UNIVERSITY BRAND MANAGEMENT THROUGH ADDITIVE MANUFACTURING APPLICATIONS

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Abstract

Brand management is vital for identity development of any educational entity. The paper proposes a brand management strategy developed for a large university using several additive manufacturing applications. A product design and development team identified the need for brand establishment through identity promotion of the universities' unique capabilities. Several concepts were generated and analysed in accordance with product requirements and restrictions. After technology selection, the selected product was a key chain manufactured with Fused Deposition Modelling. To expand the product portfolio and thus the range of proactive actions within the branding process, two more products were selected for manufacture. Open cast epoxy resin medals and open cast chocolate candies required the development of specialised RTV silicone moulds. Branding management was done in strict correlation with the developed products. Various proactive, reactive and mixed actions were developed and implemented throughout the course of one academic year, targeting short, medium and long term results. The branding campaign included the modification of some study programs, the development of interactive demo shows and implementation of open days. Future research is targeted at ensuring sustainability of the proposed brand management strategy.

Keywords: brand strategy, proactive actions, additive manufacturing, product portfolio

Introduction

Brand and reputation builds a company up. Company perception is key to customer loyalty and has the potential to create added value. According to Roper et al. (2018) an effective brand management should reflect a companies' vision, mission and values throughout all their activities, ranging from product quality to employee behaviour and everything in between. Universities are essentially organisations which skilfully create the future employees and entrepreneurs. University branding is managed in a very similar way to a company, by sensing threats, seizing opportunities, shaping perceptions and measuring customer experience. In this case, the customer can take various appearances from students to SMEs and any other third party that is involved in a professional bounding relationship with academia. One example of a good brand management strategy is given by Rao and Khawaja (2014), and involves the development of a brand risk-intelligent culture and strategy by embedding the brand in everything they do. Cultivating internal and external brand advocacy through formal staff engagement programs is another proven strategy given by Rosenbaum et al. (2015). Taking advantage of opportunities to positively impact brand perception can be achieved through a proactive attitude of upper management according to Kapferer (2012).

Iglesias and Ind (2016) state that brand perceptions can be positively impacted by aligning business strategies with brand vision and positioning to further differentiate from the competition. Each academic environment has unique features that should be distinguishable within their brand management strategies, thus ensuring market segmentation focus. Social media is also rapidly becoming a powerful marketing and brand awareness tool in conformity with Odhiambo (2012). Nevertheless, three essential principles need to be considered if social media brand management is chosen: uniqueness, positivity and consistency. In a sea of "the same" one needs to be different and stand out in a positive fashion, concludes Dessart et al. (2015). Identity of a university is given by its' unique capabilities. The true art of brand management is to portray this identity in such a way that people can identify with it and resonate with its' vision at a personal level. Burmann et al. (2017) claims that identity-based brand management has proven to be the most efficient management model to make brands a success.

Adapting to the rapidly evolving technologies and the dynamics of the business environment is not an easy task for universities. Junyent and Geli de Ciurana (2008) remarked that study programs, subjects and research activities are sometimes bound by local rules and regulations, leaving universities with limited options for change. In this case, competitive advantage is gained more and more through reputation. According to Sung and Yang (2008) creating and consolidating trusted reputation is acquired through programmatically owned and accountable brand management. Universities executives must constantly innovate, create, experiment and learn in order to deploy and maintain a top brand management strategy. Nowadays universities should build their brand up in the same way they fulfil their performance indicators. Targeting an array of market segments, universities need to be in contact with both downstream and upstream key players in order to create a fresh and easily adaptable brand management strategy. Engaging future candidates, own students and the business environment in common activities might create the necessary synergy in order to both bridge the gap and achieve brand establishment and growth, according to Hobson et al. (2018).

The current paper proposes the development of brand management with the aid of additive manufacturing (AM) technologies. A series of proactive and reactive actions are designed and implemented throughout the course of an academic year, based on a product portfolio developed from a faculty's corporate logo. Comprised of short, medium and long term targeted actions the strategy also has clear identified future development paths.

