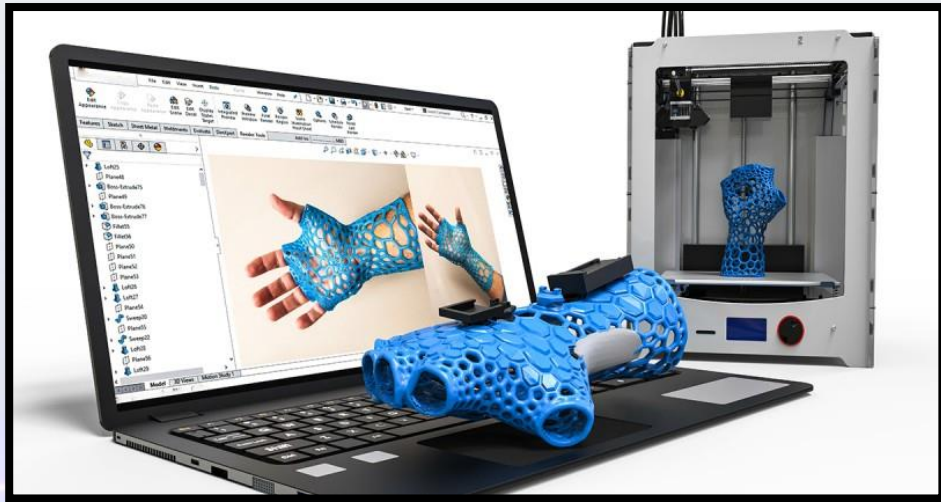
**\$500–\$1,500**

**Lifespan:** Similar to traditional

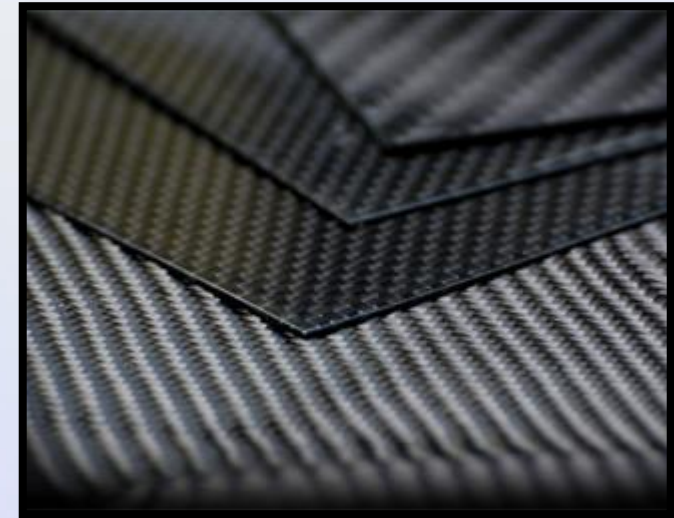
# Maintenance Technologies

But not limited to

**3D Printing and  
Digital Design**

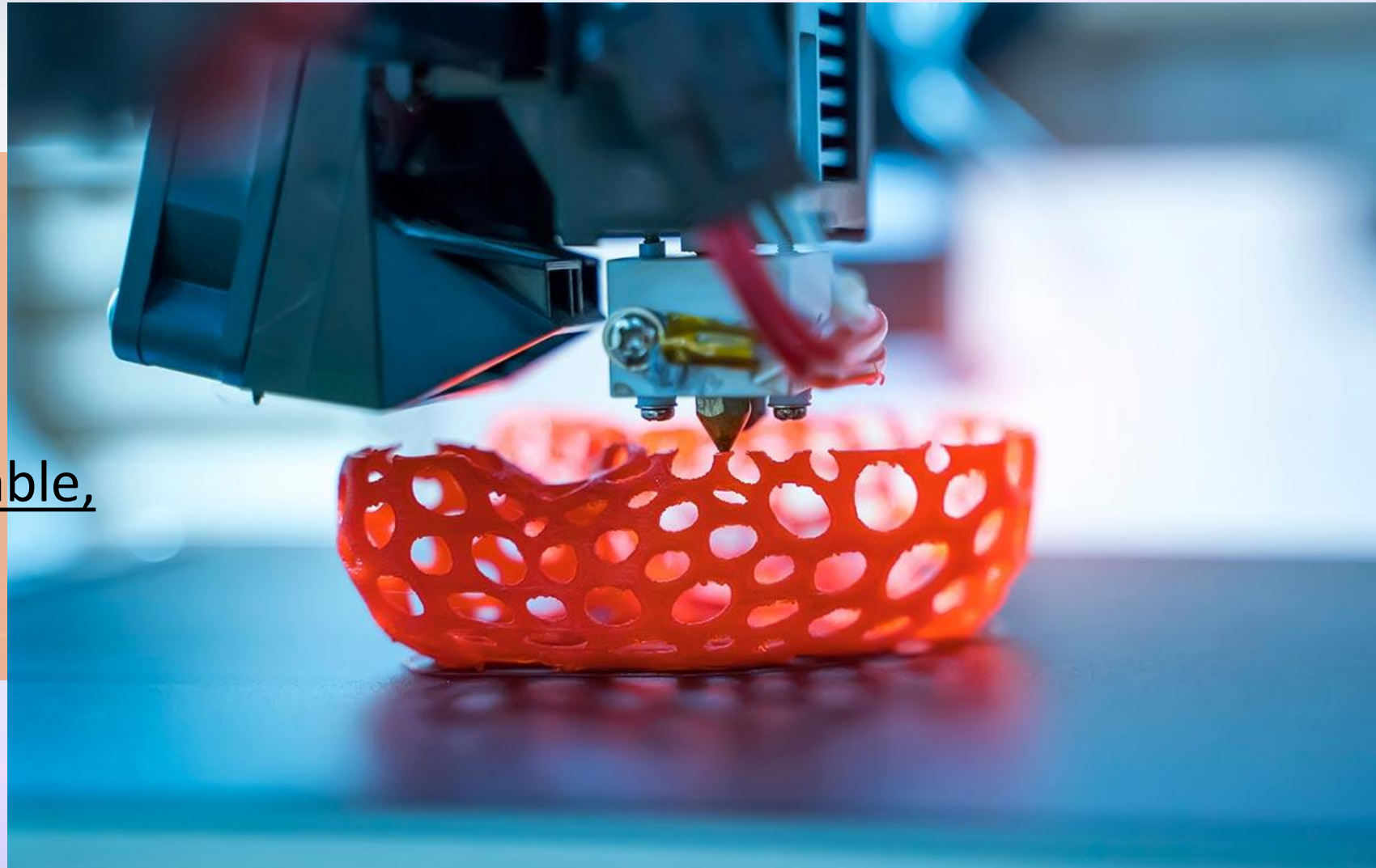


**Advanced Materials**



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**3D printing** creates prosthetics by layering materials like plastics or metals, enabling affordable, customizable solutions.



## 3D Printing

3D Printing: Rapid production and affordable customization.

“The **3D printed** orthoses showed similar or superior effects on **biomechanical parameters** and **kinematic parameters** such as wrist-hand function, wrist spasticity, arch height index, foot plantar pressure, and joint range of motion (ROM).”

2020



# Advanced Materials

Lightweight and biocompatible

materials (e.g.,  
carbon fiber,  
titanium alloys)  
improve  
durability and  
comfort.

**Biocompatibility**



**Lightweight and Flexibility**



**Strength and Durability**



# Training Technologies



**Augmented  
and Virtual  
Reality**



**Machine  
Learning and AI  
Integration**



**Neurotechnology  
and Sensory  
Feedback**

# Augmented and Virtual Reality

Simulating **realistic scenarios**, AR and VR allow individuals to **familiarize** themselves with their prosthetic devices, improving their **confidence** and ability to perform daily activities.



