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**INDUSTRIAL PHD – A CHALLENGE FOR BOTH
SMALL/MEDIUM SIZE ENTERPRISE (SMEs) AND
TECHNICAL UNIVERSITIES (HEIs).
GIENAHs PROJECT – CASE STUDY**

BY

**CĂTĂLIN GABRIEL DUMITRAȘ^{1,*}, ANNAMARIA PATELLA²,
MATILDA MALI³, NICKOLAOS KRIKIS⁴ and LIVIU VORNICU⁵**

¹“Gheorghe Asachi” Technical University of Iași, Romania,
Department of Machine Tools

²Universus Csei Consorzio Universtario Bari, Italy

³Politecnico di Bari, Italy

⁴NOESIS Technologies, Patras, Greece

⁵EXQUISITE SRL, Iași, Romania

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Abstract. Industrial doctorate is increasingly encountered in industrially developed countries. This is due to a need to solve production problems or to make new products in medium-sized companies. At European level, the concept is developed differently and the legislation in the field of education is not uniform. The paper aims to present an initiative at European level materialized through the ERASMUS + project. Also, there is a case study conducted within the company EXQUISITE that can very easily be assimilated to a PhD theme.

Keywords: industrial doctorate; packaging; manufacturer.

*Corresponding author; *e-mail*: catalin.dumitras@tuiasi.ro

1. Introduction

An industrial doctorate is a research project focused on industrial results, which is conducted jointly by a university, has co-tutor a company and is made by an industrial PhD student (<https://www.universityworldnews.com/>). The PhD student is in the same time employed by a company and with contract at a university. The student must allocate working time for the company and the university, and works at both places on the project and on the education. The project duration is generally three years, the same as in standard doctorate. As long as the project's research quality and the cost significance and effect can be argued convincingly, the research can be done in any field of activity. It was proven that industrial PhD and industrial postdoc create economic growth and employment by using innovation in designing of a product and/or process. The industrial researcher programme has the following specific purposes:

- to find and form industrial researchers from researcher talents;
- to implement innovation in developing companies;
- to develop collaboration between companies and universities;
- to fund part of the student's salary and travel expenses due to the doctorate programme, equipment and other expenses for the PhD student's education.

The industrial PhD student is supervised both at the university and at the company.

The Rise of Industrial Doctorate

Recent economic and social changes given by Industry 4.0, a revolution in manufacturing domain, rise a new challenge with respect to the traditional place in education and function of higher education institutions (HEIs). The new type of economy requires the need of specific skills from the graduates to compete in labor markets. Policy emphasis, together with economic crisis and unemployment rates in many EU countries, lead to the idea of a mutual relation between education and labor market. The aim is to increase employability between young people, especially since a part of PhD graduates in many countries – we can name Germany and Italy – do not want an academic career. This has led to the initiation of 'hybrid' doctoral degree that combine academic research with practical elements, called 'professional doctorates' and/or 'industrial PhDs'. The root of these types of doctorate is the standard notion of 'doctorateness' – an concept that imply both a specialization in a certain field and the ability from the graduates to use scientific research methods with the aim of knowledge contribution.

Types of PhD

Industrial doctorate in many countries from Europe is different from standard PhD and from professional doctorates (encountered in the United Kingdom). The professional practice doctorates in the US is also a 'branch' of doctorate. Standard PhDs is preparing graduates for a career in HEIs. They

follow specific theoretical discipline and they want to bring a contribution to knowledge. Professional doctorates are generally for the mid-career professionals. They want to bring a contribution to practice and they are organization orientated and generally they are employee of the organization, being undertaken by people who have already a place in the labor market (Dastbaz and Cochrane, 2019). Professional practice doctorates differ from professional doctorates. They are a sort of 'pre-service' – being demand by professional associations or agencies to in starting a professional practice career. This type of doctorate is orientated towards a certain profession and, in contrast to professional doctorates from UK, they are not equivalent to PhDs. Both professional doctorates and professional practice doctorates are not applied in Europe. Here industrial PhDs, a form of standard PhD, are the only practice-oriented doctoral programmes. Industrial PhDs is a typically characteristic in Nordic countries. A common legislation at the European Union level settlement the matter is only a desiderate and the title 'European Industrial Doctorate' refers only to a EU programme realese within the Marie Curie Action framework. This name indicate a doctorate developed between an academic participant (university, research institution) and a company established in EU member states (Goodwin and Graebe, 2017).