Methods and Materials

The research was conducted in the course of the academic year 2017 – 2018 within the Faculty of Engineering and Management of Technological Systems (IMST) from the University POLITEHNICA of Bucharest (UPB). IMST is a large faculty with over 3500 students enrolled in bachelor, masters and PhD study programs, from which over 1200 students are enrolled in the 1st year (bachelor and masters). Some of the AM applications were developed at Lancaster Product Development Unit (LPDU) from Lancaster University in the United Kingdom. A product design and development (PDD) team was put created in order to undertake the current research. The design team was comprised of three PhD students, one Lecturer, one Professor and one professional in 3D printing from UPB, and one Senior Lecturer and one PhD student from Lancaster University.

The current research proposes a university brand management process consisting of four main steps, as follows: 1. Identification and establishment of IMST Brand Identity and Position; 2. Planning and implementation of IMST Brand Marketing Strategies; 3. Measuring and interpretation of IMST Brand Performance; 4. Improving and sustaining IMST Brand Equity. Strategic brand management was developed with the aid of AM technologies, by creating a bridge between potential students, active members of the university environment and technology providers.

From Concept to Product

Brand management strategy development started from the need of creating awareness of the university's opportunities through improvement of university image. The branding strategy was constructed on a classic product design and development methodology (Figure 1). A logo was created for IMST, manufactured in a variety of product variation. The IMST logo product range is at the core of the branding strategy, all other activities being constructed around it.

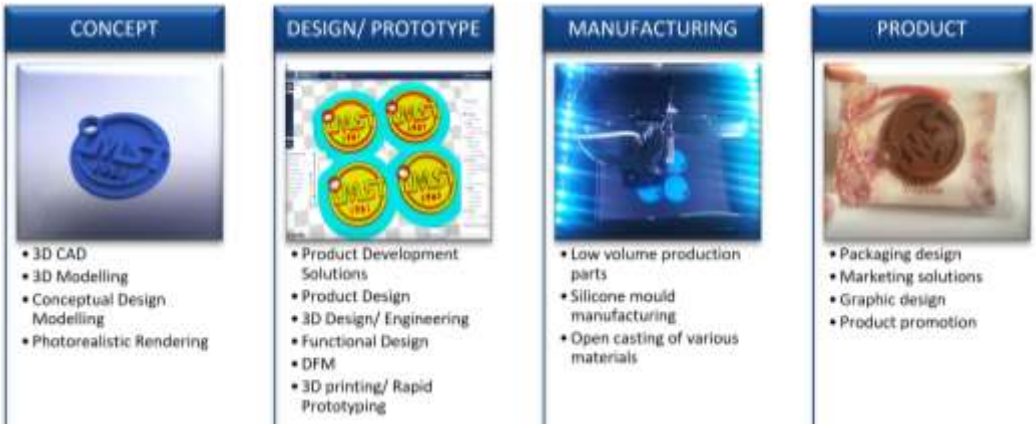

Figure 1. Product design and development methodology flow

Four stages are at the base of any PDD process, beginning with concept generation which usually starts from basic needs, in this case the need of creating a stronger university brand name. Based on the vision, mission and values of the university, the PDD team generated various product concepts, linking available technology whilst incorporating brand identity features. A list of product restrictions was set in order to select the optimum product concept. Restrictions were defined as follows: low costs, short manufacturing times, low labour costs and minimum manufacturing stages. Three product concepts were selected after restriction consideration, as follows: key chain, coffee mug support, smart phone docking station. The next step was to evaluate the available technologies, considering the same restrictions as for the products. Evaluation led to the selection of AM technologies with applications in rapid tooling and direct part production. AM technologies available in the IMST laboratories and considered for university brand management are, Fused Deposition Modelling (FDM), Digital Light Processing (DLP) and Binder Jetting (BJ). Selected product concepts were analysed in terms of manufacturing capabilities. Product requirements were developed in relation to the available technology capabilities, such as: geometric complexity, orientation and positioning of functional surfaces, material costs, ease of post processing etc. A thorough analysis conducted by the PDD team determined that the selected product would be a keychain, manufactured with FDM. Rapid tooling was selected for the development of a product variety based on the same CAD concept. Based on the selected technologies, the concept product which fulfilled most requirements and restrictions was the key chain. Within the same stage, conceptual design modelling was undertaken in order to generate several geometrical variations of the key chain. Photorealistic rendering was undertaken for five main concepts and the product development solutions were undertaken.

