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UPM INNOVATIVE RESEARCH
UNIVERSIDAD POLITÉCNICA DE MADRID

nº 4

UPM INNOVATECH

Technical University of Madrid innovative research

BETsMA
Solutions for
6.000 tons of space debris

Contents

HIGHLIGHTS

Cover photo: European Space Agency (ESA), http://bit.ly/O99yYg

UPM researchers that sell their technology

Technological solutions such as new early detection devices for hearing impaired, the design of a photobioreactor for the production of microalgae for energy purposes and water purification, smart windows able to filter the sunlight on buildings and finally, advanced services for elderly and dependent people are some examples of technological projects that participated in the 2nd Training Course of UPM Technologies Commercialization.

The Centre for Support of Technological Innovation CAIT-UPM launched this new edition that is designed to support the assessment and the commercial exploitation of technological solutions developed within UPM.

This training program, within the university-industry chair Clarke, Modet & Cº with the UPM, is addressed to UPM researchers who have a result or a potentially marketable technology. Firstly, this program aims to reinforce the skills of the participants for the anlysis of commercial viability of R&D result. Secondly, the program helps to design a marketing plan of the technology allowing the application of theoretical knowledge to a real case study.

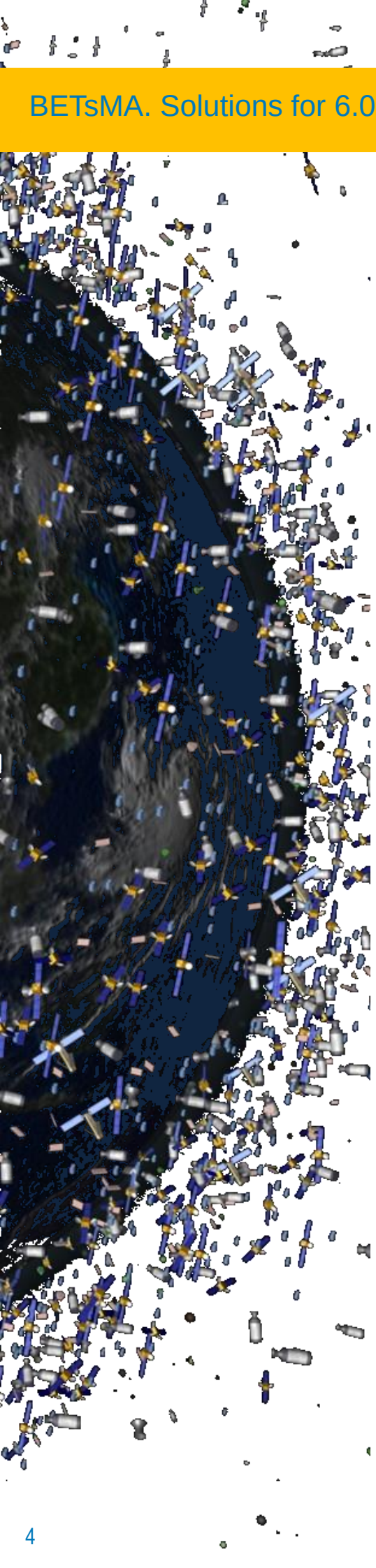
As a conclusion of the course, the researchers submitted their projects to a group of investors and partners of the centre who gave feedback. They selected three projects highlighting their specific potential to be commercialized and later aiming to be presented to 1st UPM-innovatech International Workshop.

The 3 best projects that were highlighted by their potential to be commercialized were Silfrared @ IES-UPM & UCM (below left), Structural Fiber Sensing @ *ETSI Aeronáuticos* (below right) y BETsMA @ *ETSI Aeronáuticos* (on the front page).

Silfrared (Javier Olea, IES-UPM)
Photodetectors based on silicon that allow thermal night vision. It does not require refrigeration to work and it is developed with abundant and non-polluting chemicals. These properties involve a reduction up 20% of production costs compared to the current technologies. The performance of broad-spectrum infrared photodetectors can increase its field of application: security, ICT (optical communications), health (medical imaging)...

