THE IMPORTANCE AND PROSPECTS OF SYNERGETIC INTEGRATION OF HIGHER EDUCATION AND INDUSTRY IN TRAINING MODERN ENGINEERS

Saydaliev Ismoiljon Nurmamatovich
Senior lecturer, Andijan Machine-Building Institute, Andijan, **UZBEKISTAN**
E-mail address: ismoiljonsaydaliyev@mail.ru

ABSTRACT

This article describes the concept of integration, the meaning of the term synergy, the areas of use of the term, and the synergetic integration of higher education and production. Opinions on the joint activities of higher education and industrial enterprises are expressed. Synergetic integration aims to train high-quality personnel, achieve scientific developments and form a strong base of specialists.

Keywords: Integration, synergy, synergetic integration, higher education, industry, training engineers.

INTRODUCTION

It is currently important to establish cooperation between higher education and manufacturing enterprises to ensure the quality and employment of personnel, to supplement the content of education with integrated knowledge and to organize the integration of higher education and industry in the training of modern engineers. Various forms of integration of higher education and industry are widely used. Moreover, the rapid development of science and technology, the rapid change from one technology to another, and the constant increase in interest of future professionals in professions related to innovative processes in higher education and production require constant updating of knowledge of engineers and continuous improvement of training.

With the rapid development of intellectual potential in the field of engineering and technology in our country, strong scientific and technological prospects exist. However, in the post-independence years, the lack of modern laboratories in higher education institutions in Uzbekistan and the lack of a clear mechanism for cooperation between higher education and industry have made it difficult for employees to meet the needs of employers. Graduates with higher education do not have the knowledge and skills to work as specialists in enterprises and have been stuck for years as ordinary workers. The participation of industrial enterprises in the training of highly educated personnel in the field of engineering is insufficient [1]. There are many barriers to effective cooperation with industrial enterprises. Therefore, in the current situation, there is a need to form educational institutions based on modern educational technologies, to apply pedagogical innovations in education, and to seek new approaches, forms and methods of engineering education based on the best practices of developed countries. The Action Strategy for the further development of the Republic of Uzbekistan sets the tasks of "continuing the path of further improving the system of continuing education, increasing the capacity of quality educational services, training highly qualified personnel in accordance with modern needs of the labor market" [2]. In this regard, it is important to systematize the processes of integrating higher education and industry, increase the efficiency of the use of innovative technologies, and introduce innovative models for the level of professional training based on the requirements and attitudes of customers.

MATERIALS AND METHODS

The current education system focuses on a number of interactive methods aimed at training quality personnel, achieving partnerships with customers, and making effort to work as a team. The integration of higher education and industry is one of these efforts, in which we can see different forms of the integration process. For example, students participate in internships in manufacturing enterprises, diploma and course projects are based on production problems, the results of research projects are recommended to enterprises, and so on. We have set a challenging goal: to train modern engineers and meet the needs of customers. What should be the role of the two sides in cooperation to achieve this goal? We think thatto achieve a mutual benefit, the tasks of the parties must be clearly defined and approached responsibly.

Research on improving the quality of education in higher education institutions and the integration of higher education and industry was conducted by scientists of the republic, including Z.K. Ismailova, R.H. Djuraev, Sh.S.Sharipov, R.G. Isyanov, and Sh.S. Abduraimov. Others considered methodical and didactic aspects of labour and vocational education, including A.A. Abdukadirov, B.C. Abdullaeva, U.Sh. Begimkulov, O.A. Abdukuddusov, A.I. Avazboev, Sh.T. Khalilova, D. and Sharipova, E. Furthermore, scientists such as R. Yuzlikaeva, S.Q. Kahharov, and S.E. Kurbanov contributed to the development of the field by studying the psychological, pedagogical, and methodological problems of integration in the educational process and their solutions.

Z.S. Sazonova, I.D. Zverev, and S.Ya conducted research on the theoretical and methodological bases of integration and pedagogical integration in the educational process in Russia and the CIS countries. Special studies were also conducted by scientists such as Batysheva, S.L. Rubinstein, R.S. Safin, and N.K. Chapaev. The organization of teaching in foreign countries on the basis of integrative knowledge is reflected in the research of scientists such as J. Gilbert, F. Cochran, S. Merriam, J. Fernandez-Balvoa, S. Wilson, P. Ertmer, and J. Wilson.