The second stage of the process consists of product design and rapid prototyping. All five concepts were fabricated using the FDM technology on a 3D Kreator machine. Based on functional performance and quality checks a single CAD concept was selected for redesign. In order to obtain the final CAD concept presented in Figure 1, five iterative redesign steps were required. Each redesign of the IMST logo keychain was subsequently followed by rapid prototyping and prototype testing. As FDM was the chosen manufacturing technology, Design for Additive Manufacture (DfAM) principles were considered all throughout this stage.

Manufacturing was undertaken for low volume production on ten available 3D Kreator machines. The IMST key chains were manufactured in batches of 100 parts, but could sometimes vary depending on the activity type they were needed for. A single batch of 400 parts were built for enrolment of 1st year students for all undergraduate study programs of IMST. Individual print jobs were set to four parts per build plate with a build time of 1 hour and 18 minutes per machine. Parts were built in two consecutive days, and during each day five builds were undertaken on ten 3D Kreator machines.

The final product had both a key chain connection and a tag name in various colours. All stages were recorded and progress was posted in real time on the university's online media, ensuring a proper product promotion.

Rapid Prototyping of IMST Logo

As mentioned above, several prototyping stages were necessary in order to obtain the optimum product concept. Using the optimum CAD concept, a *.STL file was generated with the *fine* resolution options from SolidWorks, leading to an angle tolerance of 10 degrees and a deviation tolerance of 0.0265 mm. Several tests were undertaken for this concept in order to determine the accurate build plate layout (3D Simplify and Cura software were used). Jobs were tested for one, four, six and twelve parts per build plate, analysing the manufacturability of the parts in relation to the overall build job duration.

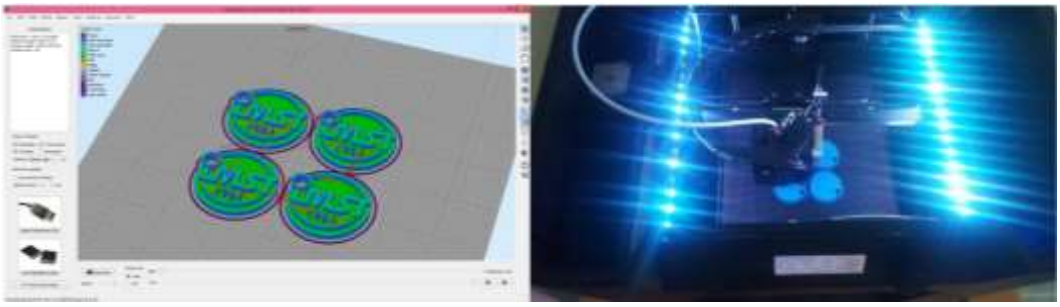

Figure 2. Manufacturing of FDM prototypes on the 3D Kreator machine

Rapid Tooling

In order to further develop the IMST brand strategy it was necessary that the PDD team expand the product range offer. Using the same base CAD model, the team had to create several product concepts, but within the same requirements and technology restrictions as the initial developed products. Thus, two options emerged as feasible, namely: open cast epoxy resin medals and open cast chocolate candies.

