PUBLISHABLE FINAL ACTIVITY REPORT

Objectives

The **SCULPTOR Project** aims at innovating radically the European sheet metal sector by providing this industry with an **optimized, flexible, low cost, safe and environmental friendly forming technology**. It is expected that the new technology will replace traditional processes in the mid-term for small and medium-sized batches and Rapid Prototyping applications. In the long term, it will pave the way for fundamental changes of manufacture, enabling the production of advanced design products, whose manufacturing with current technologies is highly cost and quality ineffective, even unapproachable.

Description of work

As an alternative to conventional stamping and deep drawing processes which are based on big and costly dies and presses, the shaping process proposed in the SCULPTOR Project is based on the **incremental sheet forming technique (ISF)**, a new, clean and affordable process. ISF consists of the gradual plastic deformation of a metal sheet by the action of a spherical forming tool whose trajectory is numerically controlled. Thus, **complex shapes** can be achieved eliminating the dies or using a simple support die. The process can be carried out in either in a standard CNC milling machine or a robot. One of the key advantages of ISF is that initial investment costs are around a 5-10% of those of conventional stamping process since **dies are eliminated or significantly simplified** (one support die with simplified geometry and/or made of cheaper materials). Moreover, ISF is a quite more flexible method since different geometries can be obtained in the same machine just by adapting the CAD programs and optimizing the process parameters. In spite of the mentioned advantages, the process has a limited industrial penetration yet because it is **not completely flexible** (support dies are needed most of the times), **not self-controlled** (cracks and defects are unpredictable) and **not fully optimized** (parts lack of geometrical accuracy and uniform thickness). In order to solve those problems, several aspects need further investigation and a deeper knowledge has to be reached.

The SCULPTOR Project targets to achieve a significant advance in ISF. On the one hand, while conventional ISF usually requires a support die, the project proposes a **new ISF concept** where the support is replaced by a second forming tool. Thus, the part is formed by the action of two opposite tools. Path of both tools will be controlled in terms of position, tilt, speed and force. The new ISF process (SCULPTOR process) will provide compared to conventional ISF with the capabilities for shaping more complex and larger geometries and decreasing processing times. The control of the two generic forming tools will also provide with a higher flexibility since a die with a dedicated geometry will be no more required.

On the other hand, conventional ISF limitations have only been solved for simple geometries through multi-stage strategies where consecutive optimized intermediate surfaces are numerically calculated to get the desired geometry without wrinkles or cracks. In this sense, the SCULPTOR project will research into more general

strategies, developing and optimizing **computational modeling tools** and a **specific process methodology**.

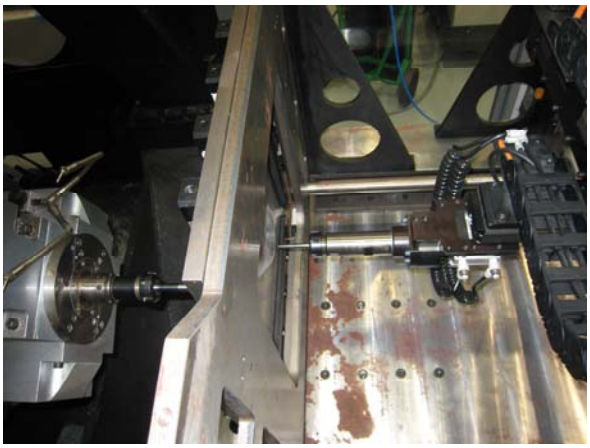
Therefore, the **development** of both **conventional ISF** and the **new SCULPTOR process** is the other target of the project.

Results and conclusions

Major achievements of the project can be summarized as follows:

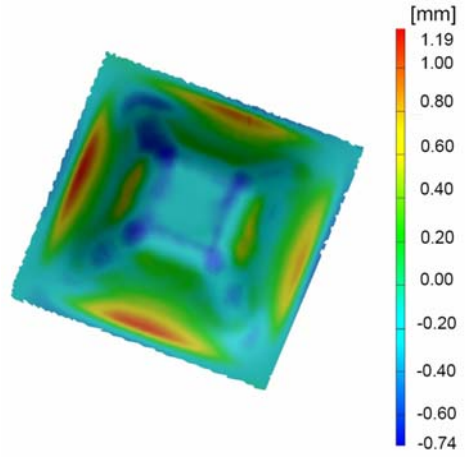
- Two **SCULPTOR prototypes** have been developed and some basic shapes have been produced to test the feasibility of the process.
- Prototypes of two **sensory forming tools** (thickness and force measuring) as well as a **sensory blank holder** (force measuring) have been developed and tested. Their potential to monitor ISF processes has been demonstrated.
- A **one-step model** allows estimating part thickness with accuracy quickly. A **full-scale numerical model** allows predicting strains for both conventional and SCULPTOR ISF but computation times are still very high for complex geometries.
- Important contributions to the development of a **methodology for ISF** have been made in terms of **machine parameters, lubricants and forming strategies**. These contributions have made possible to fabricate two automotive applications using conventional ISF.

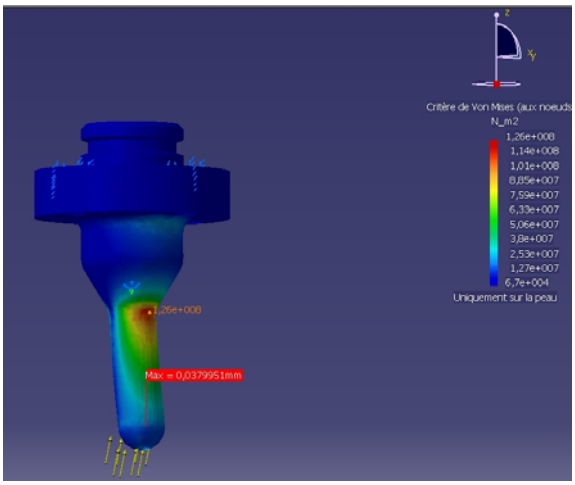
It can be concluded that the SCULPTOR project has made relevant contributions to the take up of the ISF. New challenges involve now to fabricate parts using ISF in advanced materials, with a high complexity/accuracy for a broad range of industrial sectors as well as the development of ISF capabilities with the robustness and reliability to fulfil industry requirements.



SCULPTOR prototypes

Full-scale numerical model

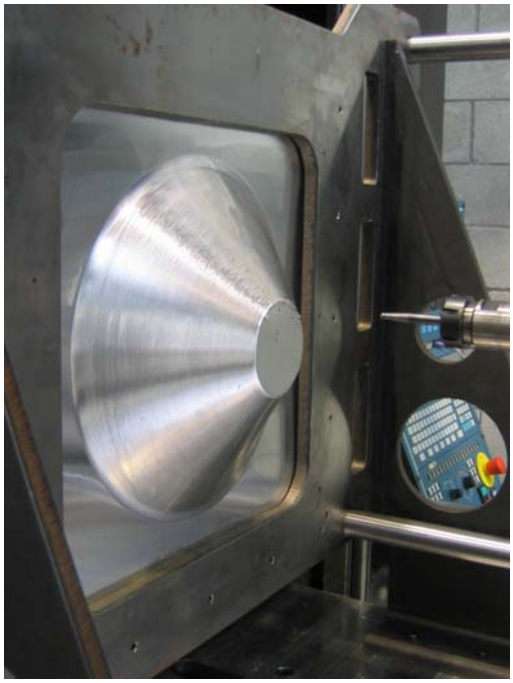




On-line thickness measurement

Suspensión dome produced by conventional ISF

Side window mounting produced by conventional ISF



Basic shapes using the SCULPTOR process

Consortium

fatronik tecnalia (coordinator)	Mrs. Asun Rivero Fundación FATRONIK Mikeletegi 7, Parque Tecnológico E20009 – San Sebastián ✉: arivero@fatronik.com ☎: +(34) 943 00 55 00 Fax: +(34) 943 00 55 11 www.fatronik.com	ES
ASCAMM CENTRE TECNOLÒGIC	ASCAMM Centre Tecnològic	ES
CENTRO RICERCHE FIAT	Centro Ricerche FIAT	IT
DISTRIM2	Distrim2, Industria, Investigação e Desenvolvimiento	PT
EADS	EADS Deutschland	DE
ensmm	Ecole Nationale Supérieure de Mécanique et des Microtechnologies de Besançon	FR
ISC Institut Silicatforschung	Fraunhofer Institut Silicatforschung	DE
ibf	Institut für Bildsame Formgeburg	DE
MTA SZTAKI	MTA SZTAKI	HU