SFS (Antonio Fernández, ETSI Aeronáuticos)
A system that allows the detection of structural damages of infrastructures such as wind turbines, aircrafts or civil works. The system is integrated into the structure through a sensor network of optical fiber. It is a non intrusive and slight system and allows the monitoring of the propagation of elastic waves in the structure. Its relevance: the profitability in future wind turbines, for example, is to reduce by 40% the maintenance cost of the blades.

BETsMA. Solutions for 6.000 tons of space debris



Half a century of space activities and the lack of a natural and effective mechanism to bring the objects back to the Earth, gave rise to a collection of defunct objects in orbit around the Earth. Space debris includes non-functional objects like satellites out of service, spent rocket stages and a huge population of fragments result of explosions and collisions. There is around 6,000 tons of space debris that, due to the high orbital velocity (about 8km/s) can produce severe damages to operative satellites. The space debris problem is critical in LEO (Low Earth orbit) with near-polar inclinations and altitudes within the range 800-1000 km. These orbits contain massive and big satellites, which have a higher collision probability and would produce a large number of small fragments in case of collision.

ESA and NASA models show that, even without new launches, the number of objects in orbit will increase. We are now under the Kessler syndrome: current space debris density is high enough to make the fragmentation rate of space debris due to collision exceeds the elimination rate due to reentry in the atmosphere. The last collision, in 2009, involved a non-operative Russian satellite (Cosmos 2251) and an operative satellite from the Iridium constellation (Iridium 33). Two years earlier, a Chinese missile impacted against Fengyun-1C, a satellite orbiting at 860 km of altitude. In both cases the result was a dangerous cloud of 1.5 ton of shrapnel.

"… 6.000 tons of space debris with speeds of up to 8 km/s…"

A first step to solve the problem is to prevent the generation of new space debris. It is necessary to deorbit, i.e. to bring back to the Earth, the satellite and upper rocket stages at the end of mission. This action requires a deorbit technology. Kessler syndrome, however, reveals that critical orbits must be cleaned with Active Debris Removal

"Even without new launches, the number of objects in orbit will increase…"

"…the fragmentation rate of space debris due to collision exceeds the elimination rate due to reentry in the atmosphere"

missions. This second scenario involves both capture and deorbit technologies. In the long term, i.e. once the critical orbits have been cleaned, just a light, reliable and effective deorbit technology is required.

Current deorbit technologies are organized in two families. *Propulsive systems*, which include chemical rockets and electrical propulsion, use a propellant to deorbit the satellite. Chemical rockets are reliable but have a high cost due to the required propellant mass. Electrical propulsion, which are less reliable, can reduce dramatically the fuel mass but they need power system and attitude control during the long deorbiting. On the other hand, *dissipative systems*, i.e. sails and electrodynamics tethers, do not require propellant and they are passive. They deorbit the satellite because a natural resistance force dissipates the orbital energy. Sails work thanks to the aerodynamic drag due to the relative motion between the sail and the atmosphere. This system, however, is not effective at critical orbits because of the atmospheric density. In the case of electrodynamics tethers, the relative motion with respect to the ambient magnetized plasma leads to the Lorentz drag. Plasma density and geomagnetic field strength in LEO are high enough to yield deorbiting times of the order of few months for well-designed missions using electrodynamics tethers.

Market

Taking on board a deorbiting technology to eliminate the satellite or a launcher upper stage at the end live is, in principle, economically unproductive. This can lead to an initial rejection by part of the space

sector. International organisms and space agencies, however, agree that the current unsustainable model need to be change. Beside the harmful long term state predicted by Kessler, economical losses due to collisions by operative satellites (like Iridium 33) can be also important. This unfavorable scenario does not help to the space industry, which plans to launch about 1,000 satellites in the next decade with a total cost of 150,000M€.

