

R&D studies carried out by the VIGO-System Ltd. as exemplary ones for self-financing enterprises⁺

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The problems related to R&D studies, carried out by the innovative enterprise, dealt with IR semiconductor detectors, electronic devices, and professional optics using own engineering solutions are presented. A product range and introduction of results of scientific research into a production process are given. Additionally, management activity aimed at its improvement to meet the world market demands is described.

1. Introduction

Political and economical changes which occurred in Poland after the year 1989 resulted in significant transformation of the Polish market. The economical subjects being previously only the executors of the decisions undertaken according to the Central Planning, now are obliged to adapt the "free market" rules which are different, often unknown, and what is even worst not willingly accepted. Yesterday, strictly isolated economy with the controlled access to raw materials, foreign currency, foreign trade were unfavourable for dynamic development of production and its modernization. Ineffective economic system, in spite of verbal critic, tolerated the state of hibernation of producers imposing the market conditions. Opening of the borders made possible easy flow of concepts, products, and services from international trade to all economic subjects, limited exchange of the Polish currency, faced the domestic producers with a world competition. Customer and its needs start to play important role at the market of products and services. Science and art, embodying the values regarded so far as an out-of-the-market untouchable sphere of the very chosen like the artists and the scientists have now become the product - though not very exactly in the language of marketing.

Inadequate preparation of managers for acting in new conditions caused intensification of difficulties of transitory period. Proper location of a company in new

economy became a main problem not only for government factories, R&D institutions but also for new formed private companies seeking their places on the market.

The everyday reality seems to confirm that it is unattainable for many enterprises. Finding own way in the complicated economical and political conditions is not easy. It is necessary to change organization habits, relations to customers, attitude to work, as well as to find the "gaps" on the worldwide market. Today, it is especially difficult when capitals concentration is very strong and generalization of economical processes with simultaneous deficiency of private capitals. So, in these conditions, well educated and good qualified staff could create the best chance for development of national economy.

Experiences of the developed countries indicate that finding a miraculous recipe for market success is impossible. For example, in Germany, many hundreds of thousands of economic subjects are formed and lost during only one year. However, there are known some instructions for economical success achieving. The necessary condition is put them into practice but unfortunately it is not sufficient to keep good market position.

2. Short history of the firm activity

Distinct division of the world into two political systems, competing at the military and economy areas was in the last years the reason of strong political

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⁺ Presented at the 12th School of Optoelectronics: Photovoltaics - Solar Cells and Infrared Detectors, Kazimierz Dolny, May 22-24, 1997.

domination on economical arguments, especially in the socialistic block countries. Highly developed West countries commonly blocked access to their advanced technologies what caused defensive impulse in Eastern countries block aimed at activity independent of cooperation with Western countries. Policy of economical autarky, in the situation of significant differences in the levels of economical development of the both systems, with simultaneous low efficiency of the socialistic economy and existing barriers limiting flow of goods, services, and advanced technology caused systematic extension of technological gap and it failed after long period of such activity.

In the East countries the special attention was paid to the investigations and technologies important for military applications.

At the beginning of the 70's, at the Military University of Technology the team headed by prof. Piotrowski (at that time doctor of science) elaborated, for the first time in the world, the method of production of non-cooled photon IR Mercury-Cadmium-Telluride (MTC) detectors, i.e., semiconductor detectors with a variable width of energy gap. The elaborated detectors which need not cooling with the liquid nitrogen were promising for IR technology applications, not only within military fields but also civilian ones.

Information on the elaborated in Poland new type of detector, reported in the world scientific literature, has been met with disbelief of specialists of Eastern and Western countries.

For the Polish inventors it was the beginning of, so called, "bed of thorus".

This invention, in comparison with those days products of electronic industry, was ahead of its time product. Western specialists, apart of a few reports in scientific literature have no access to commercial information. All activities of foreign trade in Poland have been concentrated in several centres with no experts managed to give the authorized opinion on the invention. Unrealistic exchange of the US dollar course and strict control of access to foreign exchange made impossible to start a promotive action without the state authorities approval. No possibility for products sale caused lack of financial means for fast development. The Military University of Technology having its own statutory tasks was not interested in creation of suitable conditions for detectors production and increased number of their applications. True vicious circle.