Manufacturing of both products require a silicone mould with cavities replicating the shape of the desired part. To create the cavities, master patterns were fabricated on a Stratasys J750 3D printer. This equipment was chosen for manufacturing of the master parts due to the superior surface quality and feature precision over the 3D Kreator. Master patterns of the IMST logo were printed on a batch with other parts and were oriented on the build platform (Figure 3a) according to their geometry, targeting a low print time. Using this Material Jetting (MJ) technology, the equipment prints out durable parts in polymeric materials (Figure 3b). Post-processing includes power washing the soluble support structures, after which the parts sit for a period of three hours in a washing machine with sodium hydroxide solution to dissolve any remaining support material. A final power wash leaves the parts free from any residue and they are left to air dry before being used. This application was undertaken in the LPDU laboratory.

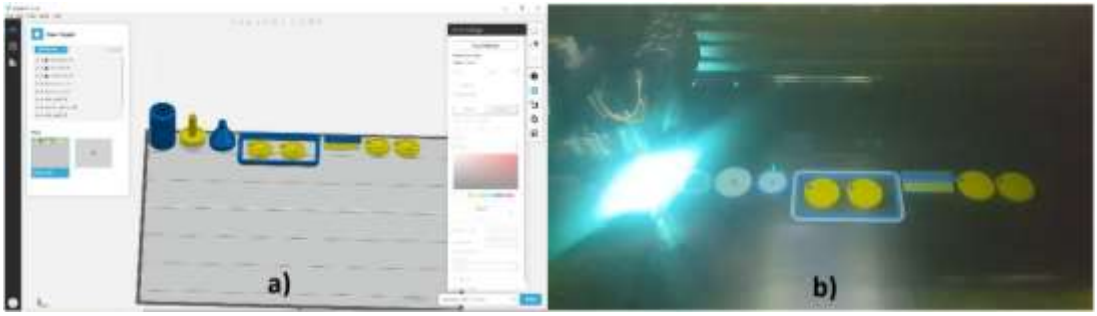

Figure 3. Master patterns being manufactured on the Stratasys J750 machine: a) print layout of components; b) 3D printing with Material Jetting

Several manufacturing stages are required to obtain a silicone mould for epoxy resin open casting of the IMST logo medals (Figure 4). Four cavities were provided for the open cast silicone mould. For the base of the mould, a circular sandblasted glass was used and the walls were laser cut from 5mm plywood (Figure 4a). To prevent any leakage the corners were sealed with tape and the bounding box was pressed downwards with scale weights. Master patterns were glued onto the surface of the glass base to prevent them from floating in the liquid silicone. The mould was poured from a silicone rubber with a 10 Base : 1 Catalyst mix ratio by weight. After weighing the right amount of base and catalyst, the resultant solution was thoroughly mixed and degassed to eliminate any air bubbles from the final mould. Air bubbles are particularly inconvenient if they get trapped in the shapes of the cavities, as it would turn the mould into a scrap part. Pouring should occur with a steady flow and from one side of the mould box, thus avoiding the apparition of new air bubbles (Figure 4b). The liquid silicone rubber was left to set for 24 hours, after which the weights, the tape and the plywood box were removed from the finished mould. The obtained mould is quite flexible, allowing the master patterns to pop out and revealing the freshly formed cavities (Figure 4c). Any loose silicone was carefully trimmed using a sculpting cutter. In this stage the mould is ready to be used for pouring of the epoxy resin to produce the parts. Epoxy resin is mixed with a catalyst, degassed and poured in the moulds cavities. The epoxy used set in one hour and the parts could then safely be released from the mould. The epoxy IMST medals are exact replicas of the master patterns manufactured with the J 750 3D printer. The moulds were used to create IMST medals in several combination of resins, depending on the required application (see Figure 6).

