

3.1 Publishable summary

Context and project objectives

Over the last decades, human body metrics have been used to improve human-product interaction. Along this period, the use of 1D-measurements in “classic” ergonomic applications (e.g. workplace design) has been extended to consumer goods industries such as the automotive, apparel, furniture or orthopaedic products.

New technologies for the gathering, storage and analysis of anthropometric data (i.e. 3D scanners) **have boosted the availability of digital anthropometric resources**. Since 1999, over 16 large-scale national body scanning surveys have been conducted around the world (six in Europe) gathering 3D shape data from over 120,000 subjects (~50,000 Europeans). The availability of these data pools has created the **opportunity to exploit shape information** beyond current 1D-measurement use (Figure 1).

However, these data pools are dispersed and heterogeneous (e.g. obtained through different scanning technologies and owned by different organisations) and, above all, **the exploitation of 3D data at industry level requires knowledge, skills and resources beyond the means of companies**, especially SMEs. These barriers have until now confined the use of existing 3D shape data to scientific and academic research.



Figure 1. State of the art on the use of digital anthropometric data and Eurofit advances

Our main objective is to develop and deliver **the Eurofit portal** (Figure 2), an online platform and an open framework that enables:

- [1] Designers and industrialists to draw useful shape information and use it in their product development processes in an easy and direct way
- [2] Database owners to pool the data they already hold and obtain revenues from its exploitation
- [3] Third party IT companies to develop new services to reuse pooled data in unforeseen ways

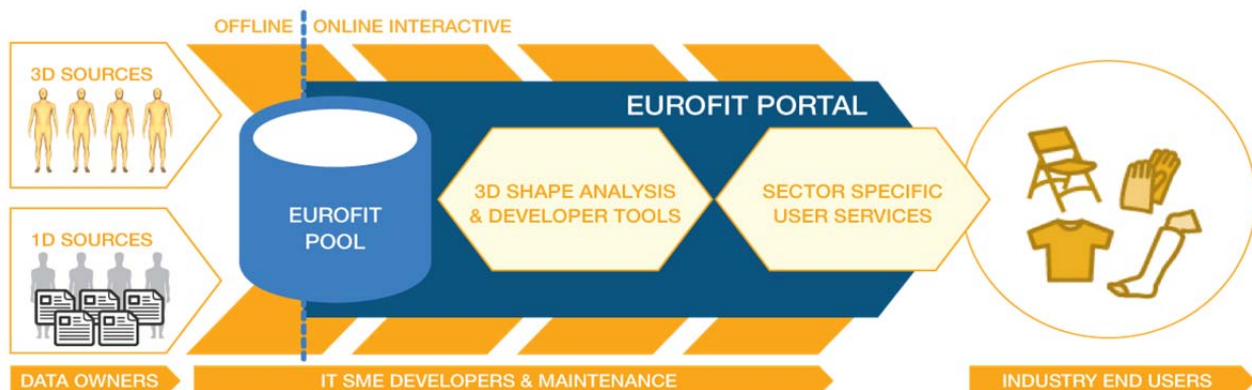


Figure 2. Eurofit portal scheme and stakeholders

R&D work focused on the systematisation and extension of proven methods for 3D shape data aggregation and analysis in a reliable but economically sustainable way, as well as on the development of sector-specific applications and user-friendly interfaces. Main R&D objectives of the project were:

- (i) **Anthropometric Data Harmonisation** – making original 1D and 3D data usable. In order to make original raw scan data and 1D-measurement sets treatable by the multivariate analyses that will render shape information exploitable in product design environments, we need to convert the original data into a common and manageable 3D mesh structure based on the correspondence of homologous anatomical points, hereafter referred as “Homodel”.
- (ii) **Analysis and extraction of new shape information from Homodels.** In order to analyse and extract shape information from large samples of dense 3D meshes of Homodels describing human body shape, complex multivariate analyses should be applied (e.g. Procrustes Alignment –PA, and Principal Component Analysis - PCA). These treatments can synthesise, from a sample of subjects, the modes of variation of the thousands of points configuring the Homodel mesh to a manageable number of parameters (eigenvectors). These parameters may represent, for instance, how body weight, height or muscularity varies across the population analysed. These techniques allow the consistent and objective generation of statistically representative mannequins corresponding, for instance, to the average shape (or to the dimensional boundaries) of the analysed population sample or of a number of sub-samples of it.
- (iii) **Developing specific functionalities to the reach of design teams of companies.** Even if (i) and (ii) solve the problems of DAD gathering and its efficient analysis, end user companies will still be far from directly using its outcomes, since it requires certain knowledge of advanced statistics. Thus, we aimed to develop intuitive user interfaces enabling designers to select target populations, launch shape analysis, focus on the relevant body parts, and directly connect the results to their design activity.
- (iv) **Implementing a secure, upgradable and scalable Eurofit portal architecture.** In contrast to existing DAD portals, the Eurofit portal was conceived to enable its upgrade and up-scale to new data and services adapted to the needs of data owners, developers and end-users including: (1) secure hosting of centralised and decentralised databases of homologous models; (2) the development of application-specific services to exploit the new 3D DAD resources, by defining an open framework enabling innovative ICT SMEs to create novel data management tools and services, or recombine the existing; and (3) reusing of existing 1D-based analyses.

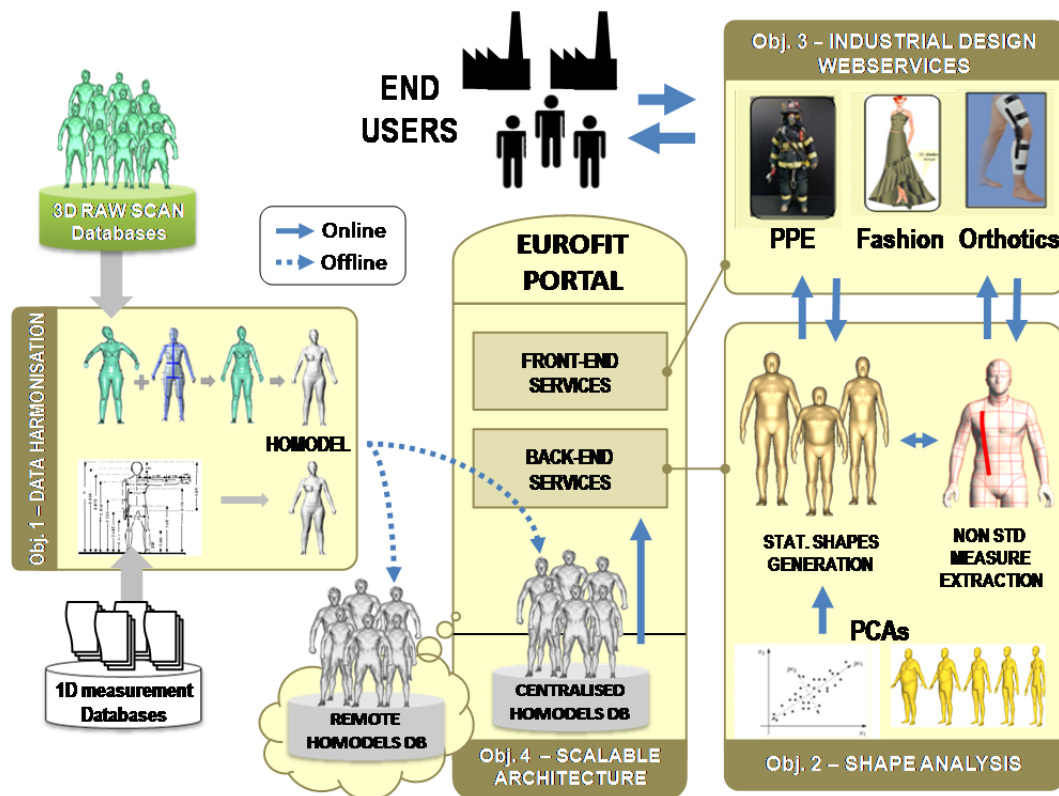


Figure 3. Eurofit portal scheme of developments and S&T Objectives of the project

Eurofit consortium

The Eurofit consortium (Figure 4), coordinated by the [Institute of Biomechanics of Valencia](#) (IBV), was a just-right group covering all the required expertise at a top level. It brought together a critical mass of actors with all different vested interests.