Notably, in the higher education system, no specific study has been conducted with the aim to improve the pedagogical capacity of interaction with industry to ensure the quality of training of modern engineers. In the study of higher education and industrial integration, we must consider the content and essence of the concept of direct integration.

Integration [lot. integratio - restore, restart, replenish]

1. The concept of the state of connection of individual parts, elements, and their combination.
2. The process of convergence and interconnection of sciences.
3. Mutual coordination and integration of the economies of two or more countries [3.P.216].

A number of scientists involved in the integration process in our country have expressed their views on the concept of integration based on their scientific work.

A.I.Avazbaev concluded that integration is "the process of merging individual components into a whole, creating a new character." In this case, integration is interpreted as a process, which is a more complete definition, that is, a whole, integral part with a new property, formed as a result of the merging of individual parts involved in the process.

R.A.Mavlonova also interprets integration as a process, noting that it is used in two different senses:

1. The system is a concept that expresses the state of interdependence of individual stratified parts and functions of the organism and the process leading to this state.

2. The process of convergence of disciplines is conducted in conjunction with the process of stratification.

M.Jumaniyozova describes it as "the result of the synthesis of integration in education." At this point, the term integration appears to be somewhat privatized, i.e., the concept of integration is introduced in education.

O.A.Abdukuddusov explains integration in the sense of "uniting as a whole, making it a logical whole." The author again argues that "it is a high level of integration-synthesis." In this case, the author explains integration as a high level of the synthesis process; that is, in the synthesis process, parts or elements are combined (generalized). The author referred to the combination of parts or elements as a result of integration.

E.O.Turdikulov described integration as "bringing things to a fragmented, fragmented, individual state into a whole, whole, systematic state."

Sh.S.Abduraimov argues that "integration is the unification of the elements of the system into a single, integrated state, creating a new property according to the state of interdependence in order to develop certain parts and functions." This definition has a broader meaning that implies the creation of another system with a new property, combining them into a single stateto develop the functions of some parts of the elements involved in a system [4.P.11].

DISCUSSIONS AND RESULTS

Research and analysis of the scientific pedagogical literature show that the term integration is a complex concept with many meanings and refers to multi-level processes. A vivid example of this is the integration of higher education and industry in the socio-economic, political, cultural spheres, the education system, interdisciplinary, interdepartmental, interdisciplinary integration, and the training of modern engineers.

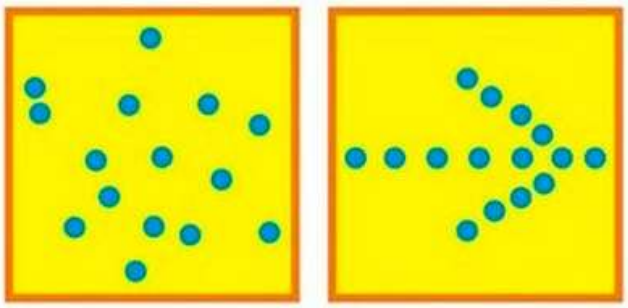
In addition to the term integration, the term synergy is now widely used to describe collaborative relationships in a variety of industries. Integrating to obtain a logical whole is a little different in terms of synergy the level of synthesis is high. That is, synergy focuses not only on the overall outcome but also on the effectiveness of cooperation between the two sides.

Synergy is a popular concept used by marketers, managers, linguists, economists and educators. This modern word is used by everyone from sports teams to cottage villages without fully understanding its meaning.

To understand the essence of the term synergy, we turn to history. The term "synergy" is derived from Greek and means "syn" - "together" + "ergeia" - "work, labor, activity", i.e. "joint activity" or "joint action". The term synergy exists in many European languages, for example, German and Italian. Historically, the word has passed from German to Old English. According to the Etymological Dictionary of the English Language, the first new English document on the term “synergy” dates to the 1650s. The term synergy was used in everyday speech and meant “collaboration” [4.B.546]; that is, the effect of an action made by several factors together is greater than the effect of an action made by each factor individually. Alternatively, 1+1=3, i.e., a result is greater than the sum of its parts. For example, it is not possible to create an orchestra-played symphony because of the individual performance of each musician. The word “synergy” should not be confused with the word “synthesis”. Synthesis also means bringing individual elements into a set. In both cases, the final result properties differ from the initial components (constituents). However, in synthesis, integrity is more important, and in synergy, the addition is quality, or the “fifth wheel” that emerges seemingly from nowhere (actually from the right combination of elements) [6].