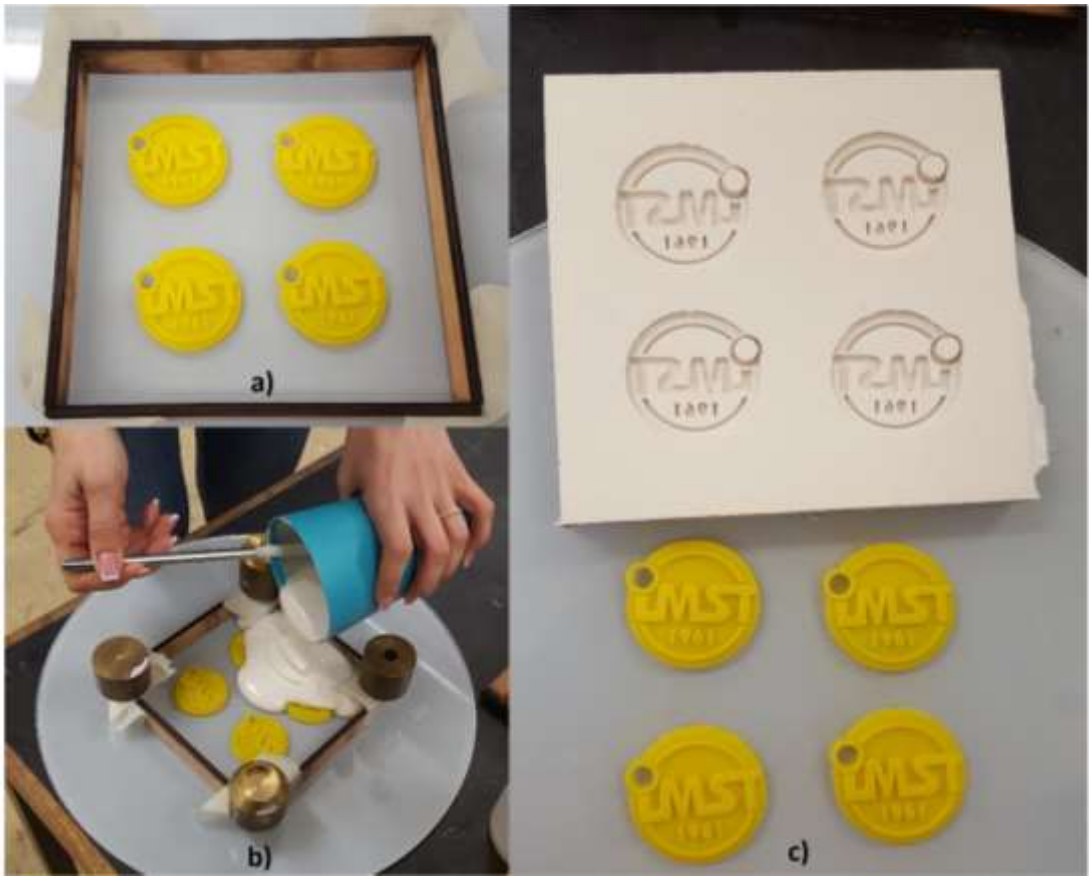

Figure 4. Manufacturing stages of silicone mould for epoxy resin open casting: a) layout of master patterns and bounding mould box; b) degassed silicone rubber pouring; c) final mould with cavities and released master patterns

Manufacturing of the food safe silicone moulds (Figure 5) was undertaken in a similar way with the epoxy resin mould. Differences consisted in the following: the silicone used, which in this case was a

food grade silicone rubber; the number of cavities per mould, in this case one; the shape and the overall dimensions of the bounding edges; the bounding edges material. To create the cylindrical shape of the mould 10 mm slices were cut from a 50 mm diameter aluminium pipe.