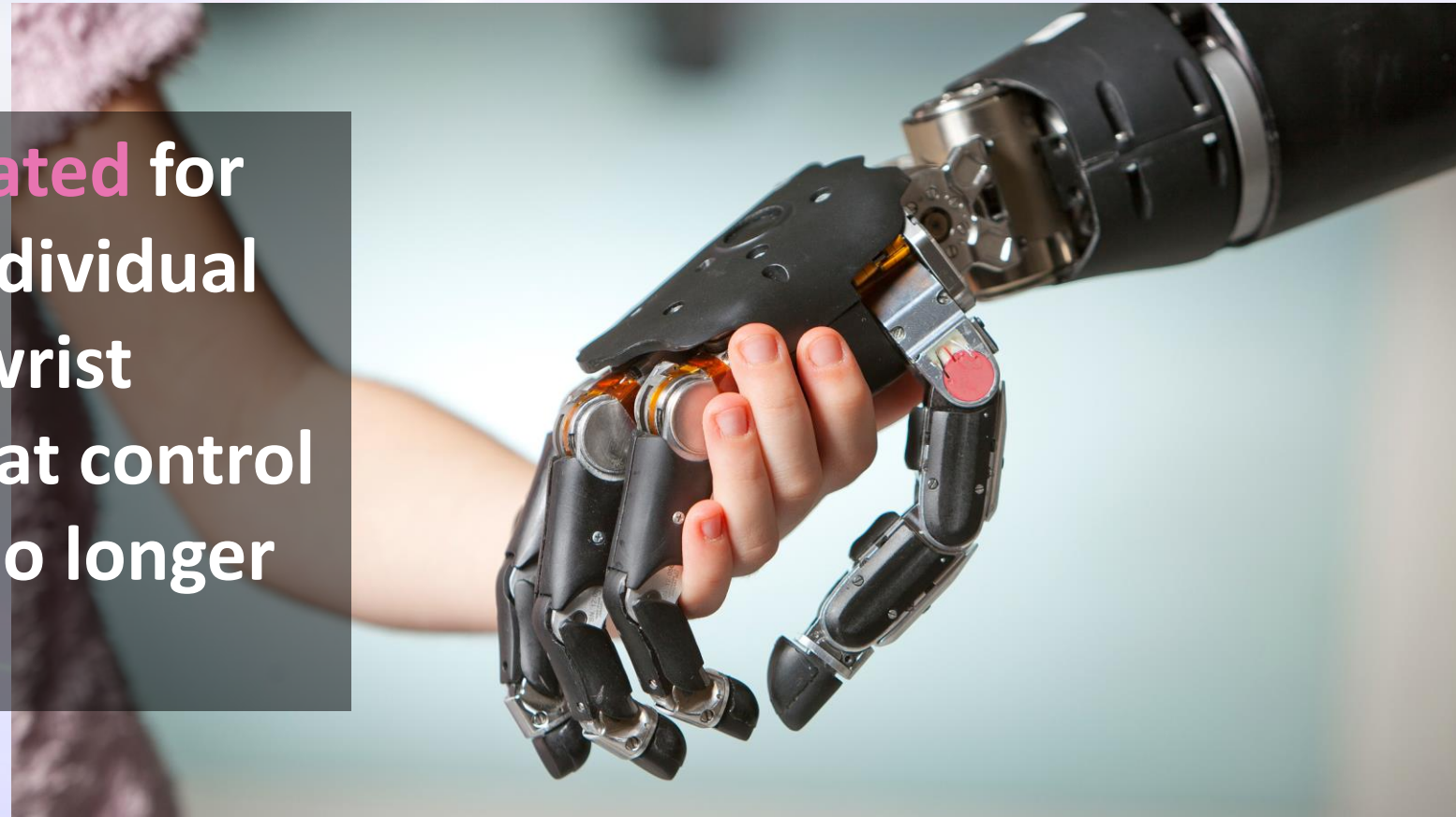
## Machine Learning and AI Integration

The problem with  
current prosthetics?

