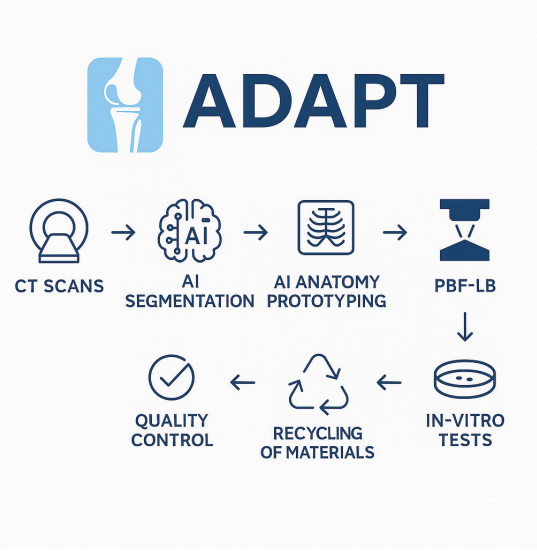
ADAPT - Digital Manufacturing of Customized Orthopaedic Implants

Abstract:

ADAPT aims to integrate technological and digital advancements in the field of Advanced Manufacturing of Customized Orthopaedic Implants. The project addresses upstream and downstream manufacturing stages that directly affect performance, autonomy, and flexibility in industrial AM of metallic implants.The project's digital advances achieve "First-Time-Right" approaches in AM, replacing "trial 'n error", reducing material-energy uses and the number of defects, with gains on the whole value chain.



Countries involved

Application sectors
Consumer goods, Biomedical

Research and innovation domains
Advanced manufacturing processes, Customer-based manufacturing

Total cost in M€ (millions)
1.9 M€

Starting date
05/05/2025

Duration (in months)
36 months

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RATIONALE OF THE PROJECT

"Current solutions for manufacturing orthopedic implants are frequently not patient-specific and require storing different sets of implant sizes to cover the varying joint phenotypes (morphometry and morphology) of patients, where an optimal solution is not always found. Personalized implants optimize the bone-implant fit by designing the implanted components to follow the specific morphology of the resected bone surfaces, thus mitigating the risk of prosthetic over- or under-coverage. These advantages overcome the limitations of current standard implants and tackle the unnecessary proportion of unsatisfied patients. In this scope, ADAPT provides advanced and scalable solutions in AM of customized implants, simultaneously addressing upstream (anatomy scans, 3D CADs) and downstream (post-processing, quality control) manufacturing stages that also significantly affect performance, autonomy, and flexibility in industrial production of customized metallic implants. ADAPT returns significant social impacts by enabling the production of personalized implants designed for the specific anatomy of each patient with high-precision manufacturing by Additive Manufacturing for complex and customized geometries and microstructures. The project establishes a new business model by matching the different value chains, actors, and clientele involved in orthopedic services, industrial materials and AM, quality control, and recycling of used materials."

TECHNOLOGICAL INNOVATION, ACHIEVEMENTS AND RESULTS

ADAPT innovates on multi-process Additive Manufacturing of customized implants using achieving “First-Time-Right” manufacturing with the objectives:
- Develop an AI-based algorithm for segmentation of tomography scans and high-precision 3D generative designs.
- Implement digital-twin systems for flexible manufacturing at different scales and materials conditions.
- Ultrasonic Atomization (UA) of medical grade Ti alloys qualified for orthopedic implants to ensure demanding mechanical-functional and biocompatibility requirements.
- Implement advanced geometrically specialized laser toolpaths for precise control of heat distribution and residual stress on the implants produced by Powder Bed Fusion – Laser Beam.
- Implant post-processing, in-vitro testing, quality control, and validation.
- Develop the process chain for recycling waste metallic materials back to UA.

MARKET POTENTIAL

The competitive advantages of ADAPT match the needs of key end-users and customers. Engagement of end-users is driven by facilitated medical procedures (reduced time and high-quality scan segmentation and prototyping) for doctors; reduced time, cost (materials and energy) for implant manufacturers; and the need for fully personalized solutions for patients. This is accomplished by appropriately integrating capabilities and advancements of the ADAPT ecosystem. The post-project financial model of ADAPT considers revenues by licensing, services provision to manufacturing end-users, and the cost savings for clinical and manufacturing partners of the project.

IMPACT POTENTIAL

The technological, scientific, and economic outcomes of ADAPT foster EU competitiveness and its Global leadership by reinforcing cross-linked value chains through collaborative business models based on innovative production via combined digitalization and advancements in Additive Manufacturing (AM) for healthcare and other manufacturing market segments. The project also promotes circular economy models, minimizing metallic alloy waste that is directly recycled in production, accelerating the pathway to climate-neutrality in the EU. Furthermore, the digitalization of implant manufacturing and healthcare services facilitates technology adoption through digitally enabled and holistic solutions.