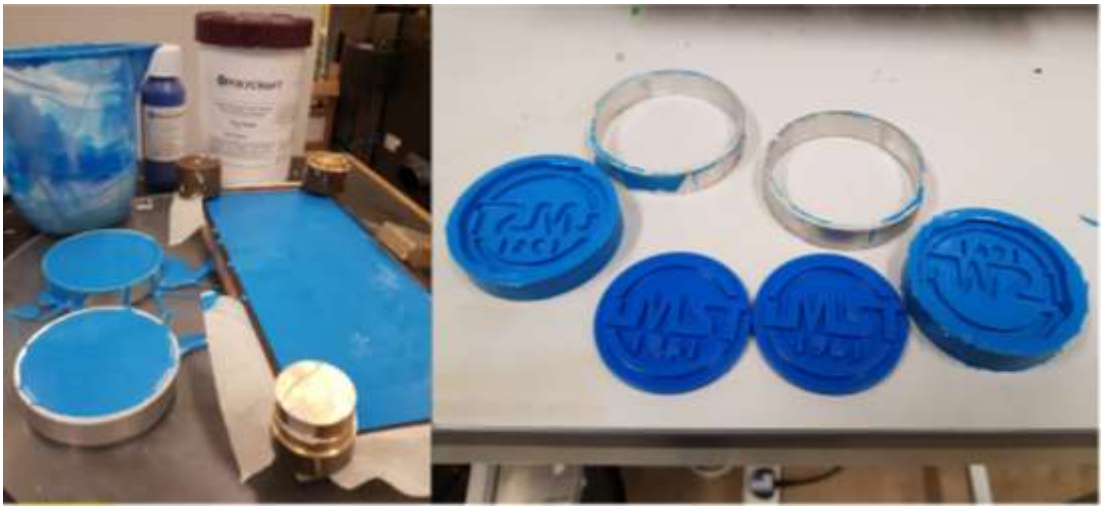

Figure 5. Manufacturing stages of food safe silicone moulds for milk chocolate candy open casting: a) poured food safe silicone moulds; b) final food safe silicone moulds with released master patterns

After degreasing and thorough cleaning the food moulds obtained can be used for chocolate candy open casting.

Results Interpretation

Development of IMST brand strategy led to the design of several final products obtained with the aid of AM technologies (Figure 6).

Figure 6. Final products used as promotional materials for IMST branding: a) FDM single colour key chains; b) FDM two colour key chains; c) Casted milk chocolate candies; d) Casted epoxy resin medals

Considering the results obtained, the university branding strategy was constructed on both proactive and reactive measures with short, medium and long term targets. Promotional activities were developed and conducted within a one year time frame, as follows:

Short term proactive actions:

- High school campaigns for 12th grade pupils were designed as oral presentations of the IMST study offer. A team of five to seven people gives the presentation, comprising subjects such as: interesting courses, available technology and common applications, student projects with finished products, student extracurricular activities, student association activities, scholarship opportunities, learning abroad opportunities and also job and internship opportunities. Special workshops are held before each campaign session in order to gather the newest results of the team members and ensure a coherent presentation for pupils. Product presentations are also given, with emphasis on the design and development of the IMST logo. All attending pupils receive an FDM keychain.
- Open day activities for high school students are held once a year, during which pupils have the opportunity to participate in all university's academic and research activities. *I'M STudent!* is the IMST name for this activity which involves both staff and students alike. Pupils visit the university in groups of ten to fifteen, usually supervised by a high school representative. A student or a university staff member gives them a tour, allowing them to participate in classes and laboratories. Special demonstrative laboratories are held for the visiting pupils. They all experience 3D modelling and printing of the IMST logo and receive one of the printed products to take home.
- Participate in Study Fairs with applications for Undergraduate, Masters and PhD study programs. *Hands-on-IMST* is an interactive demo show comprised of a mobile stand equipped with a 3D Kreator machine, a portable laptop, the entire variety of IMST branding products and all available material samples. Products and services developed by previous undergraduate, masters and PhD students are showcased and available for demonstrations. Pupils visiting the IMST stand are given basic CAD and 3D printing lessons.
- Developing and implementing a personal Study Fair Brand: PoliFest under the aegis of UPB. The fair is open to all universities and, of course, to all UPB faculties. The participation in this fair is similar to external events and encloses the *Hands-on-IMST* interactive demo show and the *I'M STudent!* interactive tour.