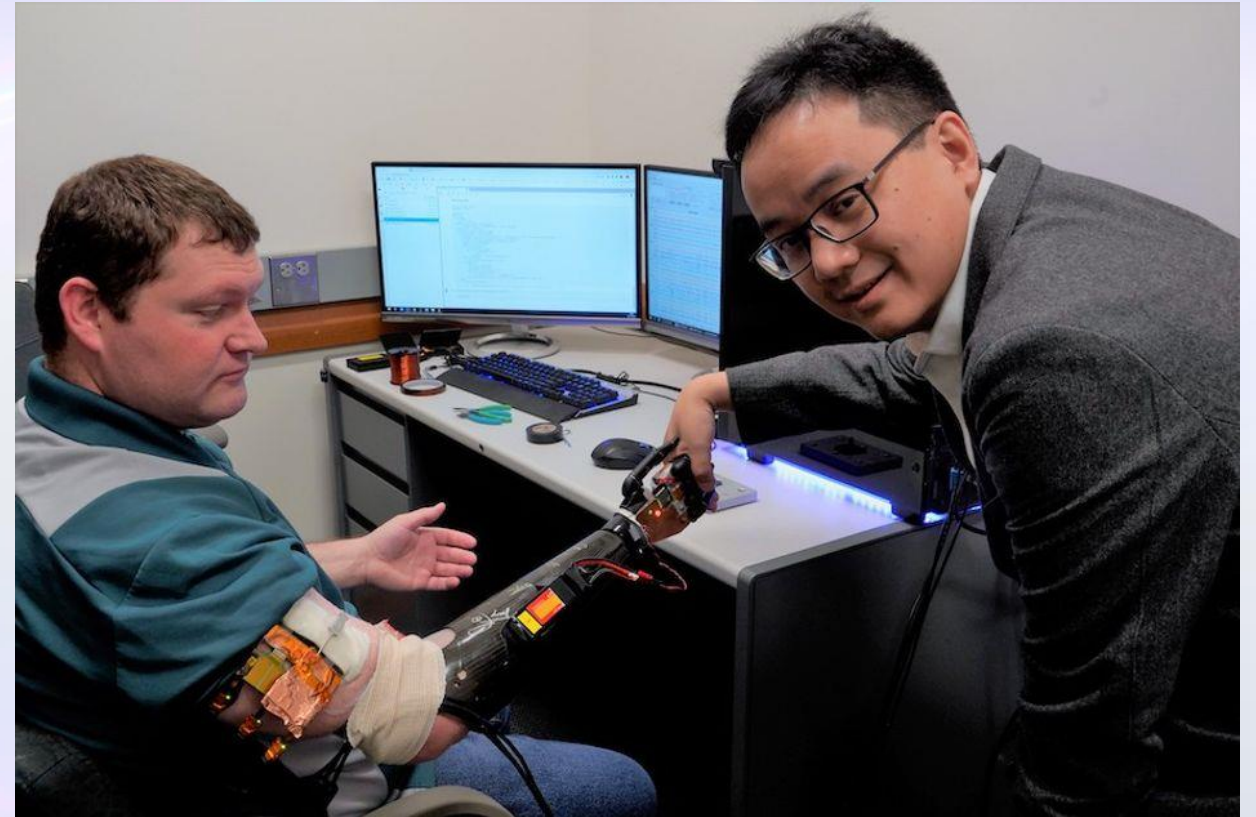
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things become **complicated** for **tasks** such as moving individual fingers or rotating the wrist because the muscles that control these movements are no longer there.