The first market success was in 1980 when at the CLEO'80 conference in Boston, after the paper presentation, we came into the private contacts with

American distributor, who decided to take the risk of promotion of Polish detectors on the American market.

In 1987, after many unsuccessful trials to interest a national electronic industry in an invention, the group of authors of this technology established a private company. Due to favourable climate for inventions, the company management received in 1988 the governmental order for both research completion and new production of Mercury-Cadmium-Telluride IR detectors. Reality has verified very quickly the previously made plans. Deep economical crisis in the country and related to it lack of financial means caused in 1990 breaking the accomplishment of the governmental order because of the reasons independent of the firm what was dangerous for the whole enterprise affair. Having still the possibility to sell the firm's products on a few foreign markets and some accepted foreign orders the firm could survive and despite significant difficulties it could finance its development and research works from its own funds.

3. Characteristics of the VIGO-System Ltd. firm

The VIGO-System Ltd. is an average size, fully private, firm dealing with elaboration and implementation into production its own elaborations and technical solutions from the group of the advanced technology of the optoelectronic branch. The main part of the team being substantial firm's management and administration is the group of highly-skilled specialists (1 professor, 7 doctors of technical science, 15 engineers) who have cooperated for over 20 years in academic structures as well as scientific organizations and since 1987 they have worked in the VIGO company. Fifty persons are employed in the firm, mainly well-educated technicians. The essential part of the firm receipts is obtained from the sale of subassemblies and optoelectronics devices, electronic and optic devices, all of its own production as well as produced on the basis of its own original solutions.

At the average, about 50% of the firm production is sold on the markets of highly developed countries. Sixteen distributors in the world cooperate with the firm. The main foreign markets for the VIGO-System Ltd. firm are the US, Canada, Germany, Japan, and Great Britain market. The firm workers have frequent scientific contacts with domestic and foreign research-scientific institutions which consist in exchange of experiences, common investigations and elaborations as well as scientific trainings. The students from Polish

High Schools are directed to us for practices and theses preparation.

4. Innovative character of the firm

Characteristic feature of the innovative firm, in my opinion, is undertaking the advanced research-implemented tasks of technical level significantly higher than the level of the hitherto made works. Innovation is mainly the result of intellectual effort of creators leading to unconventional use of materials or subassemblies what finally gives a new high-quality product and sometimes discovery of new phenomena or materials with new properties. However, the condition necessary for efficient firm activity is easy access to the world market and to its intellectual and material sources.

Jasiński [1] widely described the problems occurring in the innovative enterprises on the basis of western companies experiences, especially the British ones.

Such problems being for many years weak points of the animators of national economy have not been solved yet satisfactorily by any government. Evident separation of science and industry caused appearance of ill tradition for division of research centres into "true" ones (high schools, institutes of the Polish Academy of Science, academic institutes) with the research teams of recognized authority and "apparent" ones (industrial research-development centres) of low prestige. The effect of such division is a paradox manifested as industry expectation for spontaneous delivery of new solutions from research institutions and still being heard complainments of workers from research workers society on no interest in new solutions.

In the era of high-tech advanced technologies it cannot be neglected. One cannot even imagine to start a production of electronic subassemblies in great scale of integration or other complex optoelectronic elements without direct, continuous engagement of creators.

It seems that the VIGO-System can be a good example of economical organization in which scientific ambitions of highly-skilled specialists are in harmony with effective accomplishment of production undertakings within the field of optoelectronics.

In the firm there is no clear border between research and productive teams. The world market requirements are natural stimulator for research works and new elaborations which performance influences on firm existence. Most of the firm products which are

listed in the firm offer were made as single elaborations prepared for individual customer orders. The average time of performance of such orders usually does not exceed 6 weeks, what is a standard time for majority of the world's firm. All the firm products are still modernized and improved and at the average of every year two or three new products are made which parameters significantly surpassed parameters the hitherto existing ones.

Continuous contact with the worldwide customers, by means of traditional communication and electronic means, creates some kind of feedback enabling recognition of customers needs and information on direction of market development and expectation of users of VIGO firm products. Such a feedback, in natural way, initiates innovation in searching the methods of fulfilment of potential buyer expectations. This activity is equally fascinating as laboratory works. The effects of works are at once verified on the market which is, in my opinion, the only objective criterion for evaluation of value of the applied investigations.