Industrial doctorate

In the absence of common legislation at the European level, industrial doctorate have developed differently across countries in Europe. In some cases, industrial doctorate is well regulated and definded both in legislation and government programmes. Denmark is the first country that introduce three-year industry-orientated doctoral in cooperation with private SME, a PhD student and a HEIs. In this form, the leading organization can apply for a grant from the Danish Agency for Science, Technology and Innovation in order to cover part of expenses for the PhD student. In France, similar certifications are entitled Industrial Agreements for Training through Research and are aimed to promote public-private research partnerships. The company that organize the PhD get three-year grants from the National Association for Research and Technology. In Germany, industrial doctorate is not defined by law, despite of the 16% of all doctoral students that every year get company-based PhDs. Sometimes, the companies make available some own positions for applicants interested in having an industrial PhD. Candidates start with an interview as if they are getting hired and, if they are successful, they start to look for a professor who is willing to become a co-tutor for their research project. In other countries, such as Italy, industrial PhDs are only partially regulated. In 2013 the Italian government release a decree which define three different practice-oriented doctoral programmes: doctoral programmes in collaboration with companies; industrial PhDs; and doctoral programmes based on apprenticeships. Only doctoral research programmes based on apprenticeships are well shaped, being defined in Italian law for more than a decade. In this case apprentices, who are

in fact employees not PhD students, sign an apprenticeship contract with their company. Thanks to agreements between the company and the university, they attend courses to obtain a doctoral degree at the end of the apprenticeship.

2. GIENAHS Project

Based on the demand for industrial PhD and on the lack of knowledge at the EU level regarding the stages of implementation of industrial PhD in each member country one initiate a project ERASMUS+ KA2: Cooperation for innovation and the exchange of good practices - Knowledge Alliances entitled *Grasping Innovation in Europe through a closer iNterAction between HEIs and Smes - GIENAHS* (<http://www.gienahs.eu/>).

There are 10 partners involve in this project 6 universities and 4 small/medium-size enterprises from 6 countries such as Italy (project manager), United Kingdom, Sweden, Greece, Poland and Romania.

GIENAHS desire is to approach the strategic problem of interaction between HEIs and the particular target represented by SMEs, that even if is the real driving force of European economy, still has difficulties in managing R&D processes.

Innovation has an important role in economy both for citizens, here seen as workers and for companies, due to its contribution to the improvement in creating products.

But the innovation does not have impact without research and education. In order to achieve the objective of investing until 2020 the 3% of EU GDP on R&D, Europe needs to train more researchers and eliminate all kind of obstacles regarding mobility.

A better understanding between SMEs and HEI is still necessary: SMEs need to develop employee skills to face innovation in a systematic way, while HEIs need to get a better interaction with SMEs in order that researchers can adapt easily to the SMEs environment.

GIENAHS will follow a number of steps like:

- sharing informations about interaction between HEIs and SMEs at EU level;
- defining a EU methodology of HEIs / SMEs interaction in order to enhance the competitiveness obtain by innovation;
- find an new industrial PhD paths approach “SMEs oriented” targeted on the specific needs of European SMEs that will allow the integration of different cultural approaches to R&D;
- testing the approach by designing a new industrial doctorate path “SMEs oriented” in Manufacturing field.
- proposing the harmonisation of Industrial doctorate disciplines in Europe, to concretely promote the mobility of researchers.

Consistent with the result of the analysis of the needs and challenges we intends to address, the specific aims and objectives of the project are:

- to define new methods and tools that will be used by universities in partner countries for the developing HEIs – SMEs collaboration, comparing strengths, areas of improvement, from HEIs and SMEs perspectives;
- understanding the way to stimulate interaction HEI and SME and establishing collaborative research towards innovations;
- to detect the key methodology for innovation in SMEs and the key competences and skills that must have the industrial researchers and company staff to implement innovation methods in SMEs;
- to identify the rules which will be applied for the regulation of industrial PhDs at national level in partner countries;
- to concept a proposal for legislative harmonization to bring to the attention of the European Commission;
- to realize a legal framework for the joint implementation of a common Industrial PhD path;
- to study the procedure to be adopted for the European recognition of the new industrial PhD path for SMEs;
- to test a new methodological approach for the joint (HEIs - SMEs) design, inside the Alliance, of a first industrial PhD path for SMEs;
- to lay the foundations, within the Alliance, for the implementation, after the end of the project, of the new path jointly managed by the 6 countries involved (Consortium agreement).