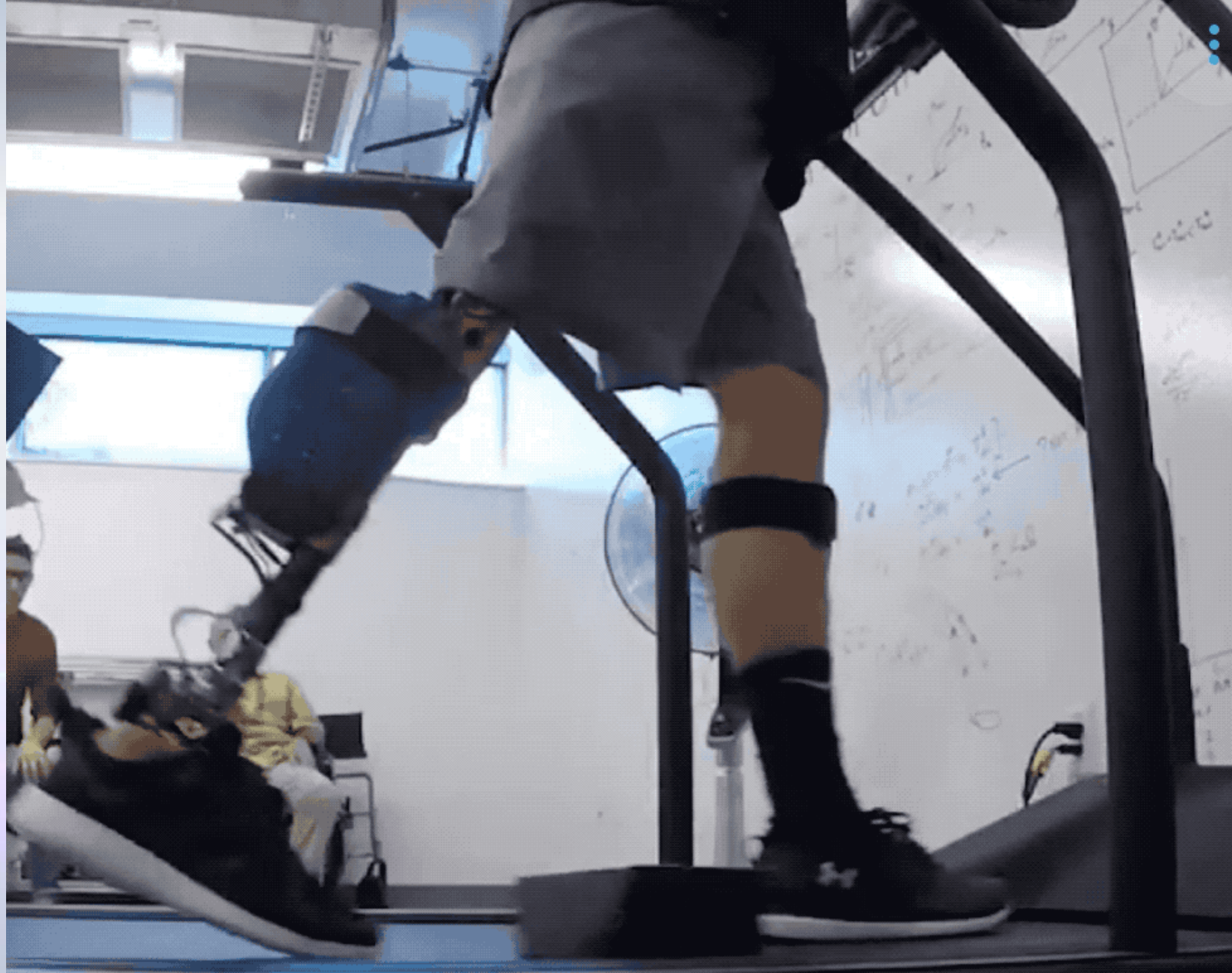


team of researchers created a prosthetic **hand** that uses **computer vision** to **identify** the **object** that it's about to grasp and adjusts the grip **without manual** intervention from the user.



professor Zhi Yang shakes hands with research participant Cameron Slavens.

For a person using a **prosthetic leg**, tasks such as jumping over **obstacles**, walking on **uneven grounds**, or navigating a flight of **stairs** can be **challenging**.