5. Characteristic of the firm's product

New semiconductor material was discovered at the beginning of the 60's. It was Mercury Cadmium Telluride $Hg_{1-x}Cd_xTe$, promising for infrared technique development. This material, different from the traditional semiconductors has a unique, especially attractive physical properties, among which the most important is the possibility to control a width of energy gap within a wide range. It enables to produce, using the same apparatus and technology, wide assortment of IR detectors sensitive in, a priori, selected spectral range – from visible range up to far infrared one.

Production of semiconductor itself as well as IR detectors on its basis is the very complicated technological process and it needs deep understanding of accompanying its physical processes.

For many years some false opinion have been heard and often considered as a true one that semiconductor photon detectors of far infrared can operate only in the conditions of very low temperatures. The world technology was directed to such detectors and nowadays produced detectors have peak parameters which upper level is limited by the fundamental laws of physics. It is also evident that exploitation of devices which required deep cooling is very troublesome. This fact strongly limited development of IR technology, especially for industrial and medical applications.

Carried out in Poland theoretical works, which

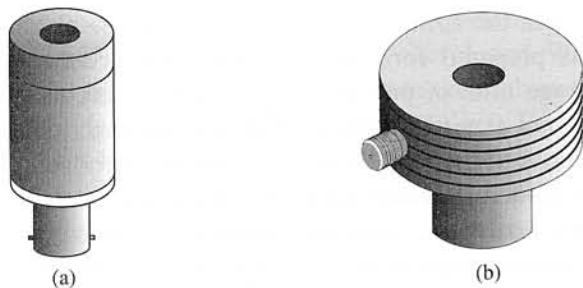


Fig. 1. First uncooled IR detectors of 10.6 μm radiation: (a) R005 photoresistor, (b) photomagnetoelectric detector (after Ref. 7). Its detectivity is up to $3 \times 10^7 \text{ cmHz}^{1/2} \text{ W}$ for $\lambda = 10.6 \text{ μm}$.

were next experimentally verified, showed that the opinion on necessity of deep cooling of IR detectors is ungrounded. At the beginning of the 70's there appeared in Poland, for the first time made in the world, non-cooled semiconductor MCT IR detectors. Their parameters were not so good as the cooled detectors with liquid nitrogen but for many applications they were good enough.

The offered detectors can be applied for the research works, especially for investigations with high temperature plasma, for laser technology, construction of military and civilian devices such as; rangefinders and laser velocity meters, lidars, laser communication devices, non-contact temperature meters, linear scanners, laser welders, gas and atmospheric pollution analysers, laser surgery devices, and others.

Characteristic feature of such detectors is extremely low (below 2%) consumption of material and energy in the cost of their production. The detector price (at the average about 1000 USD for one detector) includes, first of all, technical concept and intellectual achievement of the team.

From among wide assortment of the detectors offered by the firm, the dominating ones are non-cooled or weakly cooled thermoelectric detectors of the

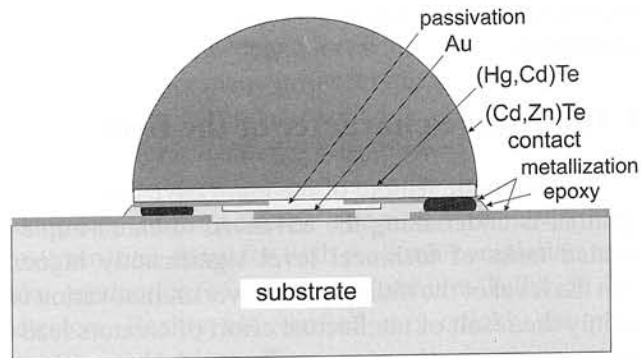


Fig. 2. Cross-section of a monolithic immersion photoresistor.

medium infrared range (3–5.5 μm) and far infrared range (8–14 μm) used for various applications.

At present, the most important application of these detectors is military technology. Many of detectors are also used for the Fourier spectrometers, laser devices control, construction of anticollision devices, non-contact measurements of temperature and the like.