It included [Human Solutions](#) Group, the main European supplier of 3D scanner machinery and software, which is also managing the largest international portal offering 1D anthropometric data; IBV, a highly acclaimed Research Institute in anthropometry, ergonomics and movement analysis; [Hypercliq](#), a highly specialised IT start-up; as well as three end-users from key new application areas: [Össur](#) (non-invasive orthopaedics), [Rieder-Moden](#) (fashion) and [Iturri Group](#) (personal protective equipment) with wide geographic coverage.

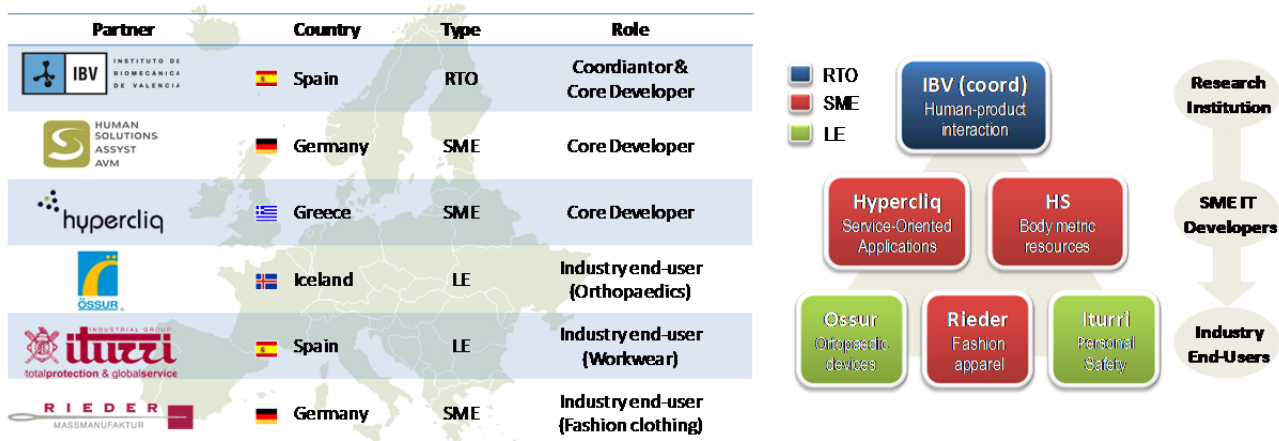


Figure 4. Eurofit consortium members

This mix of partners was built in order to guarantee:

- The access to the required background knowledge/technology to be used as a baseline;
- The skills and resources to undertake the challenging RTD proposed work;
- The industrial capability to absorb the delivered tools, assure its acceptance and carry out the demonstration activities;
- The access to different 3D databases in order to both test the developments in terms of aggregating different types of 3D raw data, as well as to prepare for future exploitation of the aggregated data.
- The capability and experience to commercially exploit results;

Results achieved

The [Eurofit project](#) has delivered 18 valuable results. All these have been integrated either directly or indirectly to the project main result, which is the [Eurofit portal prototype linked to an external Shape Analysis Service](#) (Figure 5). This prototype:

- is the **first 3D-based online resource for the trade of large pools of digital anthropometric data** (both 1D and 3D), offering the opportunity to organisations owning 3D or 1D national/regional databases to obtain revenues for their assets;
- is the **first online resource offering 3D-enabled functionalities** for large anthropometric database exploitation to product developing companies. The main 3D-enabled functionalities developed in the project are:
 - PCA-based shape analysis exploration linking underlying shape variations with measurements.
 - Creation of digital 3D avatars from measurements, size tables or shape modes of variation.
 - Obtaining user-defined measurements beyond ISO standard sets.
 - Obtaining estimated shape information from 1D-measurement databases.
 - Interfaces with 3D CAD software for product development. The portal is connected natively with Vidya (3D patternmaking software) and is connected via 3D file exchange formats (OBJ or PLY) with any 3D modelling CAD.