Mechanical engineers from **Utah University** have taken steps to make these common tasks easier by **develop a bionic leg** that leveraged AI and machine learning to adapt to different environments based on **feedback from the user's residual limb**.

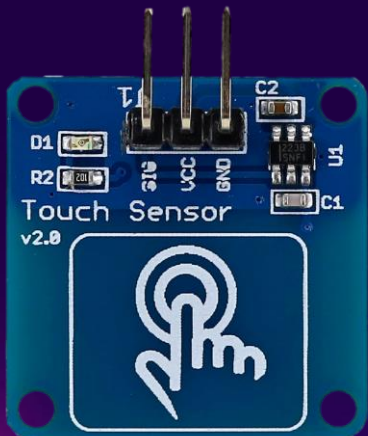
can also, adapt to a user's specific stride pattern leading to effortless and more natural movement for the user.

The researchers have now **partnered with Ottobock UK** to take the leg to market.

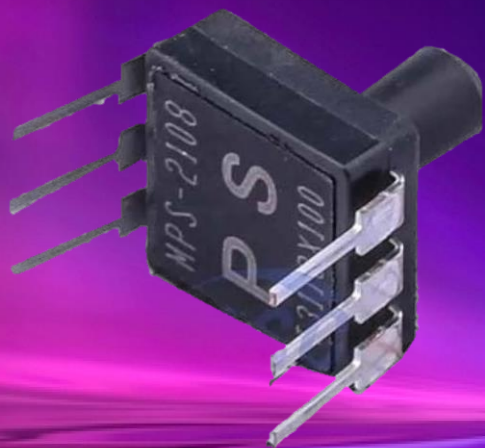
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# FUTURE WORK

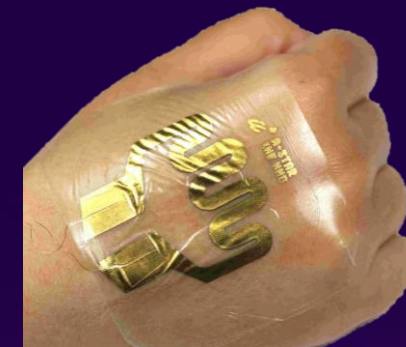


Touch sensor

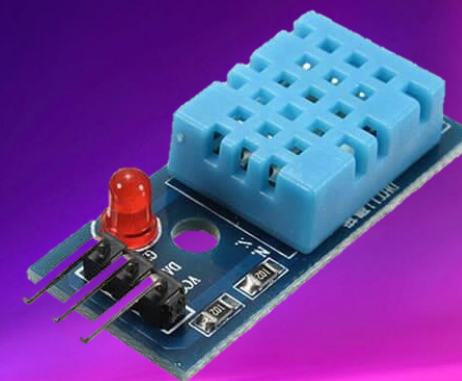


Pressure sensor

Future prosthetics will **integrate sensory feedback** (touch, heat, pressure) using AI and neurotechnology to **mimic natural limb functionality**.