The firm offers also photoconductive detectors as well as photovoltaic ones which due to original three-dimensional architecture of energy gap can operate at room temperature. The last mentioned solution was recognized as the best optoelectronic product introduced into the world market in 1995 what was awarded by the American periodic magazine *Photonics Spectra* a prestige prize "The Photonics Circle of Excellence Award". It was the first case of nine-year-history of this prize award when the firm not being among the firms of highly developed countries was awarded. Among the prize winner there were also the following firms IBM, Bell Labs, Eastman Kodak, Philips, Xerox, and others.

Recently, the team has concentrated its great effort on the research works for technology of production of

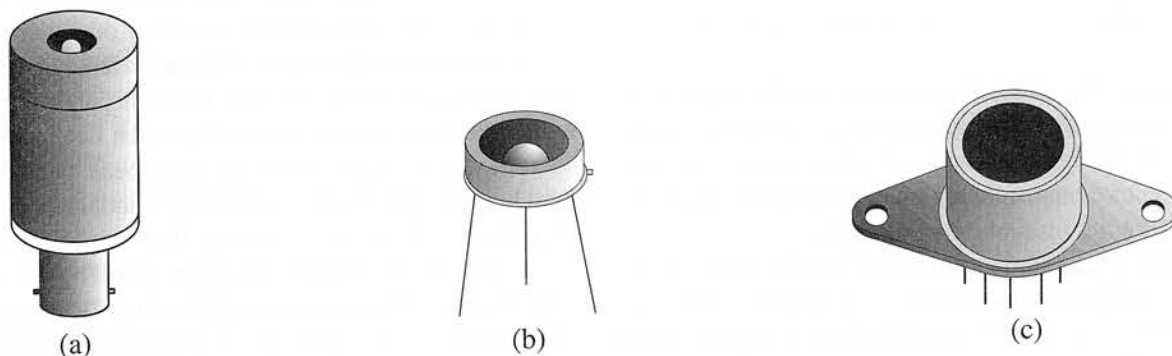


Fig. 3. Immersion IR detectors: (a) uncooled photoresistor working in broad frequency band, (b) uncooled photoresistor for frequencies up to 30 MHz, (c) thermoelectrically cooled photoresistors and photovoltaic detectors (after Ref. 7).

multielement linear detectors coupled with binary optics. This technique makes it possible to attain already unknown parameters of multielement detectors.

6. Reorientation in activity of the firm management in the period of transition to market economy

Necessity of deep privatization process in all fields of economy, earlier or maybe later, will concern also scientific society. The beginning of privatization process in this society is activity of private high schools which after the time passing will be forced to work out their own financial means for scientific research and for keeping good level of education. Total commercialization process of scientific research would be rather difficult to imagine and, without any question, harmful one. On the other hand lack of sensible criteria for choosing directions of research work directions which should be financed from national budget as priority ones caused that effectiveness of such financing of science is rather insignificant.

According to Jasiński, for example in Great Britain, significant part of national budget funds devoted to research and implementations is given for indirect and direct aid for small innovative enterprises which have been formed from R&D institutions carrying out the applied investigations and implementation of the advanced technical solutions. Such enterprises are the sources of innovations and new technologies for the whole industry. Their workers are able to transform the results of investigations into engineering tasks and to adapt them for technological requirements.

Similar purpose was the subject matter of the Technical Development and Implementation Office previously existing in Poland. Unfortunately, this Office was relatively quickly transformed into the State Committee for Scientific Research which statutory purposes rather weakly fulfil the tasks which can be fulfilled by the institution supporting development of innovative firms. There is no another institution having better adapted structure.

Analysing the existing situation, the board of the VIGO-System firm has undertaken some activities aimed at accommodation of the firm for new economical conditions, basing on the experiences obtained from many years lasting activity on the world market and still improving managing qualifications by literature studies and post-diploma studies.

The management staff attended the management studies organized by the INSEAD (the European Institute of Business Administration in Fontenbleau, near Paris), post-diploma marketing study, as well as the staff trainings at the courses. The gathered knowledge enables us to estimate the problems of market economy from a new perspective. We essentially changed our management activity, production control, staff policy, and method of management of the possessed funds. Total revaluation underwent the aims of the firm and methods of their accomplishment, the way of settlements of accounts and presentation of financial state of the firm, finally hierarchy of tasks validity changed too. Marketing role has been appreciated and some activities were undertaken, having in view subordination of the firm tasks for the market needs.

