T.I.I.P.:
A GROUP OF INJECTION MOLDING TRAINING AND RESEARCH

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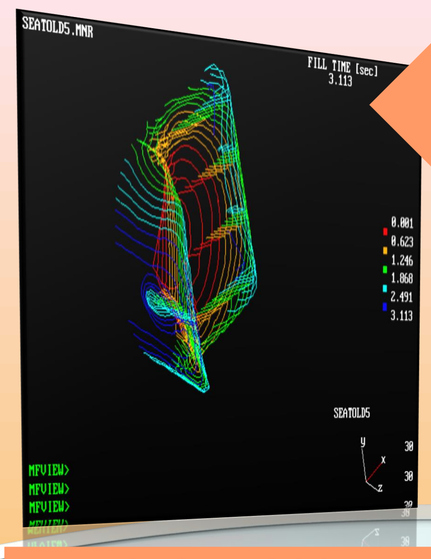
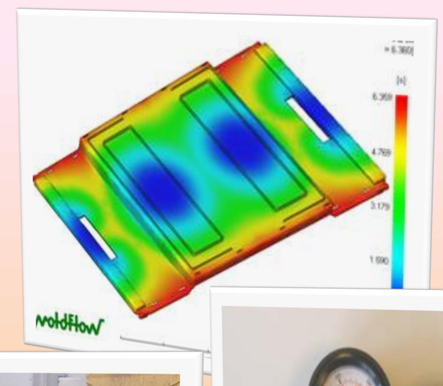
MORE THAN 3000 PEOPLE TRAINED:
2000 tech-level, 1000 engineering students, 250 master students



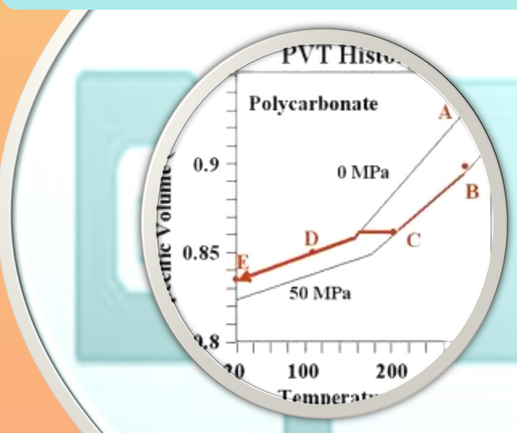
MOLD DESIGN:
1500 items since 1990 (MONDO-Seat 4, 1994)

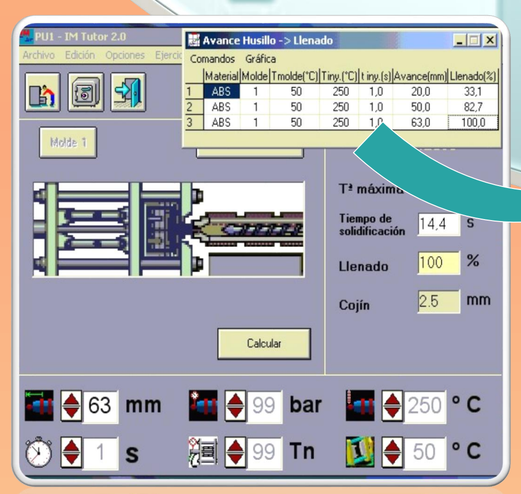


DEFECTS: 1200 problems solved;
air trap in electric box

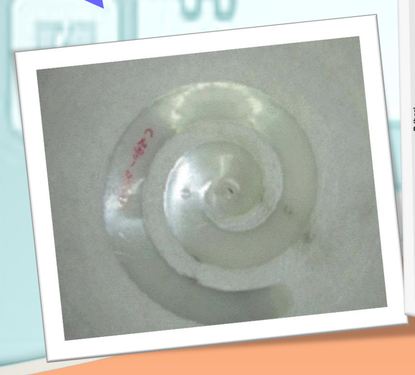
INNOVATION, new products

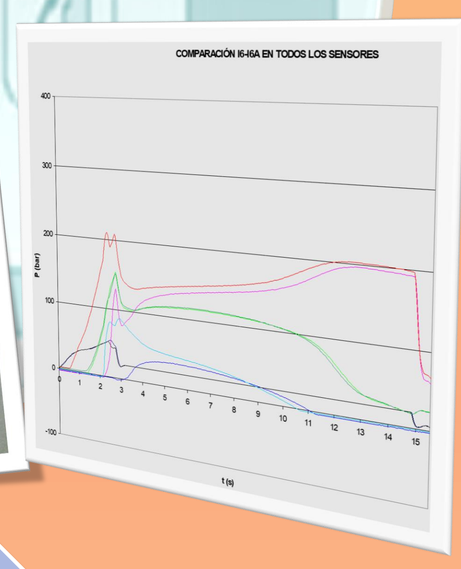
FUNDAMENTALS EXPLAINED:
using logic, not "magic"solutions





WORKSHOP FACILITIES: 50 and 200 ton machines, CNC-milling, rapid-prototyping, ProEngineer, Moldflow …





RESEARCH:

Our final goal, around injection molding: process, design, rheology…

20 TRAINING PROGRAMS DEVELOPED:
example, setting up process

DEVELOPMENT:

second step, TIIP team works **with** plastic companies giving them additional value

PROJECTS:
Web activities
Partners in America
New Master on Polymers

TRAINING:
Basic for success, "taylor-made":

Basic: for all departments, principles in plastic design and injection;
Intermediate: four short courses (material, machine, mold and setting-up) to technical staff;
Master level: graduate students

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Abstract

Created from University of Zaragoza, the group T.I.I.P. has developed its activities since 1989 around injection molding. This team has always worked as near as possible to the industry (its name includes “workshop”, not “laboratory") and, in its aims, it promotes the research work pushed from market demands. However, for an effective knowledge exchange, the members of the group T.I.I.P. have promoted hundreds of training courses teaching to all the injection´s actors, about how to arrange the whole process to improve final results. During these twenty years, fifteen doctoral theses and twenty friendly computer programs for training were made, closing the loop.

Introduction

If the young graduate played by Dustin Hoffman, had taken the advice given ("Just one word: plastics"), probably would have become rich. This idea, picking from the movie "The Graduate", has led to numerous journalistic articles and debate forums until now and demonstrates how, sometimes, even fools are right. Plastics mainly gained ground with the introduction in the automotive industry during the decade of the 80s, result of the need to cut costs and consumption, and have extended its implementation to all sectors and markets and especially in all objects high consumption.

In this line, in the mid 80's, at the University of Zaragoza were receiving lots of questions about designing with plastics. This demand led to the creation of engineering team associated with these materials around the teachers included within the Area of Mechanical Engineering, in order to incorporate this knowledge to the training of future engineers.

More than twenty years later, that small group has developed more than six hundred plastic projects, has given more than four hundred training courses and has defended fifteen doctoral theses in plastic engineering. Furthermore, from this university group was born another industrial structure as “spin-off” in 1999, the Foundation aiTIIP. This is a small overview about its activity in plastic engineering.

First step: training

As result as it’s born inside University of Zaragoza, the T.I.I.P. group has a great vocation to training activities. These can be classified in three levels:

a) *Focused on companies staff*: starting from machine operators to the quality office, all the company should understand that plastic design involves all the roles inside the plant. It is no possible to produce with an excellent mold (high steel quality, valve gates hydraulically operated, with conformal cooling…) a poor design part (non uniform thickness for example). This effort has always a positive result if applied, because rejected parts will be eliminated, cycle times become faster and so on. Courses have been held not only in Spain but in other countries like Egipt, Mexico, Ecuador or France.

b) *For undergraduate engineering students*: all the knowledge and examples developed with the industry are used to introduce plastic materials and plastic design in the traditional subjects as “Machine Design”, in order to improve the student’s vision on polymer capabilities and plastic behavior.

c) For post-graduate students: during last decade, more than 200 post-graduate students had studied new technologies in injection molding and, furthermore, in other plastic process with the agreement between European universities as Queen´s Belfast (UK), Université d´Pau or Ecole des Mines de Douai (France). Simulation tools, the setting up process in the injection machine, understand rheology principles, tool design, etc. were their objectives during nine months, just before starting to play their knowledge in plastic companies. This was the European Master in Plastic and their Manufacturing Processes, sponsored by European Plastics Converters, and promoted from the University of Zaragoza.

Forced by this spirit, the group developed more than twenty training software, presented in different technical conferences [1-3], for their use in courses and to calculate several basic results in planning phase (basic estimation on clamping force or injection pressure, or machine selection for a new mold under technical considerations). All this codes were done for “friendly use”, over BASIC code, as a “role playing scenario” to promote decision criteria in the learning sessions. A typical example of this training software is shown in Figure 1, presenting the ram speed profile for filling phase.

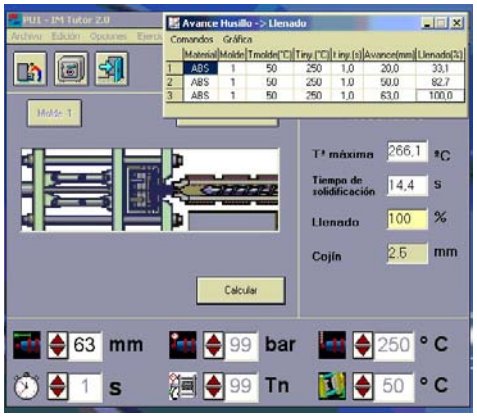

Figure 1: software developed to understand the setting up process

Development: case studies

During all those years, the T.I.I.P. group has encountered many injection problems which have been studied under technical point of view. This effort had generated a great background and a continuous curiosity about new trends and process limits. More than two thousand molds has been analyzed and, even simulation was used in most of cases, common sense and a deep comprehension of injection basis was always the best tool to solve each defect.