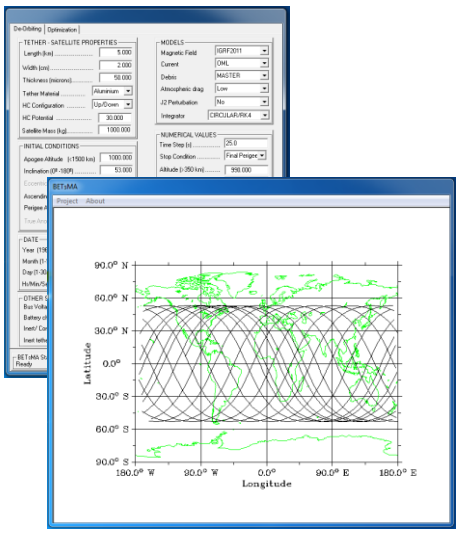
The in-orbit demonstration of an efficient deorbiting system can trigger an international agreement about space debris. Every launched satellite and upper rocket stage could be deorbited and the end of mission with a low cost. This would probably accelerated legal changes in order to achieve a sustainable model. The space market for deorbiting technologies would be open and the lightest and reliable technology would be selected among others to be on-board of every launched satellite.

Space tethers and the BETs project

A bare electrodynamics tether is an aluminum tape of length equal to few kilometers, width few centimeters and thickness of the order of tens of microns. The tether is rolled up in a reel during the satellite operation and it is deployed along the local vertical at the end of mission. The tether acts as a giant Langmuir probe, thus collecting electrons from the ambient plasmas. The electrons are ejected by a plasma contactor, a small device placed at its end. The tether works passively, without propellant or power system, thanks to the Lorentz drag on the electric current. The tether system can avoid a possible collision with another satellite during the long deorbiting maneuver by just switching off the plasma contactor for a while.
BETs is a FP7/Space project funded by the European Commission and coordinated by Professor J. Sanmartín, who introduced the bare tether concept in 1993. The BETs consortium is made of seven specialized partners on tether technology: UPM, Universitá di Padova, emxys, DLR, ONERA, Tecnalia and Colorado State University.

BETsMA software solution

UPM activities leaded to a design algorithm for a generic deorbiting mission using electrodynamic tethers. This algorithm has been implemented in BETsMA, a friendly software aimed at



the preliminary analysis of tether missions. In addition to the optimal tether geometry (length, width and thickness), BETsMA computes the main figures of merit of the system, including the deorbiting time, the masses of the subsystems, the satellite trajectory and the probability of survival of the tethers. Both experts and beginners can design their own tether missions by just interacting with an intuitive interface. The software is indicated for quick parametric studies in a broad range of orbital and tether conditions, which must be followed by detailed simulations.

UPM researchers

BETs coordinator, Prof. J. Sanmartín, has been the director of several projects from the Spanish *Ministerio de Ciencia e Innovación* and he partipated in the design of several space tether missions. Gonzalo Sánchez Arriaga is currently a PhD Assistant Professor at the *ETSI Aeronáuticos* (UPM). After finishing his PhD, supervised by Prof. J. Sanmartín, he spent two years at the Commissaria á l'Energie Atomique (Paris) for a postdoctoral fellowship on laser-plasma interactions.