The Alliance intends, by this way, to contribute in achieving Knowledge Alliances action's objectives and in particular:

- to improve key skills and capabilities, with an emphasis on their relevance to the labour market, through greater opportunities of mobility for researchers and enhanced cooperation between HEIs and the world of work;
- to promote improvements in quality, excellence in innovation and internationalization at the level of HEIs, in particular through enhanced transnational cooperation between HEIs and SMEs;
- to elevate the quality of training of Industrial Researchers and internal company staff, improving the benchmark between HEIs and SMEs, and their better cooperation;
- to improve the "knowledge triangle", linking education, research, and innovation.

HEIs partners are involved both in project preparation and in the implementation of the core-activities of the proposal. Each University partner brought in the project preparation phase their internal assessments, the analysis of national/local data, interviews with privileged testimonial of innovative SMEs (mainly within manufacturing clusters), local policy makers for

economic development, aimed at clearly defining the framework of the project. During the implementation phase the HEIs will define, flanked by the SMEs, an update model of interaction HEIs/SMEs and will map the Key Processes/Competences for Innovation in SMEs. In this way they will identify the optimal profile of interdisciplinary and technical skills that endow industrial researchers to more effectively support the innovation processes. The work on defining legal aspects or other obstacles for the new industrial PhD path foreseen will allow them to benefit by a new designed of the Industrial PhD path for SMEs and the related infrastructure (e-learning platform and observatory) to be launched at the end of the project. A new updated model for designing the industrial PhD path through the constant monitoring of skills needed by SMEs, is another direct benefit of the HEIs involved as well as the implementation of high performance and “market applicative” researches.

SMEs involved in the project, choice among best performers in innovation, will support HEIs in defining all the improvement actions necessary for a better interaction HEIs/SMEs. In addition, they will work closely with HEIs, monitoring, evaluating and ensuring a coherent and effective connection between the joint curriculum development and the real needs of SMEs in terms of skills for innovation.

Through the achievement of the project goals, the future SMEs that will join the created Alliance will have the opportunity to properly train their internal staff and, at the same time, to have industrial researchers better prepared to face their specific challenges of innovation. Through the Alliance they will also be constantly informed of the EU and International opportunities in the field of R&I (market trends, competitors, possible alliances, funding, etc), raising their networking capabilities and their potential for internationalization.

The Alliance chose to target the analysis on SMEs operating in the manufacturing sector, as first important and extended area of experimentation, supporting the definition of a model replicable in Europe also in other fields.

Manufacturing provide more than 30 million jobs in 230 000 enterprises, mostly SMEs. Manufacturing is also a dominant element in international trade, having many Europeans companies that are world leader in areas like automotive, machine manufacturing and agricultural engineering.

This project is undergoing. The results until now indicate different approaches to industrial doctorate. Thus, in the north part of Europe the industrial doctorate is applied and there is legislation that clearly sets out how to apply for and obtain a doctoral degree. In Poland, the new law of education refers to industrial doctorate but there are still timid steps in applying this concept.

In Greece and in Romania there is no clear reference to industrial doctorate and of course even if there are researches in companies that can be completed with doctoral theses they can only be realized as standard doctoral internships. In the following we will present some case studies made in Romanian small enterprises.

3. Case Studies

We will present an example of doctoral research carried out in a small enterprise in which are implicated PhD students from technical university.

This research is made in Exquisite company, one of project partner.

Exquisite company is a private one which held packaging machinery manufacturers in Romania. It is a designing, manufacturing, consulting and service firm specialized in constructing labeling machines, complete filling machines, capping machines, turnkey packaging systems and bottling equipment. The packaging equipment is crafted from food grade stainless steel and other food grade materials in a modular system, which allows easy operation and maintenance. Engineers strive to always modernize and simplify our designs giving our customers a competitive edge with the most efficient, technologically advanced packaging equipment (<https://www.exquisite.ro/>).

The equipments are designed for food products, pharmaceutical, chemical, cosmetic and specialty industries. For obtaining the equipment on use quality materials with quality workmanship. We work with electronics, programmable logic controllers, and pneumatics to achieve filling, capping and labeling at the most accurate pace possible

In the following we present some examples of equipment in which the PhD were involved:

Rotary bottling lines

The running principle of rotary bottling lines (Fig.1) is based on the overflow filling method. These machines are designed to simplify your bottling line, by combining multiple machines into a single space saving unit. The recommended products for the rotary monoblock lines are: juice, water, tea, and sport drinks.