Medium term proactive actions:

- High school campaigns for 9th, 10th and 11th grade pupils are programmed between September and March. The campaigns are quite similar with the ones given for the 12th grade, with the difference that the pupils are invited to participate in mixed teams (students and pupils) to the IMST Scientific Research Session.
- IMST developed and constructed the *FirstTech Challenge Hub* for high school pupils. The hub hosts mainly design, development and manufacture of equipment (controlled and autonomous robots) for the FirstTech Challenge national and international robotics competitions for high school level.

Long term proactive actions:

- Develop and implement a multidisciplinary interactive programme, targeting pupils between 8 and 12 years old, which combines physical space modelling, CAD and 3D printing in order to enhance transversal competences. Under the *3D Mind* name the programme sits under the umbrella of the IMST brand and is undertaken within the central Learn & Lounge Space of the faculty. Groups of 10 to 15 pupils assemble 3D figures, they model them in 123 Design software and then print them in the AM laboratory using the 3D Kreator machines. The product they develop is the IMST key chain which they get to take home after fabrication. The modules are taught by student association volunteers, academic staff members and industry professionals. 3D Mind is held on weekends and is comprised of 30 sessions of 3 hours each. An interactive experience and a science oriented environment targets the development and attraction of future IMST students.

Short and medium term reactive actions:

- Introduction of a new subject in the curricula of 4th year bachelor students in Manufacturing Engineering study programme (taught in Romanian), namely Additive Manufacturing Technologies. The subject is taught as 5 hour (a 2 hour lecture and a 3 hour laboratory) a week

module during seven weeks within the second semester of the final year. The subject was introduced in the 2017-2018 academic year. Students are actively involved in the universities branding process as they have tasks in the following: idea generation of new products; innovative ways to use the available technologies for the development of university branding strategies; CAD design and redesign of the logo (and other product); manufacturing of established products for the universities promotional activities, creating a much needed stock of material.

- Two new subjects were introduced in the Industrial Engineering master's programme (taught in English) curricula. Additive Manufacturing (lectures and laboratory) and an Additive Manufacturing Project are implemented in the second semester of the first year masters' students. The subjects were introduced in the 2017-2018 academic year. The courses are taught as a 6 hour per week complex module during a 14 week period. Students form mixed teams and undertake focused activities mainly in the rapid prototyping and redesigning for AM process of promotional processes. They play a key role in developing innovative branding products and services for the university.
- Product Design and Development was introduced in the 2016-2017 academic year within the curricula of 4th year students in Industrial Engineering bachelor study programme (taught in English). The subject is taught as a 4 hour per week module during a 14 week period in the first semester of the 4th year. While learning about a variety of product design and development methodologies, students are required to present a final working prototype of a branding product. The module has a total of 24 hours of rapid prototyping (RP) on FDM machines.
- Giveaway products which gain approval for university branding are manufactured by students and the PDD team and are used for all campus special promotional activities. During the last academic year, the giveaway products consisted of FDM key chains, silicone mould open cast resin medals and cast milk chocolates candies. They were given away to students and staff members on special occasions (mother's day, women's' day, birthdays and name days) and on bank holidays. Each student that enrolled in 1st year in one of the 10 undergraduate study programs and 28 masters' study programs of IMST received one giveaway product manufactured on-site.

Mixed actions:

- Develop and implement a powerful media campaign in written, audio-video and online environments. The universities social media accounts (Facebook, Twitter and Instagram) were used to showcase the different stages of design, manufacturing and product launch of the IMST logo. Feedback was impressive and lead to the development of new applications. On the university's YouTube channel were posted short videos on how to design the logo using free software tools (123Design, Cura) and tips & tricks for 3D printing of the product. Also, the silicone mould manufacturing process was detailed for interested viewers. Short communications on the product design and development process were published in the local newspapers. Televised apparitions on news channels and IT shows were presented as interviews with the Dean of the faculty, academic staff and students.

A graphical representation of the brand management process flow and the interactions between the main actors is presented in Figure 7. The process was developed with the aim of creating a unique university brand, while trying to bridge the gap between possible candidates, university environment and the private sector.