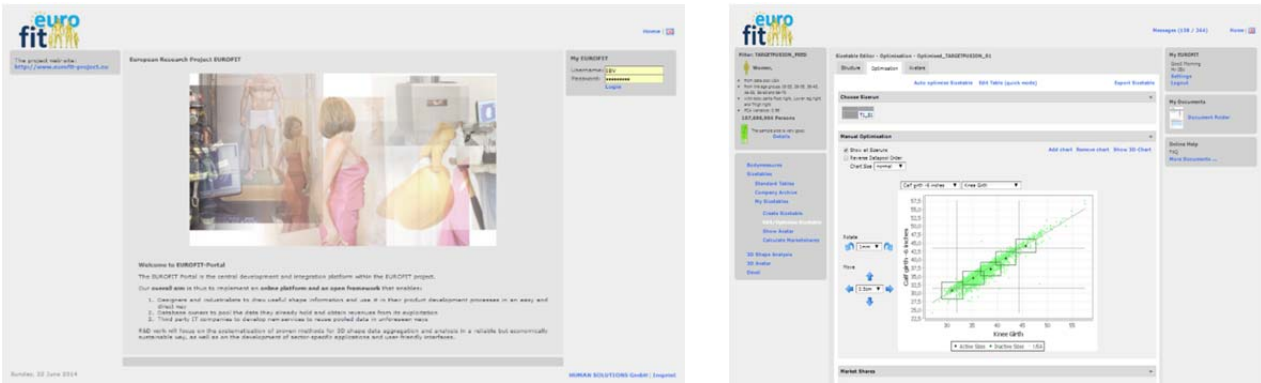


Figure 5. Screenshots of Eurofit portal prototype

Within the project, 4 large national 3D databases have been aggregated to the Eurofit portal, namely from Germany, Spain, USA and China.

Eurofit 3D-datababases and 3D-enabled functionalities will be made available to companies through [iSize](#) portal. iSize was released in 2010 and it constituted the first international anthropometric 1D-measurement data trade resource. It currently has over 160 clients and 8 national databases (Germany, France, Netherlands, Switzerland, USA, China, Japan and Korea) of individual measurements datasets (according to ISO-7250 and ISO-8559 measurement definitions). New Eurofit functionalities and 3D data will be progressively introduced into iSize. Apart from the new functionalities and the extension of databases from 1D to 3D, the Eurofit portal introduces additional upgrades with respect to its predecessor, which has been used as baseline platform for developments:

- Improved user interfaces like the management of garment ease values for the definition of size tables, from the needs and requirements of three potential customer sectors: fashion, workwear and orthotics.
- Service Oriented Architecture, enabling the decentralisation of database hosting and the implementation of external services. This will open the possibility to 3rd party IT developers to enter the data trade business by offering for instance new data exploitation functionalities. The first two external services integrated in the Eurofit portal are (Figure 6):
 - Shape Analysis Service developed by Hypercliq
 - AvatarStudio Web developed by Human Solutions

