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ON CO-OPERATION BETWEEN UNIVERSITIES AND INDUSTRY ✓

by

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On Co-operation between Universities and Industry

Advisability of Co-operation

Technical universities are to be approached as an element of the countries economic structure. They provide the national economy with engineers promoting the technical development and progress of the country. Thus the program should give the graduates a thorough general knowledge to keep up with the future development when they are most efficient i.e. within 10-20 years after they had graduated. At the same time the graduates should be easily adapted in industrial establishments. No remarkable differences between the graduates and industry staff as to their technical knowledge should take place. The industry in some countries develops dynamically, introducing technical novelties of its own investigations or foreign licences. That is why the staff ought to be well informed about present economic state, both of its own country and the leading countries of the world. University staff possesses a good theoretical knowledge of technical problems, though it frequently lacks the direct contact with the industrial establishments. The permanent work of the university workers in industry is a rare case, as it is rendered impossible by a strict specialization and at the same time high demands at the University. Loose bounds of scientists with the industry are observed. That is why it is so important to initiate these ties still at the University through practical training. However they don't often give expected results being sometimes superficial excursions to the establishments. To sustain a high level at the universities a good laboratory and computing equipment should be used. As there is a quick accumulation of information on the world's technical progress, the knowledge of the one ought to be quickly transferred to industrial establishments. There are scores of other reasons to prove the necessity of co-operation between universities and industry:

- 1) The co-operation allows for a deep knowledge of the theoretical and practical aspects of the processes. Thanks to it students can be informed as to the production activity.
- 2) The practical work of a student in a factory allows him a quicker adaptation as an engineer.
- 3) The knowledge of University staff can be put into practical use for an acceleration of economic development.

Summing up, there are two fundamental forms of co-operation connected with two streams of university activity. The first-to train specialists for industry the other-to conduct scientific work.

To achieve a useful co-operation, several conditions should be fulfilled. First of all the understanding for that co-operation should be aroused between scientific workers. Then, that understanding ought to be worked out in industry centres, concerns, factories, research institutes of industry and institutions controlling the work of industry. Aiming at the co-operation can be stimulated by propagating its idea.

The University ought to accumulate an information about the site, technical state and level of development in industrial establishments, which belong to it as to geographical situation and specialization involved. On the other hand the University information service should inform the industry about the possibilities of the higher schools. That is why some publications describing the University activity ought to be issued, as well as exhibitions, conferences and industrial fairs should be organized.

The University co-operating with industry ought to have sufficient number of workers and materials to meet the demands of industry. It makes the University have at its disposal more scientific workers, technical and laboratory ones and laboratories and workshops, than it is necessary for its didactic purposes.

Co-operation as to staff training

In comparison with classical character of University having no connections with industry, the co-operating one admits the industry specialists to work out the University programmes. They indicate which forms of education are most easily adaptable in industry. That co-operation also allows for removing out dated designs and methods.

A very important element of co-operation is student's practical training. Here a student ought to get acquainted with the scope of work and manufacturing methods by work at a stand. At the same time he ought to be under care of a University worker. The latter one can, thanks to the student's practical training, get some information about the state of industry. Students are expected to perform some tasks to be utilized in industry. They present them in the form of thesis. On the other hand, the establishment can suggest some topics to be carried out at the University and then realized in a factory. Works like that can be directly utilized in the establishment, and conducted by industry workers. That, however, causes some difficulties as to the organizational aspect i.e. in adjustment of two programmes, the University and industry ones.

It is advisable to employ industry workers at the University as over-time workers. They can lecture on specialistic subjects, project and control the scientific works.

Co-operation in the field of research and technical development.

Knowledge of scientific workers employed at the Technical University, their talents and possibilities of creative work, ought to be put to practical use in the economic development of the country. It can be realized best when the creative activity is connected with the direct demands of industry. That knowledge should be employed in industrial advancement, introducing new products, new technologies, new manufacturing methods, new desing methods and so forth.

One of the known ways is the participation of scientists in the manufacturing process through scientific consultations, participating in Councils and authorities which control and check the production. All that makes the control and influence upon the industrial development by the outstanding scientists possible. On the other hand it

facilitates them watching the actual state of industry as well as its demands. It does not however include the full employment of university possibilities. It is confined to a small group of outstanding scientists. Besides, the connections of science with industry in that case are casual.

The greater effect is obtained by a direct co-operation of teams of scientists with the industry. That one is known and realized in different ways all over the world.