The firm oriented to the product has been changed into the firm oriented to marketing problems.

Characteristic feature of marketing orientation of the firm is organization of the whole processes of management, development, production and sale products in the way subordinated to customer needs. The main task in that case is good knowledge about the market requirements, competition, and also capability to anticipate and create new market needs.

In order to meet the world tendencies, the firm started the works leading to implementation of the management system through the ISO-9000 quality.

Some time ago, in the highly developed countries it was stated that the result of industrial development is not only alarming contamination and degradation of environment but also expanding activities creating groundless, by rational consumers needs, wasteful consumer behaviours such as not necessary exchange of still efficient goods, thus new idea of, so called, social marketing was entered. Such idea is directed to the shaping of customers attitude, friendly for environment protection, saving of nonproductive raw materials and improvement of production processes what should result in better and much more comfortable life in healthy environment. Of course, such a social marketing orientation will be probably taken into account (first of all) in wealthy countries where consciousness of hazard resulting from industry development and a life level dominated on the need of fulfilment of basic needs of habitants. Simultaneously, the opinions of wealthy societies shaped under influence of social marketing orientation will be successive barrier, unformal but difficult for overcoming for the poorer countries which attempt to enter the world markets.

7. New organization of production and sale

We have stopped production of the products being non-perspective for fast sale. The production was subordinated only to current orders in order not to accumulate the stock-in-trade. The magazines of raw materials, spare materials and parts have been liquidated and we based only on the current delivery, ordered with such a calculation and in such amounts to use them directly for production. We resigned from intervention of national bureau of foreign trade and we formed our own trade bureau dealing with complete customer service, goods promotion and technical consultation as well as agency of the trade of devices and assemblies of optoelectronic famous firm. The active searching for finding the mass product ensuring sale continuity was undertaken. Finally, the firm promotion on the foreign markets was undertaken with greater courage due to participation in exhibitions and advertisements in world-wide professional magazines.

8. Searching for market product

One of the important problems of the innovative firm producing still the same and limited assortment of products is keeping financial continuity in the period of market creation and situation of no long-term contracts. It is connected with characteristic for each product cycle of development and life on the market [1,4]. The problem is much more serious when the firm products are novelty in the world-wide scale and their introduction on the market requires customers convenience of necessity to buy them and moreover, information for customers how to use effectively the advantages of such new products.

On the basis of our own experience, confirmed by distributors opinions and the results of investigations [4], introduction of new product on the market (when the product is really new) lasts about 2–3 years. The innovative firm in Poland has to find the financing sources for research works, development, and products promotion in condition of no credits in bank system. In practice it is necessity to find a sponsor or start additional profitable trade or service activity enabling to survive such difficult period.

Basing on our own analysis SWOT [5] and detailed observation of the market we decided to use our own vacuum devices for production of refined spectacle with the anti-reflex coatings and filters as well professional optics for medical application. The idea was

right, despite many problems with production, marketing and introduction of these new products on the market. At present, production of spectacle lenses stabilizes financial continuity of the firm due to their purchase by many customers and relatively stable market demand, even with continuous tendency to increase, observed during long period. Within the field of professional thin-layer optics our firm has now the biggest and much more advanced production and research potential in Poland. Beside the market products our firm produces also complicated interference filters for light technique, professional analytical devices, experimental and medical ones. Significant part of this production we exports to Western countries. The average time for elaboration of the new order does not exceed 4 weeks. Similar elaborations financed from the budget funds made by, the known by us, Polish research teams last at least 12 months.

The production of optoelectronic subassemblies (IR detectors) is still a company visiting-card in Poland and in foreign countries.

Company transformation into the market oriented unit caused the necessity of much more active undertakings aimed at market needs recognition, promotion of the products, improvement of technical consulting and faster diffusion of innovations [1]. Selection of current directions of production development in new economical conditions, was not only the result of historical events and professional education of the staff but, first of all, the result of market analysis carried out on the basis of our own investigations and our distributors experience.

Many-year-practice shows that it is very difficult to sale the Polish advanced products to anonymous customer from Western market only by firm itself. Customers from Western countries have rather xenophobic reaction to the high-tech products of "socialistic" origin (our countries are still estimated in this way) and they do not accept them easy.