Fig. 1 – Rotary bottling lines.

Mixing machines

This equipment is used to bottling carbonated beverages, Fig. 2. It has a high-technology system of mixing CO₂ with water and syrup. The machine is made of food grade stainless steel. It is recommended for carbonated water and juice, beer, sparkling wine.



Fig. 2 – Mixing machines.

P.E.T. Blowing machines

Our blowing machines are specially designed to manufacture various types of P.E.T. These machines can be semi-automatic, recommended for low productivity, or automatic for high productivity, Fig. 3.



Fig. 3 – PET Blowing machine.

Automatic rinsing machines

The automatic rinser is an ideal companion to any automatic filling line, but it also can be acquired as an independent machine, Fig. 4. This machine utilizes rinse liquid to clear debris inside the containers prior to filling.

These machines are also built using food grade stainless steel and other food grade materials and are easy to exploit and maintain.



Fig. 4 – Rising machine.

Semi-automatic filling machines

The semi-automatic filling machines are designated for filling liquids with low or medium viscosities and also for foaming products, Fig. 5. These machines are well rounded fillers able to use a wide variety of container shapes and types, such as metal, rigid plastic or glass. They can handle fill sizes from milliliters to liters for a number of products such as juice, vegetable oil, cleaners or any other free flowing liquid.

The base system contain a standard pump and two filling nozzles. These machines are designed for productivity no higher than 500 containers per hour. The crafting materials utilized are food grade stainless steel and other food grade materials.



Fig. 5 – Semi-automatic filling machine.

In the years 2018-2019 the module of application and threading cover was made on a linear device. The container was taken one by one by a screw

and transported to the application of cover and the threading cover. The lid is taken on the container with a pneumatic piston that presses a lid on the container. The threading of the lid is made with a device provided with a pneumatic drill at a certain pressure of the compressed air, Fig. 6.

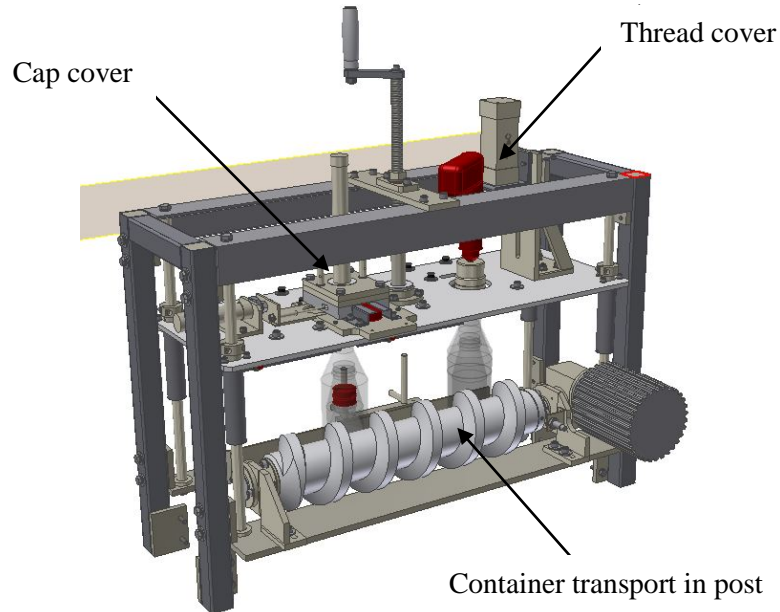


Fig. 6 – Threading cover equipment.

Filling the lid with the pneumatic drill bit did not facilitate a satisfactory adjustment for the torque tightening of the caps, this adjustment was made from the air pressure acting the drill bit and was cumbersome with a long adjustment time, Fig. 7. The container transport screw from the lid application to the lid threading group had to be adjusted each time the container type changed, this time affecting the daily production.

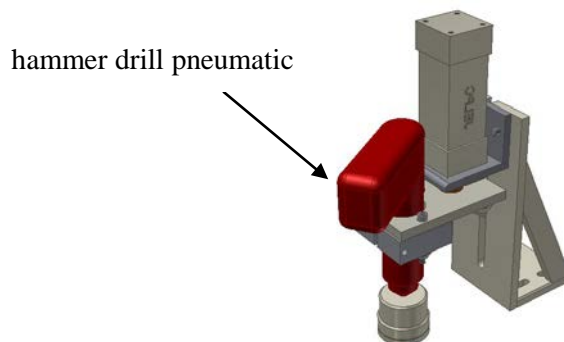


Fig. 7 – Pneumatic hammer drill.