The theme of scientific research can be formulated either by industry as a result of a concrete demand, or suggested by the University. The one presented by industry can be accepted by the University if the team specialized in the subject can be found and the work is interesting enough as to scientific aspect.

The theme suggested by the University can be accepted by industry if it is useful now or in the near future.

In both cases formulation of the theme takes place in the form of agreement between the University and industry.

The subject of that co-operation, as to the scientific contents, is varies. The works of fundamental character "pure science" of which results can not be directly realized, are carries out too. They are financed by industry for the sake of science advancement in the country. There are also works practically utilized where engineering elaborations are made or unit prototypes or products in small series are performed. The most advantageous seem to be works having good scientific base where fundamental "pure science" is enriched and simultaneously solutions to be directly utilized, bringing measurable technical and economic effects, are made.

In works performed for industry or financed by it, a large part constitutes fundamental researches in various scientific fields, namely in mathematics, physics, mechanics, geology, elasticity and plasticity, electronics, automatics, different fields of chemistry, environmental engineering, geodesy, material engineering and so on.

Apart from works of cognitive character, works utilizing the fundamental achievements of science for quality improvement and modernisation are carried out. It concerns machine design, chemical products, electronic devices in the scope of automatics, radiotechnics, telecommunication and similar.

Another aspect is the elaboration and use of new technological methods, modernisation of technological tools, devices and technological machines in a wide scope of production.

A lot of works concern, nowadays, the elaboration and use of automatic control systems over the production, exploitation by communication systems and so on. Works devoted to improvement of production and factories organization are performed too. There have been introduced computing methods into productional processes, designing processes and preparation of the production.

A lot of universities specialize in projecting and manufacturing of unique research measurement and check-up equipment. The ways of co-operation are diverse. One of them is to finance works of the university by industry not being interested in the results: without the formal accepting and application of a scientific work. The effect is, as a rule, scientific publications contributing to general science. Another case represents works bought by industry in order to be applied in production.

Here the factory pays for the practical effect and gains the rights to the exclusive exploitation. These works are usually not published. The best effects are obtained by a mutual elaboration of problems by teams of scientists and experts from industry. Then the scientists perform the fundamental research and ideas, leaving the application to the specialists.

Co-operation of the University with the Research institutes.

In co-operation of science and industry, besides universities, research institutes of purely scientific activity with no didactics, participate. They include institutions submitted to Academies of Sciences, State Committees for Research, Ministries, Concerns or Industrial Works. Between these institutes and universities an advantageous co-operation in mutual research for industry takes place. It can be the co-operation of units having a similar profile of activity.

The organization of a co-operation like that includes the division of tasks between co-operating units, or it can be realized by forming a common working group where workers come from two or even more establishments.

Another kind of co-operation is the one between institutions of different specializations to perform complex research tasks. As an example we can take research of medical scientific centres or biological ones with the chemical, mechanical or electronic institutes. In particular, the technical universities can perform the scientific apparatus for carrying out biological or medical experiments. Similarly the chemists or physicists from the University can co-operate in physical and chemical research processes performed by biologists.

Another example is the co-operation of the Technical Universities with the agricultural institutes or Universities carrying out the research in the field of agricultural production. Here, the introduction of special machines and devices proves necessary.

The co-operation of a University and Research Institutes may be strictly directed to common investigations, or it can constitute the element of co-operation of these units with the industry.

In that case the final result of work between miscellaneous centres is applied in industry.

General principles of co-operation between the Warsaw Technical University and industry.

The co-operation of the Warsaw Technical University with industry is widely developed and includes wide and various training fields and scientific research at different forms of realization. This co-operation has been carried out for a long time. It is based on the state principles, defining its forms, guaranteeing juridical means, particularly as to financing the research, exchanging the staff, common use of buildings and investments.

The Technical University of Warsaw signs the general agreements with big industrial establishments concerning the co-operation. They include obligations of both sides as to training and research works. The University is bound to give the training to a definite number of graduates for a given industrial branch, organizing and conducting special evening courses, the post-diploma and doctorate ones and so on, performing the definite scientific works, which are paid, exchanging the staff, common elaboration of research programmes. The factory often finances the purchase of equipment, machines and apparatus, particularly its own produce, e.g. cars, working machines, tooling machines etc., it guarantees laboratories, organizes the student's practical training and even invests the construction of buildings for the University.

The Warsaw Technical University develops different forms of co-operation in staff training. The influence of industry upon programmes is realized by the participation of specialists from industry in programme elaborating commissions. This co-operation particularly resulted in the reform of studies in 1970-71, when the programmes, cutting down the period of technical studies, on average a year or from 5.5 to 4 or 4.5 years were elaborated.