Pain sensor



Temperature sensor

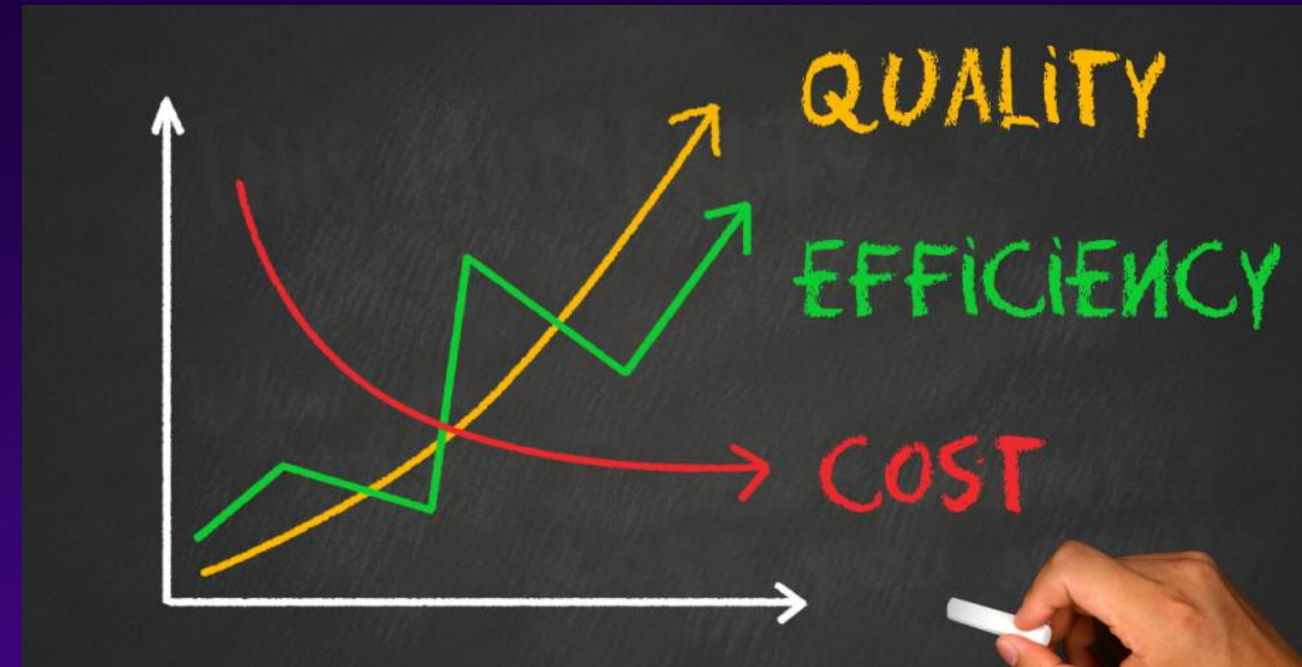
## 3D Printing in Prosthetics

### •Efficiency:

- Custom designs based on anatomy.
- Production **cost**: around \$500–\$1,500 (3D printed).

### •Traditional Prosthetics:

\$3,000–\$100,000





## Our region challenges: (specially Egypt, and KSA)

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**Access:**

**Urban-focused, rural gaps**

**Maintenance Programs:**

**Uneven availability, Rare outside cities**

**Costs:**

**Subsidized for citizens, High barriers for many**

**Barriers:**

**Low R&D funding.  
reliance on imported materials and  
advanced technology.**

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## Trends (Saudi Arabia):

- **Joint Research in GCC Countries:** Gulf Cooperation Council (GCC) nations to improve prosthetic research and development.
- **King Salman Center for Disability Research (KSCDR):** Focuses on advancing research, education, and technology for people with disabilities, including prosthetics.
- **King Fahad Medical City (KFMC):** Houses a rehabilitation hospital that offers advanced prosthetic and orthotic services, including support for amputees.
- **Healtec's Advanced Prosthetics Manufacturing:** Healtec, a Saudi-based company, utilizes modern technology
- **Ministry of Health's Mobile Prosthetics Unit**
- **Prince Sultan University's Prosthetics and Orthotics Center**