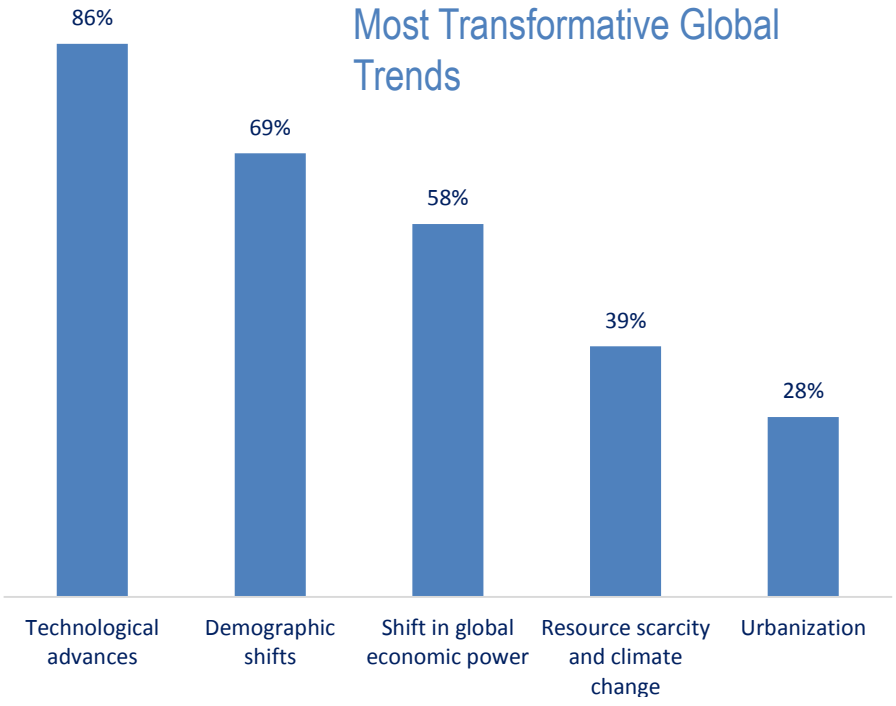
More information in this link.

Dr Gonzalo Sánchez Arriaga
PhD Assistant Professor
ETSI Aeronáuticos – UPM

Tech trends in 2014
What's new for next year?

Technology advances are the most important global trend according to a research conducted by PwC after consulting a sample of USA CEOs.

Several research studies and publications predict the most important trends and technologies in 2014. Now, we can highlight some of them: wearable technology, the concept of "smart" will be "more smart", 3D technology advances, legal aspects of technology along with other trends such spaceflight technologies, nanotechnology and electric vehicles linked to Formula E Racing.



Responses of CEOs putting that option in the 1, 2 or 3 of 5 items in total. January, 2014. Source: PwC

eMIP, bio smart tags

In the laboratories of the Institute of Optoelectronics Systems and Microtechnology (ISOM) of the UPM 'ETSI Telecomunicación', we see at first hand a new technique to fabricate nanoscale biochips. The results have been possible from a multidisciplinary and inter-university collaboration.

Carlos Angulo Barrios and Víctor Canalejas Tejero, researchers from ISOM-UPM, and researchers from the Complutense University of Madrid, led by María Cruz Moreno, are the developers of this new solution. In order to know more details about it, we interviewed Carlos Angulo.

Question: Carlos, what results have been achieved?
Answer: The collaboration has allowed us to use a lithographic non-contact technique for producing nanoscale molecular imprinting polymers (MIPs). This method enables the design of "arrays" of MIPs for the simultaneous detection of multiple (bio) chemical substances. Moreover, as a non-contact technique prevents contaminating the MIP material unlike other techniques.

This technique has already been the subject to patent application at the Spanish Patent and Trademark Office

Q: What are the potential applications of this new technique?
A: One possible application would be synthesizing smart biotags applied to the detection and monitoring of chemicals, with the advantage that their nanometer size provides important reductions in sensor response time and volumes of samples required. Another application would be in the Agro Food Industry, especially in the labeled and food safety.
An important feature of the developed technology is that the nanostructures obtained are very robust to environmental influences such as temperature. Moreover, it is possible to synthetize MIPs for applications where there are no biological receptors in nature.

Carlos Angulo Barrios, professor and researcher at UPM

This fact opens a wide range of possibilities related to future applications and conditions of use.
More information in this link.