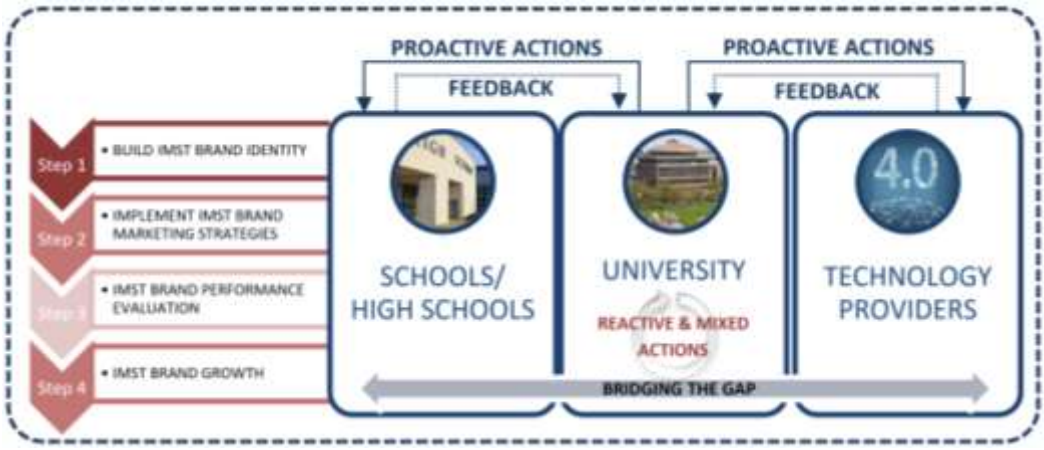

Figure 7. University brand management process and main actors involved

Based on the saying "*a picture is worth a thousand words*" the authors developed a pictorial (Figure 8) identifier for the IMST branding strategy, in order to create awareness and identification within the target market segment.

Figure 8. IMST branding campaign photograph

The best representation of IMST branding strategy is portrayed in the photograph presented in Figure 8. It was used in all promotional activities with the following key words attached: #freedom, #affordable technology, #traditions, #fun engineering, #new beginings, #opportunities, #relaxation, # open minded, #trust, #proud, #learn4future, #brightfuture, #start4life.

Conclusion

The current paper presents the development and implementation of a novel brand management strategy throughout the course of an academic year, within a large state university. The proposed brand management strategy included a mix of proactive and reactive actions, with involvement of all active member types of the university.

The usage of AM application for university branding development led to the following results: four new disciplines were developed and introduced in different IMST study programs; three new services were developed and implemented (*I'M STudent!, Hands-on-IMST* and *3D Mind*) under the aegis of IMST faculty; over two thousand products were manufactured and used in all faculty and university promotional activities; one complex media campaign was developed and undertaken in written, audio-video and online environments.

Future research includes developing a wider product and service range to ensure a sustainable and adaptable university brand management. Some of the activities will include the design and development of the following:

- Organising interactive one day workshops with available technology using the IMST logo as a model. Amongst the available technology will be considered: 2D and 3D modelling, CNC machining, laser cutting and engraving, additive manufacturing (three technologies: FDM, DLP, BJ), open casting of non-metallic materials in silicone moulds, open casting of metallic materials in plaster moulds.
- Organising one-week advanced training programs in two specific technologies using the IMST logo as the learning model.
- Organising students and educators visits to industry providers for examples of good practice in order to try to bridge the gap between the academic and business sectors. Industry providers will be asked to present design adaptation of the IMST logo in order to mass manufacture it with their technologies.
- Developing and implementing the *3D Printing On-the-Go* concept which entails attending special events (birthday parties, corporate events, school events etc.) with a mobile 3D printer and portable computer for the participants to use and experience the process. Examples will be given on the IMST logos, but personalised items will also be available to design and print.
- Several products are currently being prototyped and will further be developed and launched. Some of them include scented candles and soaps (open cast into silicone moulds), 3D printed business cards and card holders for staff and PhD students, laptop and car stickers, memory stick casings.

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