- **Trends (Egypt):**

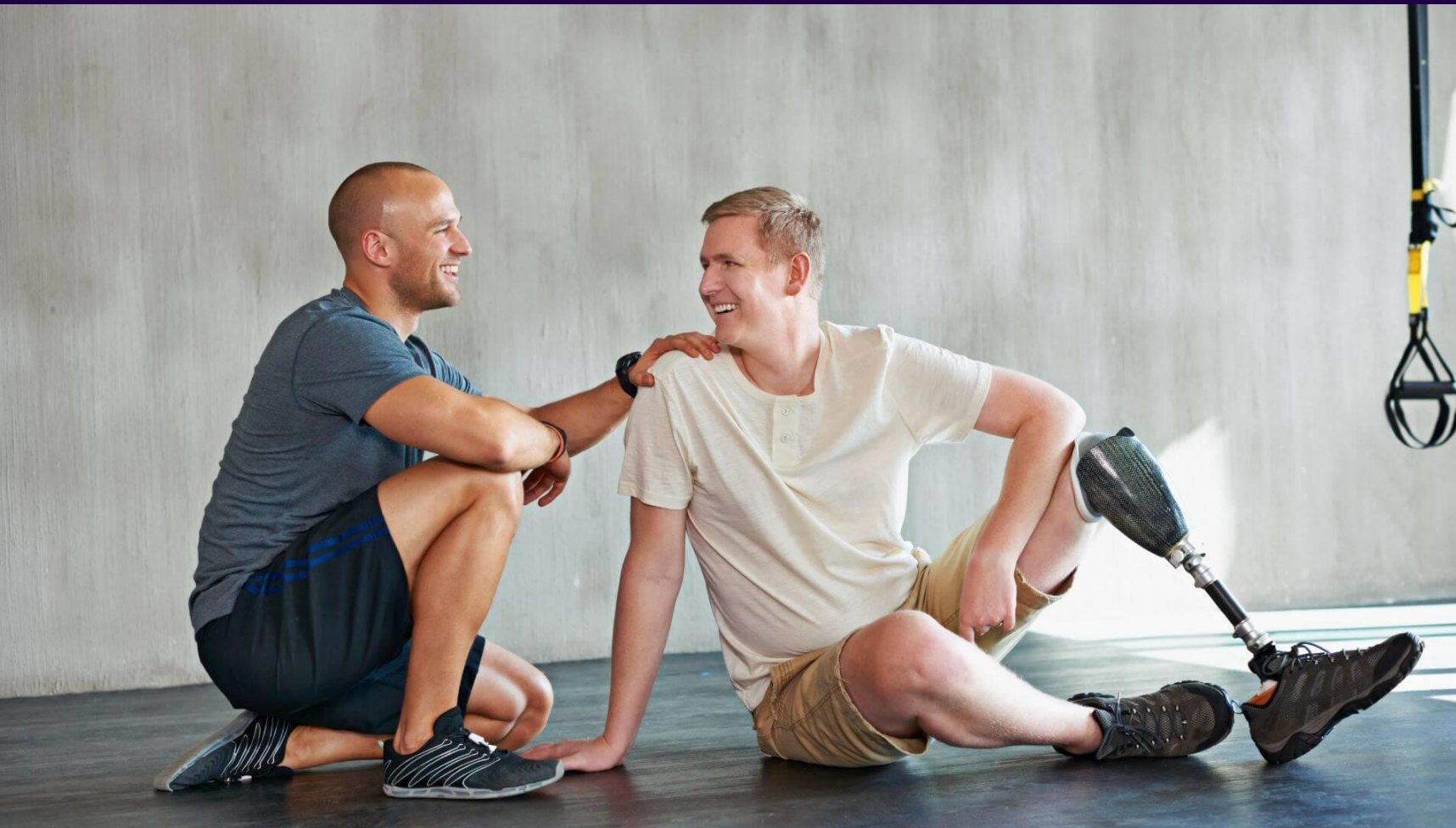
- **Integrated Industrial Complex for Prosthetics:** President Abdel-Fattah El-Sisi directed the establishment
- **Comprehensive Database for People with Physical Disabilities**
- **Project Nitrous:** a non-profit organization that empowers people with disabilities to design and produce their own assistive tools using 3D printing technology.
- **"Antimi) Dolls أنتيمي"**
- **Collaboration between NGOs and universities**
- **Emerging professionals like Esraa Ahmed Rashad** who works with **professional professors** to contribute to the design and development of advanced prosthetics using innovative materials and AI.



**BIONICLIMBS**

**HAAH**  
الحياة لذوي القدرات الخاصة





3D printing and AI are revolutionizing prosthetics.

Regional collaboration and policies are key to improving accessibility.

Future technologies will deliver fully integrated and sensory-enabled prosthetics.



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**THANK YOU!**

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