The most innovative ideas in the XI actúaupm

It is opened the deadline for submitting ideas to the XI UPM Entrepreneurship Contest, actúaupm, until March 10th, 2014. actúaupm allows launching business projects based on innovative ideas and/or research results from both students and professors and researchers of the UPM.

actúaupm is an opportunity for management training, individual counseling, accessing to external mentors, networking and assistance in seeking funding, being eligible for 40,000 € in prize money and participating in the Spanish leading entrepreneurship university initiative.

In the past 10 actúaupm editions, more than 2,200 researchers and students projects have been involved and over 800 teams have received specialized training.

Moreover, 150 technology-based companies have been created in recent years and 33 million euros of investment have been attracted only from 2007.

To participate, just fill out a short form online through www.upm.es / actúaupm

More information and guidelines: www.upm.es/actuaupm

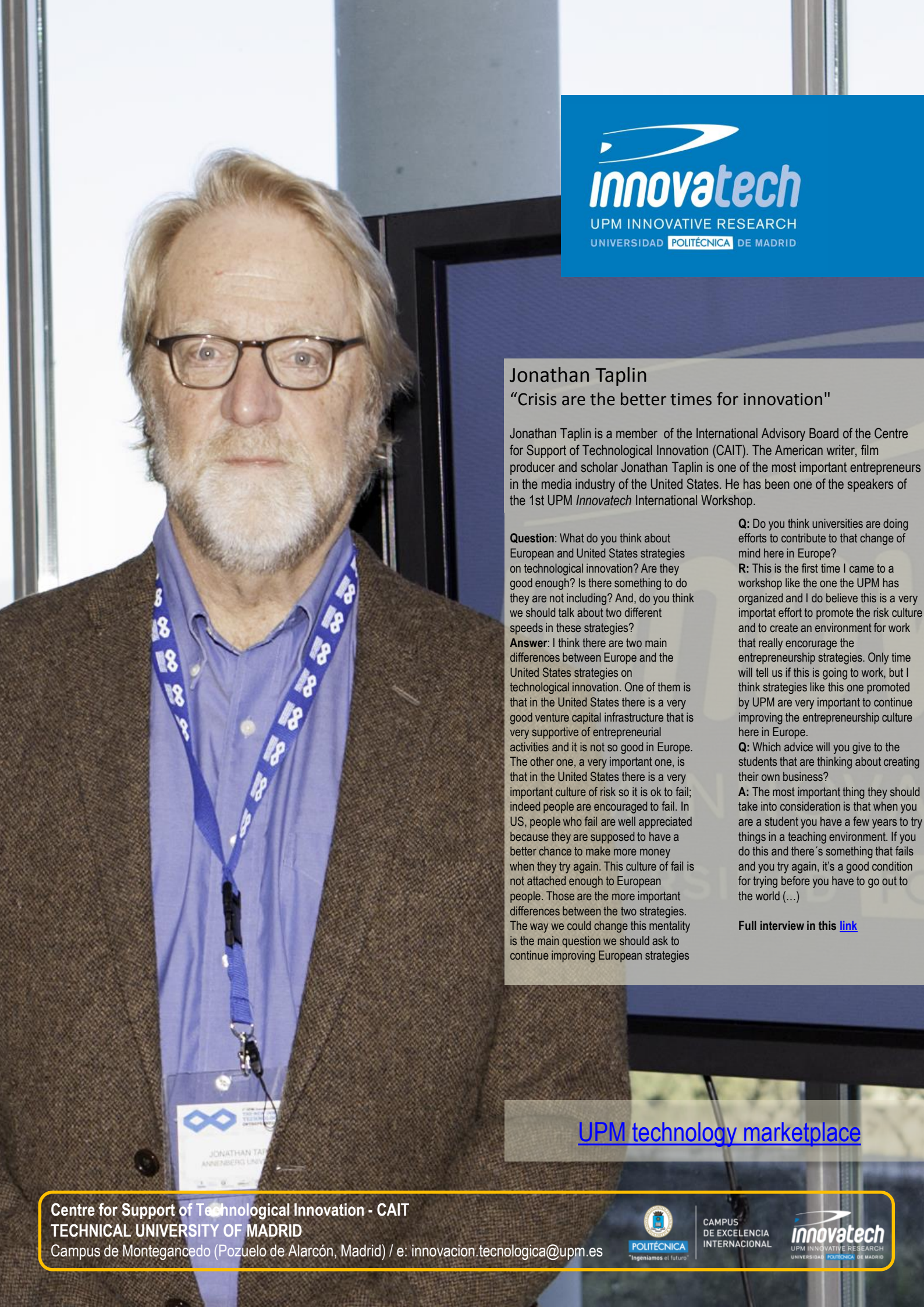
News: http://actuaupm.blogspot.com

Meet the most innovative technological projects awarded in the last edition X actúaupm promoted by UPM researchers and professors

F^2TE^3 is a project based on a UPM patented super-insulating which reaches 90% more efficent than traditional insulation systems. Promoted by Luis Alonso Pastor, architect and researcher at the UPM, the solution consists of a transparent facade system with 3.5 cm thick insulating as well as a wall of 35 cm, also allowing design by architectural freeform.
Luis A. Pastor has recently been recognized by the "Innovators under 35 Spain", initiative managed by the MIT Technology Review.

Graphene Light proposes obtaining clean energy from urban street lamps using graphene. The solar cells installed on lampposts allow daylight to collect their subsequent conversion into energy. Such cells are organic, flexible plastic material and low cost, thanks to the use of graphene instead of more expensive materials and contaminants.
Javier Martínez, a researcher of the Institute of Systems Optoelectronics and Microtechnology (ISOM) of the UPM, drives the project based on patented technology.

Robdos, Underwater Robotics, proposes the production of autonomous submarines capable of travelling long distances in the ocean to acquire relevant information. Promoted by a multidisciplinary team that includes engineers from UPM ETSI Navales, Robdos bases its activity on the development of offshore platforms that can take to the sea and complete specific missions fully autonomously and in constant communication with the ground operator.