The essential form of training performed at the University is the training of graduates who obtain the Master of Science degree. The number of students is defined by the government's plan which is made according to demands of particular industrial fields. The participation of industry in the training of this essential group of students is realized, first of all, by giving them the practical training in industrial works, then participating of workers from industry in conducting the classes and other forms of co-operation discussed in item 2.

Besides the essential form of Master of Science studies there are some other kinds which make completing the education possible. In that case the co-operation of the Warsaw Technical University with industry is still closer. A lot of these studies are conducted directly for workers of the industrial works where no breaking work by a worker takes place. Wide-spread is the form of evening and extramural studies. Their character is more of practical kind than the Master of Science Degree studies. Their programmes are more limited in comparison with the second ones, and they grant the graduates B.Sc. degrees/engineer.

To that kind of studies, the workers are directed by the Management of the Establishment. Frequently, the groups of students are formed from the workers of one establishment, which saves the student's time. In that case the teaching staff arrives at the working place of the students.

For workers who are specially gifted and have the title of a B.Sc. Degree/engineer special courses for obtaining the Master of Science Degree are organized.

The Warsaw Technical University organizes, in co-operation with big industrial works the Car Factory, the studies which are called the alternating ones. The studies are realized by providing the students with the six-month education and followed by half year of working in the factory. The studies last 3.5 years and grant the title of an engineer. The students are at the same time the workers of the Factory getting the monthly salary, both in the period of studies and work.

The candidates come from the workers of the Factory being directed by the management and the graduates from secondary schools, who starting the studies become the workers of the University.

The education is realized on the standard principles, and is free both for students or the Factory. The Factory gives the facilities of premises for lecturing, and the laboratory is available to students similarly as to the regular students. In the teaching, besides the University lectures, the workers of the Factory take part on the generally accepted principles i.e. they are paid by the University.

That system of studies, including only one specialization of a University, has been working since 1972. It meets recognition, which results in projects of forming similar studies at other industrial works. That system gives to the Factory workers the chance of obtaining a higher education, without losing the salary, and to the students entering the University. It guarantees the employment since the beginning of the studies. It also gives a good adaptation in the Factory. The one guarantees obtaining staff with higher education, well and quickly adjusting itself in the Factory, attached to the working place, which facilitates obtaining higher education. Formally, the workers were obliged to work in the Factory for six years after completing studies. One can expect, however, that they will be permanent workers of the Factory.

Another form of studies are the post-diploma studies. There are scores of them at the University. They are carried out on average in 15-30 persons groups. There are different systems depending on the agreement. Hence there are groups out of professional work, the evening and extra-mural ones. Frequently, students study at the University for some definite number of days, then work completing their education in practical training. The duration of these studies is on average 1 year. The purpose of the above studies is to become skilled at industrial work, getting acquainted with the new achievements of science, new methods of work etc. The graduates of the course are given certificates about completing the studies without any compensation for the scientific title.

Organizing the studium in any definite specialization takes place on the initiative of industry (Ministry or Management). The candidates are selected and directed to the studies by the factories, which cover the costs of courses. Examples of some studies: the studium of magnetic record for radio factories workers, the studium of projecting the industrial works for workers of the projecting offices, the studium of projecting the works of the casting industry, the studium of ancient monuments conservation, the studium of

building machine design and exploitation, the studium of chemical engineering, the studium of computers measurement techniques, etc.

The Warsaw Technical University conducts the doctorate studies with admission for everybody, workers of the industry as well. They can participate in them at standard principles applying for the state scholarship. The industry can direct the worker to the course and according to the state regulations grant a scholarship amounting to the salary he has been obtaining so far.

On obtaining the scientific degree, the worker returns to work.

Another form of co-operation of the Warsaw Technical University with industry are the doctorate studies while the professional is performed (extra-mural). The University provides the lectures and the scientific care. The factory gives the release to the workers to participate in University classes and pass the examinations. The Factory often facilitates carrying out the experiments or computations in its computation centres. In that way, the workers of so called research base of industry, i.e. laboratories centres, and research institutes near the factories, compete for scientific titles.

The co-operation of the Warsaw Technical University with industry in research.

The co-operation of the University with industry is submitted to the general plan of research works within the country. The basis for planning the researches are 5-year plans of economic development.

The plan and its realization are in competence of Universities, Academies of Science, Ministry of Higher Education and Techniques, and the scientific base of the industry. The plans are checked up and confirmed by the State Commission for Planning. The most important directions of development are stimulated by the state funds.

