Greenhouses Automation in Developing Technological Developments

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ABSTRACT: The aim of this paper is to show the value of interdisciplinary in developing technological advances and the possibilities of complex educational projects in preparing students to meet future needs. It also poses the main criteria for the construction of advanced high-tech systems. A conceptual proposal for a transport system is given which adds to the known ones in high-tech greenhouses and also shows the connections between the subsystems. The interdisciplinary approach to the application of industrial decisions in agriculture is established. Every specialization relating to these fields has its own terminology, initial criteria for knowledge, design methods, algorithms etc. To synchronize these specificities, possessing profound and flexible, i.e. interdisciplinary expertise, is of great importance to the people concerned. Thus, one of the key goals of modern education is to improve the capacity of young people to think and learn, to enhance their knowledge and skills in order to create creative ventures and to generate ideas in the fields of technical and social progress, health care, protection, etc.

KEYWORDS: Automation System, Conveyor, Greenhouse; High-Technology, Innovations, Interdisciplinary.

INTRODUCTION

The modern world product market is characterized by the following properties:

- Highest level of producers 'competition;
- Hard struggle to survive;
- Continuous increase in research in the field of high technology, high level of automation;
- Strong domain of information technology, an established international network of free and almost instant access to manufacturers' databases and catalogues;
- Continuous decrease in commodity market value with increase in quality;

Currently several teams that build high-tech ventures involve experts from various areas of science and technology. Every specialization relating to these fields has its own terminology, initial criteria for knowledge, design methods, algorithms etc. To synchronize these specificities, possessing profound and flexible, i.e. interdisciplinary expertise, is of great importance to the people concerned [1] . Therefore, one of the key goals of modern education is to improve the capacity of young people to think and learn, to enhance their knowledge and skills in order to create creative ventures and to generate ideas in the fields of technical and social progress, health care, protection, etc.

General algorithm for inventive problem-solving:

Technical advances are realized with a different functional intent and/or higher quality parameters at the design stage of original products and subsystems [2]. The general creative task-solving algorithm is shown in Fig.1.

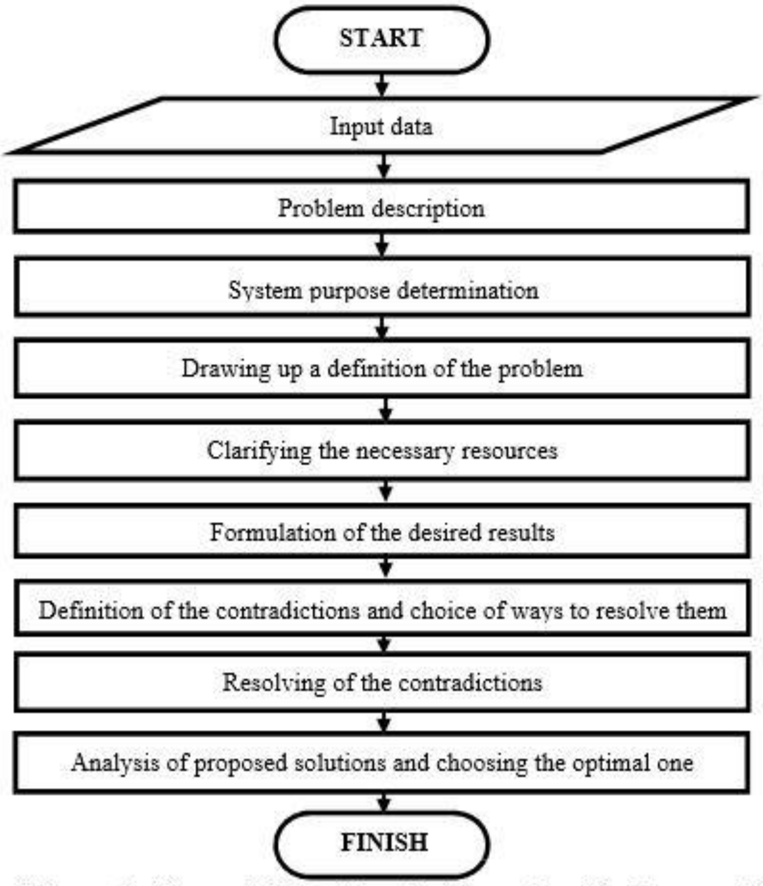

Figure 1. General Algorithm for Inventive Problem-solving.