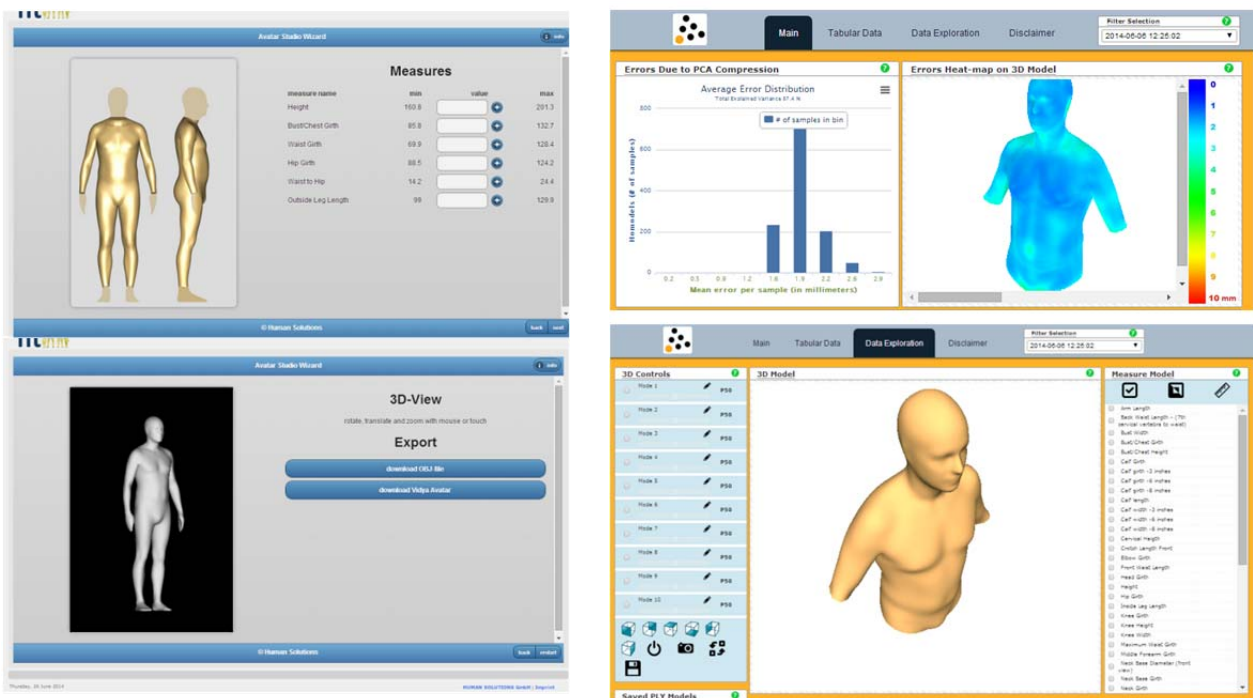


Figure 6. Screenshots of AvatarStudio and Shape Analysis service by Hypercliq

All these new 3D-based functionalities and extended features are underpinned by a series of new developments that were necessary to overcome state-of-the-art technological barriers. They are:

- New methods enabling the massive harmonisation of 3D data, based on the creation of homologous 3D models from raw scans databases and the posture harmonisation.
- New methods enabling the recreation of 3D homologous models from individual datasets of measurements. This technology has enabled both the aggregation of measurement databases and the creation of representative avatars.
- Stand-alone tools for the shape analysis, manipulation of shapes and interactive measurement.
- Optimisation of shape analysis techniques and algorithms enabling online real-time shape space exploration and the creation of statistically representative mannequins or avatars
- PCA-based data compression techniques enabling the online real-time transfer of huge volumes of shape information.