Important element of marketing orientation of the firm is organization of production enabling quick realization of untypical orders, when often elaboration of new non-standard product of "custom design" type is necessary.

9. Customer role in product shaping

The creator and next producer of new product must choose the form of product introduction into market – to promote his own standard or to adapt it, as good as possible, to the existing standards. The answer is not simple and it depends on many factors. On one side in

the case of important innovations (e.g., change in gaseous lighting into electrical lighting, from gramophone to tape recorder and then to compact disc with digital record and then to digital tape recorder, or from motion picture camera to video-camera with magnetic recording, introduction of own standard could be necessary. On the other side there are known some exceptional inventions in the history of technique development or technical solutions which have been rejected because they appeared to late or did not match to the obligatory standards and for their introduction great funds would be needed and necessity to change the used devices. The example can be recording system on a magnetic tape, significantly better than VHS but invented after implementation of video-recorders in VHS systems into production and because of it rejected by video producers.

Thus, it is supposed that creation of new standards is possible only by great producers, enough wealthy to create some favourable technical conditions for their products. The other producers are forced to match their products to already existing standards. This phenomenon is commonly observed. If we neglected the examples of piratical imitation of the products there are numerous examples of producers which tend to compatibility of their new products with the old obligatory standards.

Creation of new product in small firm should be, in my opinion, with no natural inclination of inventor for "subordination" him of the whole world. The form of a new product appearing on the market should be precisely determined and matched both to technical possibilities as well as to customer needs and habits. Majority of customers, even in scientific society, are not inclined to accept significant changes. Introduction of new product, even very advanced, but forcing many changes in existing technology is met with rather significant resistance of possible customer. Knowing the customer habits and matching to the obligatory standards is the basic task of the new product creator. So it is one but not only one factor of customer influence on product shaping. Dominating role of customer in product shaping appears especially when the "custom design" products are introduced, when producer designees and performs device strictly matched to the customer needs. Such type products require detailed agreements related to their forms and parameters because they usually must be compatible with the current system used by consumer. The products "custom design" type, within the range of optoelectronics and thin-layer optics, are the VIGO firm speciality.

10. Searching for investment capital

For proper development of national economy the State policy should be proinnovative and stimulating not only for development of fundamental research works, the lack of which can stop technological development, but also for development of applied research works and new branches of industry as well as the firms implementing technological solutions being competitive in the world scale. The practice of governments activity in the past decades showed complete helplessness in this matter. The method of "swimming learning by throwing the pupil into deep water" resulted in tragic financial situation of many firms. Wide analysis of the forms of innovation, sponsored by the British government, has been carried out by Jasiński [1]. He described many interesting forms of institutional aid, including financial one, given for the innovative firms. In Poland, mainly national enterprises, often with no chance for surviving, are aided because of political reasons.

Keeping good position on the world market of the products of advanced technologies, needs significant funds for research works and development. The same funds, expressed in percentages of turnover or profit, for great concern and small firm are very different as taken in absolute values. Thus, possibilities of R&D works of the firms of various sizes are incomparable. Because of still lack of domestic capital the only one source of funds enabling fast increase in the scale of innovative undertaking is foreign capital venture or capital alliance with the firm having similar production profile. Experiences of the VIGO-System Ltd. showed that such opinion is illusive. Not only the Polish inventors (banks) but also the foreign ones are inclined to invest rather into high-profitable undertakings with short payback period and low level of risk. According to our recognition, the West capital did not aid any Polish undertaking from among that of advanced technology group.

So, in that situation it seems to be good idea, in the initial period, joint venture or leasing of work-rooms and equipment from parent institution which could gain, in future, financial means aided its own activity. Such a solution simultaneously ensures inspiring contacts with scientific society from which the firm has "grown".