The research programmes consist of multistage systems in which the most important ones are controlled by the government, next by the Ministries and Concerns, Universities and works. Most of the tasks to be performed by the University within the plan, include the co-operation with the industry.

Universities perform works for the industry which constitute the elements of scientific research plan. Its system should stimulate directions of scientific research. Here, a natural conflict between the creative individuality of scientists and planned demands appears. That fact should be taken into account when planning, and needs of both sides should be met. Sometimes there is no demand for research in some fields or problems. Then the University undertakes its own investigations and finances them. Results are published. The subject of research carried out by the Warsaw Technical University for industry is different. On one hand the fundamental scientific elaborations with cognitive purposes are made on the other the devices are produced and sold to industry.

As there is the tendency to gain the optimal results in work of scientists and at the same time sustain a high level, the works of cognitive character have priority over the typically productional

ones. The industry orders various kinds of works. Frequently when productional power is limited and terms of performing the tasks urgent, the works of projecting or productional kind of low scientific level are ordered. Works of "service" type are sometimes performed by the University.

Works at the University are performed by academic teachers, whose main task is teaching. The number of teaching hours is about 300 to 500 yearly.

Most tasks are performed by workers out of their full-time duties for which they are paid extra. However there are limitations as to the amount of extra salary, dependently on the category of a worker and its amount is from 50 to 100% of basic salary.

Academic teachers, professors, associate professors, assistants perform, first of all, conceptional works, in which they are helped by auxiliary staff. One part of the staff is working for the didactic purposes, or scientific works of the University. That staff performs works partly within its own full-time duties, partly over-time. A special group of scientists, laboratory assistants and manual workers is specially engaged as the auxiliary staff only for the above mentioned jobs. The number of that group for optimum development of scientific research is estimated to be 40% of the total of academic teachers. The number of the auxiliary staff for the own researches is about 30% and that taking part in the didactic process also 30%.

In conducting works the workers from the industry take part. It specially concerns elaborations to be put into productional process. Special working groups are also established. They consist of University and factory workers. Costs involved are covered by the industry in form of payments for extra work. The conditions as to performing the work, terms, works calculation and amount of payments are defined by the agreement between the Warsaw Technical University and the industrial work. The results of researches come in form of reports or sometimes ready product such as devices of research apparatus or laboratory stands for investigations in industry.

The payments posted to the University banking account on covering the material and general costs, are the fund which is partly used for apparatus purchase and scientific equipment, partly for carrying out University research works and in some percent for special rewards fund. That one is allocated for workers who obtain leading results in scientific work.

An additional advantage from performing works for the industry is that the laboratory equipment, which was purchased or produced is left at the University after completing the experiments and can be exploited both by scientific workers and students. The works done for the industry are as follows:

in machine design.

reliability testing of hydraulic devices, machine work analysis for land cultivation, automatic computer programming of metal cutting, technology of smoothing parts, technologies elaborations, the method of telescope crane design and testing, research on the phenomena of lawinar flow round the aeronautical profiles.

in fine mechanics - optimization of mechanic systems of static and dynamic tape-recorders, magnetovids, designing the elipsometers prothesis elements design etc.

in material engineering - mechanical testing of metal corrosion in petrochemic industry, the structure of ventilators' blades of plastics.

in telecommunication - studies over cable tracks for telecommunication digital systems, elaboration of specialistic measuring apparatus for manufacturing and exploitation of data transmission.

in radiotechnics - high-precision time interval meters for laser measurement of distance between the earth and satellites, testing methods of microwaic cirenits with adjusted elements.

in chemistry - new methods in polireaction.

Suggestions concerning the role of UNIDO in co-operation Universities, research institutes and industry in developing countries.

UNIDO can help the developing countries in organizing the co-operation between universities and industry through instructions and propagating that co-operation.

The practical way for the above purpose can be:

1. Directing the specialists from well-organized as to co-operation countries, to the third world states to instruct, consult or help in organizing the co-operation.
2. Organizing the stay of workers, managers of University establishments, and Universities of developing countries at the universities of countries having well-developed co-operation.
3. Organizing the seminars and conferences to discuss the problems of co-operation and its propogation. Seminars can take place both in developed or developing countries.
4. Periodical meetings held at well-known Universities for scientists from the developing countires.
5. Establishing the permanent group or groups of expert: as consultative body initiating and checking the activity in the field of co-operation between the University and Industry. These groups should meet periodically to show the direction of works and appreciate the activity.

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