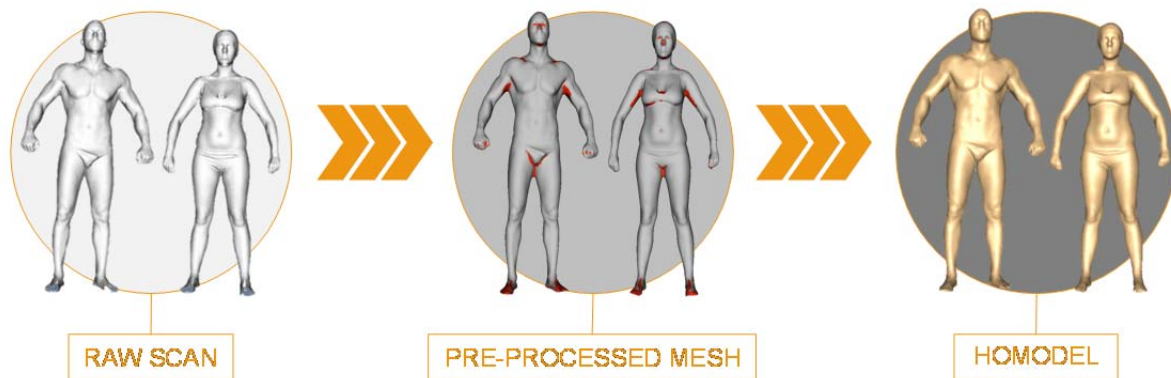


Figure 7. Steps of the 3D harmonisation process



Figure 8. Homology: point-to-point correspondence



Figure 10. Harmonised 3D data from different surveys

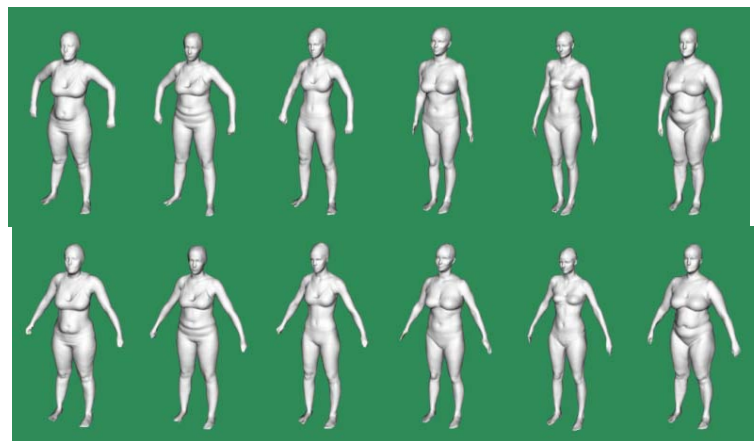


Figure 9: Posture harmonisation of 3D databases

At the demonstration phase, the end-users participating in the project had the opportunity to assess and develop new products making use of the new Eurofit functionalities and data.

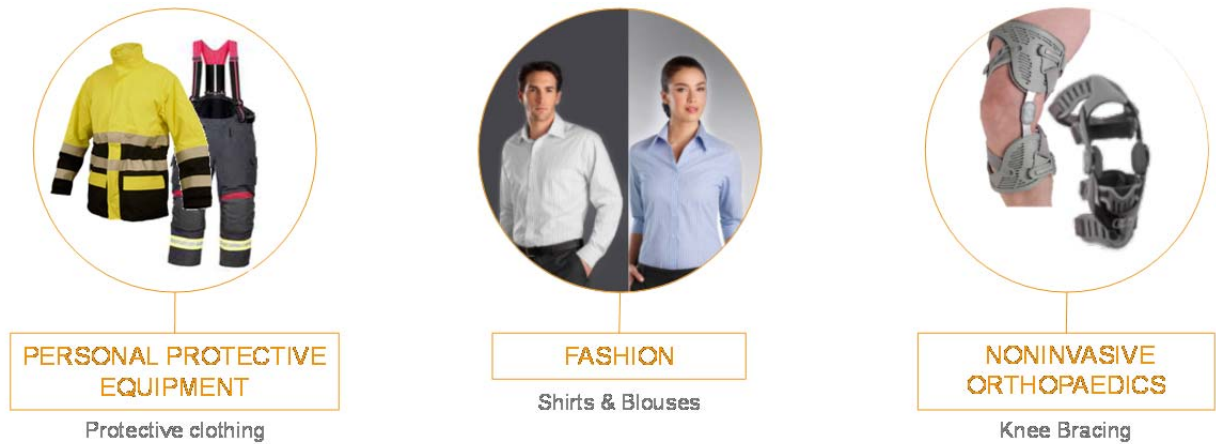


Figure 11 depicts how the main project results configure and support the Eurofit portal concept.