For example, in the mold design of a stadium seat made two decades ago, an aesthetical problem appeared in the back side, due to the plastic flow through the ribs located under the seat surface, Figure 2. A simple change in the ribs shape reducing this “racetrack effect”, suppressed this defect without remarkable seat´s strength loss. In the other hand, this change reduced the packing space required to logistics and transport tasks, a great benefit to the final customer, placed in most of cases, far away from the manufacturing plant. The simulation was only the graphic tool to demonstrate this phenomenon and to define the new part geometry, but main idea of solution could have been proposal without this resource.

In other cases, simulation helps to the designer or moldmaker to choose the gate location, as in automotive part shown in Figure 3. Automotive timing does not admit mold delays, and mold decisions are always critical.

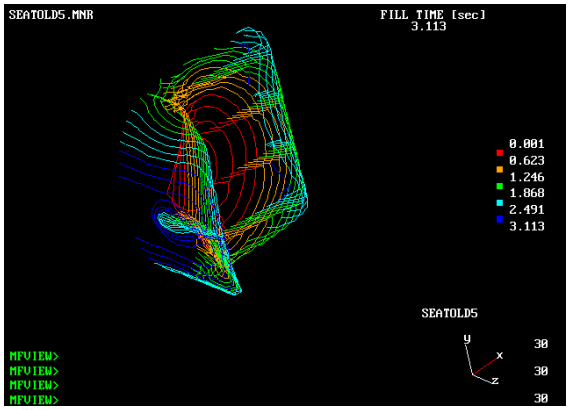

Figure 2: an old MOLDFLOW software image from the early 90´s: a stadium seat showing defect in the back area due to ribs configuration.

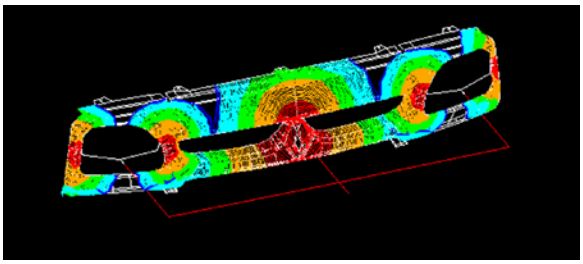

Figure 3: automotive part simulation.

In many cases, not only mold design was studied, but the whole plastic part design. Pro-Engineer tools are used for this goal combined with simulation tools. This was, for example, the point in the big rubbish container developed with CONTENUR [4], were structural stiffness and injection feasibility were connected with the main part thickness. Both values were analyzed used structural and rheological tools, to define an injection part more than sixty kilograms weight (Figure 4).

Figure 4: the 2400 l rubbish container designed with CONTENUR ESPAÑA.

Probably less impressive, but much more complex under technical requirements was the design of a new regulator for welding equipment, made in glass reinforced polyamide, developed with GALASOL [5]. Here, temperature and fatigue tests were critical, as much as process stability and tolerances. From the benchmarking to the final parts, including several prototypes and assembly questions were solved in a two years project (Figure 5).

Figure 5: the GALASOL project: final assembly of the pressure regulator plastic made

Finally, in many cases, the T.I.I.P. knowledge was only required to solve setting up problems. In those examples, an industrial benefit was provided avoiding injection flow marks or dimensional problems using injection parameters or suggesting mold changes. In Figure 6, an electrical box is shown, with an air trap produced by thickness differences.

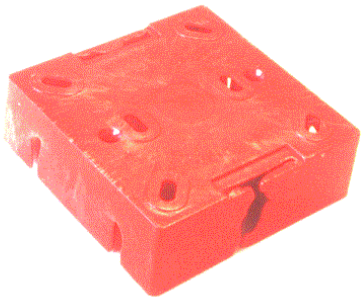

Figure 6: air trap produced in an electrical wall box.

Research: some topics under review

The T.I.I.P. group is integrated in the University of Zaragoza. In this sense, it is no possible to divide its industrial activities from its research work, focused in both cases in injection mold processes. Following this driven idea, more than twelve doctoral theses were defended last twenty years. Most of them have investigated new processes or new design tools for plastic engineers.

For example, a complete study of new technologies could be shown. Gas assisted injection molding (GAIM) or sequential injection, or textile over-molding have been investigated, as well as different tool and machine improvements [6-8].

In the same way, rheology basis has been studied in injection process with several tools as the use of spiral mold to obtain the viscose's models and several corrections depending on special conditions (Figure 7).

Figure 7: spiral mold used as basic tool to investigate textile over-molding.

Other contributions to research and development are its work in several patents (product, processes and machinery modifications), reader can have a look inside in the T.I.I.P. web site, www.tiip.unizar.es, (Figure 8).

Figure 8: the T.I.I.P. web site

This advanced work has been recognized by C.S.I.C., the main research institution of Spanish government, because the T.I.I.P. group is considered as C.S.I.C. associated unit since 1995.

The future

This Spanish group represents a small example of cooperation between industrial producers and the university structures. Starting from training courses and small practical problems, it has created technology and business for plastic manufacturers, research projects and patents and, finally, even a spin-off technical center cited above. The T.I.I.P.´s trajectory during last two decades has demonstrated that the cooperative spirit makes possible new developments for the industry, and it becomes possible if both organizations believe in new projects and they push engineering students forward, because the future is in their hands.

References

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Key Words: injection molding, training, part design