Currently, a rotary module for taking over, applying and threading the cap has been implemented, Fig. 8.

The container enters a wheel driven by an indexer that takes an exact step for each container to reach the position of taking and threading. The transfer from one container to another is done in a much shorter time than the previous version because it does not intervene on the transport device of the containers from one station to another only had changed the wheel corresponding to the pocket to be used.

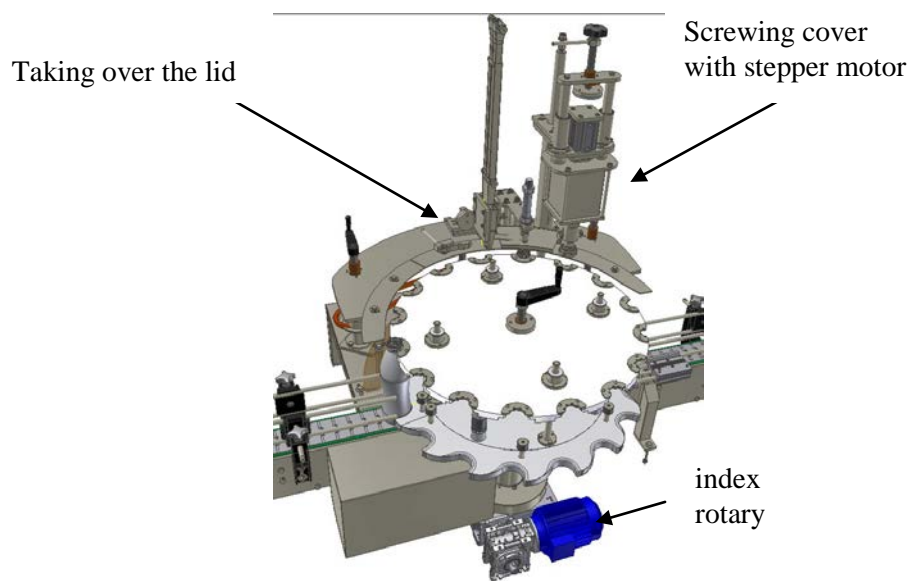


Fig. 8 – Rotary module.

The cover of the new device is taken on the fly at each step of the wheel, so the time was reduced when each cover was pressed with a pneumatic cylinder.

The threading of the lid is made with a stepper motor that allows rotation of the lid in both directions with the one of the drill that performs a single movement, parameters on the control panel.

This device was developed by a PhD student and it led to the doubling of the containers to which they are applied and threaded caps.

4. Conclusions

The industrial doctorate is more and more asked in Europe due to the need of the companies for innovative product or process which has to rapidly be applied in order to increase the productivity, to solve the complex problems that

appear in manufacturing and to optimize the cost. This industrial doctorate must be obtained by a combined effort at the level of enterprises and higher education institutes (universities). This concept is not uniformly developed at the level of EU members and it seems that it is more developed in countries from the north part like Sweden, Denmark, Germany and less developed in the south part. Here we can mention that in Greece and Romania there is no referring to this concept. Even if there is no industrial doctorate there are many standard doctorates which have the characteristics of industrial doctorate. In this paper we give some examples as case studies. There must be joint actions at EU level to ensure harmonization of legislation in the field of education and to promote industrial doctorate. Steps in this direction are realized through the GIENAHs project.

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DOCTORATUL INDUSTRIAL – O PROVOCARE ATÂT PENTRU COMPANIILE MICI SAU MEDII CÂT ȘI PENTRU UNIVERSITĂȚI. PROIECTUL GIENAHs – STUDIU DE CAZ

(Rezumat)

Doctoratul industrial este din ce în ce mai întâlnit în țările dezvoltate industrial. Acest lucru este datorat unei nevoi de a soluționa probleme de producție sau de a realiza produse noi în companii de dimensiuni medii. La nivelul Europei conceptul este dezvoltat diferit, iar legislația din domeniul educației nu este uniformizată. Lucrarea își propune să prezinte o inițiativă la nivel European, materializată prin proiect ERASMUS+. De asemenea, se prezintă un studiu de caz realizat în cadrul firmei EXQUISITE, care poate foarte ușor să fie asimilat unei teme de doctorat.