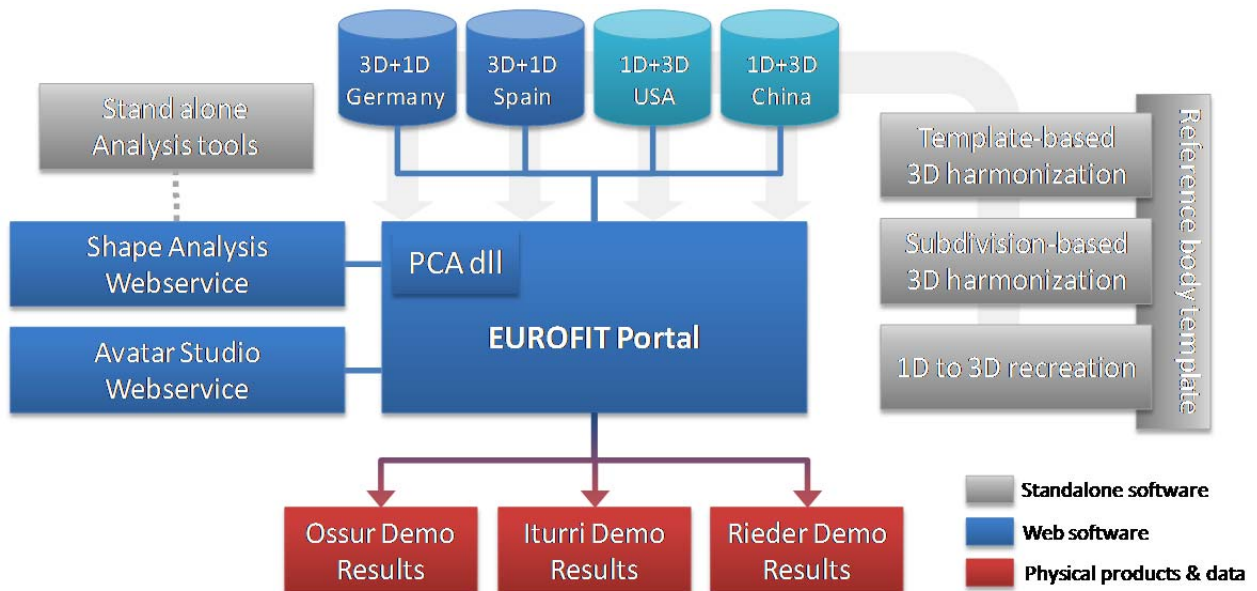


Figure 11. Schematic representation of main project results and how they integrate Eurofit concept

Project website: <http://www.eurofit-project.eu>

EUROFIT coordinator's contact details:

Mr. Alfredo Ballester Fernández
Alfredo.ballester@ibv.upv.es
 Instituto de Biomecánica de Valencia
 Universidad Politécnica de Valencia – Building 9C
 Camino de Vera s/n
 46022 Valencia (Spain)

Project impacts



Transfer of applied research results to SMEs

The Eurofit concept, novel at global scale, will consolidate and put Europe in a leading position with respect to knowledge transfer to the industry in the Digital Anthropometric Data exploitation domain, in particular to sectors dominated by SMEs. It will also enable a dramatic increase in the quantity and value of the Digital Anthropometric Data on offer to the European industry.



Supporting SME internationalisation

The access to reliable international 1D and 3D anthropometric data will provide industrial users with a better knowledge of their customers in new markets. Moreover, it will enable IT companies to offer this information to other sectors and markets, beyond the ones already addressed



Fostering knowledge-based innovation

The Eurofit portal will stimulate innovations based on the development of better ergonomically performing products to citizens. Moreover, it will significantly reduce time and cost to industry end-users in the integration of anthropometric data into product design, especially if compared to the outsourcing of equivalent services.



Bootstrapping a data economy

The Eurofit portal sets a paradigm for the trade of digital anthropometric data. It enables current data owners (either 1D or 3D) to obtain revenues from their data assets, while responding to the raising demand of product manufacturers to have access to this data. With the emergence of low cost scanning technologies, the volumes of anthropometric data available and the number of data owners will exponentially grow in the following years.

The Eurofit architecture will enable the scalability (to other industry sectors) and the upgrade (to new types of 3D data) in a fast and profitable way. This will foster the progressive enlargement of the initial IT partnership to wider communities of contributors.