The term synergy is used in various fields. For example, the concept of synergy is important in religion, where it is understood as a joint aspiration for spiritual perfection between man and the creator. In other words, the spiritual perfection of man is always the result of co-creation.

Synergy is also important in management and marketing, as it allows optimization of the interaction of resources. For example, it would be expedient for a marketing company to use several directions and funds that simultaneously enhance the effectiveness of mutual benefit, rather than insisting on a single communication channel. When networks are in a state of chaos, that is, each operates on the basis of specific principles to achieve a result, the synergy of the networks is the activity required to achieve a more effective result than the previous one [7] (Figure 1).



a) b)

Figure 1. Reflecting Chaos (a)and Synergy (b).

In 1896, Henri Mazel coined the term “synergy” in his work “La Sinergiesociale” on social psychology. He argued that Darwin's theory of the collective evolutionary engine could not explain "social synergy." He emphasizes that achieving higher civilizations is the work not only of the elite but also of the general public, but that in this matter, the participants of the two social environments must be governed through social synergy. Because the crowd, the woman, and the unconscious force, they cannot always distinguish good from evil [8.P.51].

In modern science, synergetics was formed as a science based on the term synergy. In the formation of a new system in science, some of the order parameters in self-organization can be rejected, and some can be replaced or accepted by others. These new ideas serve as order parameters in the knowledge system [9.P.272]. The cause of disorder in open, unstable systems is the instability of the system [10.P.48]. As such, unstable systems move from one state to another, and different patterns of motion emerge. These motion models subdue all the system elements and lead to the formation of a new structure. These motion models are described as order parameters in synergetics [11.P.41]. The order parameters are formed by the movement of the system elements as a result of mutual cooperation, and the new order leads to the formation of a new structure in the system. Similarly, fluctuations affecting science (Latin fluctuation - oscillation, random deviation) play an important role in creating the new order.

According to synergetics, new epistemological principles (Greek epistemology - scientific knowledge, science, reliable knowledge) apply in the system of science. Science is also self-organizing, in which chaos and order follow. Notably, the complication of science occurs as a result of transformation. The so-called crisis in science proves that it is moving to a new system. According to synergetic principles, science has order parameters and the elements of science follow the principle of subordination in cases of bifurcation. Science as a system is not a simple sum of different fields. Perhaps all areas of the science system interact with each other as parts of a whole. A new harmony emerges between the whole and the parts. The result is a new

integrative alliance that can be seen in the emergence of interdisciplinary sciences as a result of integrative processes in modern science, the convergence of natural and human sciences, and the application of values in scientific research.

Synergetics is an interdisciplinary field that explains the formation and self-organization of models and structures in open systems far from thermodynamic equilibrium [12.P.686].

The term "synergetics" was used by German theorist-physicist German Hacken in a lecture at the University of Stuttgart in 1969, but before that, the English physiologist Ch.S. Sharrington (1857-1952) first integrated the interaction of the nervous system (spinal cord) into the control of muscle movement. Such action is, of course, present in the processes of self-organization.

Convinced that both analytical and numerical approaches were limited in solving nonlinear problems in the practice of complex systems research, Zabusky concluded in 1967 that a single "synergetic" approach was needed, meaning "... traditional analysis and the use of numbers together" [13.P.56]. The term “synergetics”, which is close to the modern concept, was introduced by German Haken in 1977 in his book Synergetics [14.P.3].

Synergy initially served as the basis of the modern term “synergetics”. Clearly, the connection between synergetics and synergy is not accidental: German Hacken, one of the creators of synergetics, explains that this connection was originally associated with the name and idea of the new science he founded: “I chose the word synergetics at that time. I was looking for a word that means joint activity, common energy to do something... ” [15.P.53].

The concept of synergy is defined using the words “togetherness” and “energy”. In revealing the meaning of synergetics, synergy is used with almost the same meaning. As G. Hacken writes, “In synergetics, the interaction of many subsystems is studied, resulting in a single structure and corresponding functions” [14.P.15]. One of the main factors of synergetics is the interactive process of energies, the “joint” direction of energy to achieve a double effect.