11. Summary

Innovative idea for new product is today insufficient factor to enter the market and to not be afraid of the future. On the open market with free access of all

world producers there is necessary to start the promotion activities based on marketing studies, understand the mechanisms influencing customers behaviour, follow-up technological changes and to carry out intensive R&D works for being competitive in the world. It is doubtful if the idea of transformation of the Polish economy, similarly as South Korea or Tajwan ones, into the industrial "tiger" of Western Europe will be successful because of strong competition of the world concerns which strictly keep in secret their business and which are not interested in development of the advanced technologies in other countries. Probably we will be still the country in which the foreign capital would like to find the place for accomplishment of the technologies, arduous for environment, of the heavy industry and chemical industry (metallurgy, pulp mills, cement plants, mining), and markets for their new products. We should not believe that our country is attractive for foreign partners due to cheap manpower. In the era of automatization and computerization of industrial processes the role of manpower rapidly decreases and the cheaper manpower can be found in Asia, the CIS countries or in the Latin America. In my opinion the main and important factor decisive for the Polish success on the world market is well educated staff. It is obvious that we should seek our chance in the undertakings requiring advanced technical solutions. It is impossible to create industrial potential in the country such large as Poland basing on tenth of thousands of the innovative firms when each of them will find their "niche" in the world. However, such firms should be aided and their development should be stimulated because they are important "carriers" of technological development. That thesis has been confirmed by the history of activity of the VIGO-System firm which survived despite very difficult problems, which appeared during the period of transformation of the Polish economy, and which have been overcome due to great funds devoted for investigations, elasticity in the firm activity, and changes of management principles. Important role for the firm position on the world market marked fulfilled new idea of trade and production organization as well as new kind of contacts with customers. The trial of transformation of firm orientation from the product oriented firm into marketing one was successful and inspired by the fact that we are now in half way to the full success, the results are evident. In spite of the same number of employees for the last three years the value of production and sale increases in about 50% per year. The biggest world distributors are interested in the sale of the products of our firm. The detectors produced in our firm are now significant-

ly much more reliable for the producers of advanced devices. Even the Polish defence industry is "waking up from deep sleep".

The results of analysis of the VIGO-System firm development and its adaptation changes during the period of stormy political and economical transformations in Poland show that the chosen direction of changes was proper. Despite many adversities and no aid from national institutions, small innovative firm, left itself, survived, as the only one from among the Polish enterprises producing electronic subassemblies, due to subordination of organization of management and production to requirements of the world market. It was the result of many factors among which the most important are, finding the technological gap on the world market, high level of staff professionalism, effective management, good means of world wide communication, good knowledge of foreign languages of majority persons of staff, and marketing orientation of the firm. It must be admitted that happy coincidence was also of great importance, however the firm success results mainly from hard work of its personnel.

According to the opinions presented by Jasiński [1], having in prospects initiation of creative activity of engineers and scientists for elaboration and advanced technological solutions and their implementation, it is necessary to take adequate proinnovative policy, controlled by the State. The examples of economical factors, used in Great Britain, described by Jasiński, for simulation of development of innovative firms are worth consideration as one of the forms of aid for new sources of technological development and modernity.

The research works carried out in small innovative units should be, at least, partially aided by the State because their results are used in many branches of industry.

12. Conclusions

It is difficult to imagine the firm success on free market without subordination to the principles which are obligatory there. This statement concerns especially small firms which have rather limited chances in finding technological "gap". In Poland, at the time of legitimate disorder and various opinions on the state functioning, the small economical units were left themselves. Especially difficult was situation in the enterprises which activity was, on one hand, of high level of risk and, on the other hand, regards the important State matters. I mean here the innovative firms which activity, as it can be noticed from experience of the Western countries [1], has significant influence on

technology development and new solutions for industry. Industry, traditionally adapted to mass production, from the nature of its structure, is characterized by inertia in production of the unit products and in acceptance of new solutions of technological processes. Small innovative firms ensure elasticity in industrial activities and possibility of short-run production, often requiring very specialistic qualification of personnel. Effective activity of such firms can be possible, in many cases, only with the aid of the State or industry. Working out financial means enabling the firm existence and necessity to carry out investigations to withstand competition on the market requires overcoming of some financial level [6] below which the firm selffinancing process is impossible. Often it is even impossible for small firm to make professional marketing studies which are imperative of good investment. In Polish small firms, majority of investments are undertaken by intuition. The State and industry did not work out yet the mechanisms which enable usage of great intellectual potential of the Polish engineering staff and aid for activity of small innovative

enterprises. Expectations that such enterprises will be developed only on the firms own risk, with no capital, is the same ingenious opinion as that "uncle Sam will come with sack of dollars and we will make together profitable business".

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