Now, as a company, Robdos completes its offer with advisory services.



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Jonathan Taplin

“Crisis are the better times for innovation"

Jonathan Taplin is a member of the International Advisory Board of the Centre for Support of Technological Innovation (CAIT). The American writer, film producer and scholar Jonathan Taplin is one of the most important entrepreneurs in the media industry of the United States. He has been one of the speakers of the 1st UPM *Innovatech* International Workshop.

Question: What do you think about European and United States strategies on technological innovation? Are they good enough? Is there something to do they are not including? And, do you think we should talk about two different speeds in these strategies?
Answer: I think there are two main differences between Europe and the United States strategies on technological innovation. One of them is that in the United States there is a very good venture capital infrastructure that is very supportive of entrepreneurial activities and it is not so good in Europe. The other one, a very important one, is that in the United States there is a very important culture of risk so it is ok to fail; indeed people are encouraged to fail. In US, people who fail are well appreciated because they are supposed to have a better chance to make more money when they try again. This culture of fail is not attached enough to European people. Those are the more important differences between the two strategies. The way we could change this mentality is the main question we should ask to continue improving European strategies

Q: Do you think universities are doing efforts to contribute to that change of mind here in Europe?
R: This is the first time I came to a workshop like the one the UPM has organized and I do believe this is a very importat effort to promote the risk culture and to create an environment for work that really encorurage the entrepreneurship strategies. Only time will tell us if this is going to work, but I think strategies like this one promoted by UPM are very important to continue improving the entrepreneurship culture here in Europe.
Q: Which advice will you give to the students that are thinking about creating their own business?
A: The most important thing they should take into consideration is that when you are a student you have a few years to try things in a teaching environment. If you do this and there´s something that fails and you try again, it’s a good condition for trying before you have to go out to the world (…)

Full interview in this link

UPM technology marketplace

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