Having studied a number of ideas about the application of synergy in different fields, we have attempted to understand the meaning of the terms synergy and synergetics. In the education system, as a result of the synergies of disciplines, new sciences are emerging, and many aspects still need to be studied. Today, there are economic synergetics, synergetic management, social synergetics, legal synergetics, psychological synergetics, pedagogical synergetics and others [16.P.14]. From the middle of the twentieth century, synergy began to manifest itself in the example of the educational institution. For example, in the Russian Federation in 1988, the Synergy Business School was established and later expanded into the Moscow University of Finance and Industry. The university trains individual specialists in more than 100 programmes and focuses on practice in teaching students [17].

Technical educational institutions also work in cooperation with manufacturing enterprises. The collaboration focuses on summer internships, coursework, diploma projects, and master's dissertation topics. Professors and teachers have established cooperation through their research work and various projects. Such partnerships are emerging as an integration of higher education and industry. If we analyse the work and tasks carried out jointly, it becomes clear that more interest is focused on higher education institutions. However, with such integration, it is somewhat difficult to train modern professionals who are mutually beneficial.

Synergetic integration implies that two systems work together. In doing so, both systems try to achieve the goal they have set for themselves and to achieving more than they have achieved on their own. Research and the scientific pedagogical literature have shown that synergetic integration is a multifaceted complex concept that represents processes in many areas. Synergetic integration in the laws of nature, in the socio-economic, political, and cultural spheres, in the education system via interdisciplinary and interdepartmental cooperation, in the training of modern engineers, in higher education and in production are vivid examples. In conclusion, it would be expedient for us to ensure a synergetic integration of higher education and production in the training of modern engineers.

CONCLUSION

In relation to the training of modern engineers, we attempt to define the term synergetic integration of higher education and industry as the manifestation of intellectual products created in each subsystem integrated into a whole to create a single educational space that includes the technical university, science and industry, demonstrating a strong potential for creative development of all subjects. This approach represents a collaborative creative activity to achieve quality and innovative training of modern engineers. This type of integration involves not only the training of modern engineers but also joint activities that carry out pedagogical, technical and socio-economic tasks in the interests of the two systems (higher education and production). Explaining the social and pedagogical significance of the synergetic integration of higher education and industry is an important task of our research work. Clearly, we emphasize that effective results cannot be achieved without ensuring the integration and implementation mechanism of integrated education and intersystem synergistic integration.

To ensure the continuity of synergetic integration, it is necessary to establish a systematic interaction of higher education and industry. Training, advanced training and retraining, as well as joint research, and the introduction of scientific developments, cover different areas of activity and manifest in different forms.

The synergetic integration of higher education and industry is, first, economically efficient; second, it can accelerate scientific and technological progress, and third, it can allow the rational use of the intellectual potential of science and higher education not only in one country but also in the world community. Summarizing, analysing, and putting this experience into practice can be of great benefit to all participants. Quality training of students in their chosen specialty can be achieved as a result of cooperation between higher education and industry. The impact of such collaboration depends on the form in which it is implemented, and the field of study provides the student with a wide range of knowledge, skills, abilities, professional growth and subsequent activities.
There are many forms of cooperation:

- educational-scientific-industrial complexes;
- branches and base departments;
- scientific and educational and engineering centres;
- targeted intensive (individual) student training systems;
- technoparks;
- centres for training creative work of professionals, students and creators, etc.

Each of these forms has its own characteristics in educational institutions, depending on the circumstances. Systematizing them, developing a mechanism of cooperation, and training of modern engineers will ensure continuity.

Notably, the main principle of synergetic integration is that higher education institutions and manufacturing enterprises have the same responsibilities in the process of training quality professionals. Moreover, the interests of both parties should be pursued. One of the main interests of the higher education system is to train modern engineers to work on scientific projects and conduct internships using the technical base and capabilities. First, we must consider the interests of the manufacturing enterprise - the search for, selection and creation of a database of specialists, the reduction of costs for their retraining and adaptation to production, and the training of the necessary specialists. Furthermore, the employer takes an active part in the formation of professional knowledge of specialists, the adaptation of graduates to the working conditions of the enterprise and the formation of "teacher-coaching" systems. In turn, students not only become acquainted with certain production conditions and master the basics of professional activity but also have the opportunity to obtain a job in their specialty after graduation from a higher education institution.

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