The algorithm shown above includes the following basic steps:

Input data: a prototype (or an actual object), basic prototype feature, prototype benefits and drawbacks (unwanted effects), expected outcomes;

• Definition of the issue, using simple real-world categories-case, space, time and interrelationship. Stated says:

- "What is happening" (the actual physical activities that will occur in the system under consideration);
- "Where it happens" (a specific part of the system – a process or an element);
- "When it happens" (a particular action or the moment when an undesirable action takes place);
- "Why it occurs." At this point the need to produce a new revolutionary product is grounded;

• Certainty of the purpose of the program where identification of deficiencies occurs;

• On the basis of the above definition, the problem is described in one sentence containing the answers to the questions in the definition of the problem;

• The resources required to solve the problem are identified;

• The desired final solution is formulated;

• The contradictions that may occur in the process of solving the problem are established;

• Ways to solve the contradiction are specified;

The decision about the need of new product design is formulated as a technical proposal [3]. A well-founded and precisely measured study of income and redeemable investments will follow the final decision.

Design of non-typical subsystems and devices:

Design is a dynamic iterative method that involves several informal choices. Project starts with the development of the product concept as a framework of collaborative design solutions.

Input data: Feasibility study findings, design terms of reference.

The design of non-typical subsystems and devices involves the following steps:

• Analysis of the terms of reference, providing a conceptual structure;

• Decomposition of the products into subsystems;

• Specification of the project's quality criteria;

• Analysis of the shared appropriateness of all subsystems in compliance with agreed general design solutions;

• Analysis of the results and corrections.

Conceptual proposal for an automated transport-storage system for greenhouses:

EU Member States and regions are designing their rural development policies on the basis of their territorial needs and addressing at least four of the following six specific EU priorities:

• Promoting knowledge transfer and innovation in agriculture, forestry and rural areas;

• Enhancing the profitability and productivity of all forms of agriculture and promoting new farm technologies and sustainability;

• Promoting resource efficiency and fostering the move towards a low-carbon and climate-resilient economy in the farming, food and forestry sectors;

• Promoting social inclusion, poverty reduction and rural economic growth.

The authors intend to explore the possibilities in greenhouses to improve efficiency, profitability and cost-effectiveness of quality produce production.

Pre-study of the state of the art:

Greenhouses offer the perfect setting for growing many types of plants, whether they house tomatoes, fruits, or vegetables that the farmer can track and manage throughout the year [9]–[12]. It helps producers to break out of the seasonal cycle while buyers are confident that otherwise seasonal goods are available year-round.

Greenhouse benefits:

• Greenhouses are structures that enable the cultivation of fresh agricultural products (such as fruits, vegetables, flowers, etc.) in otherwise impossible to achieve values, quantities, and time periods while cultivating in the same open region.

• The greenhouse area is isolated from the outside world by a transparent cover that allows sunlight to pass through and provides plants and farmers with a wide range of services.

• Protection against natural events such as winds, rain, hail, snow, etc.

• Protection against damage caused by pests, whether large or small, by not allowing them to come into contact with plants.

• Efficient use of pesticides in a closed environment;

• The possibility of sustaining an environment other than outside, in order to improve the conditions for development.

• Rain prevention, and regulation of irrigation and fertilization conditions.

• Allowing work and harvesting under any weather conditions.

The literature review indicates that the efforts are aimed at developing automated and computer-controlled systems for real-time monitoring and regulation of the greenhouse environment to provide optimal conditions for growing crops to minimize the initial costs of water, electricity, fertilizers, etc. The plants are thus supplied with indefinitely optimum growing conditions and higher yields.

Greenhouses Design:

Every successful greenhouse project begins with a well-considered, practical design. As every farmer knows, different conditions are required for each crop to achieve optimum growth and yield. Conditions include daylight hours, rainfall, precipitation, quality of soil, maximum and minimum temperatures and many other environmental factors.

To accomplish this goal, various technological approaches can be sought, depending on the natural environmental conditions, the type of crop and the requirements of the farmer. Providing the plants with adequate conditions during the year involves the use of more complex technical systems that are typically more costly for installation and implementation as well. The key subsystems which can be used in a modern high-tech greenhouse and the specialists involved in constructing it are shown in Fig. 2. The agronomy specialists set the input data and the technical specifications to the project. Particular specialists create each and every particular subsystem. As seen at Fig. 2, the design process requires continuous coordination between the work teams in order to organize the subsystems. The control system can be both a local system complex as well as a device that regulates the entire smart greenhouse. It is important to carry out an economic feasibility evaluation and risk assessment as well as include a quality assurance mechanism before a final decision is made on commissioning the project.

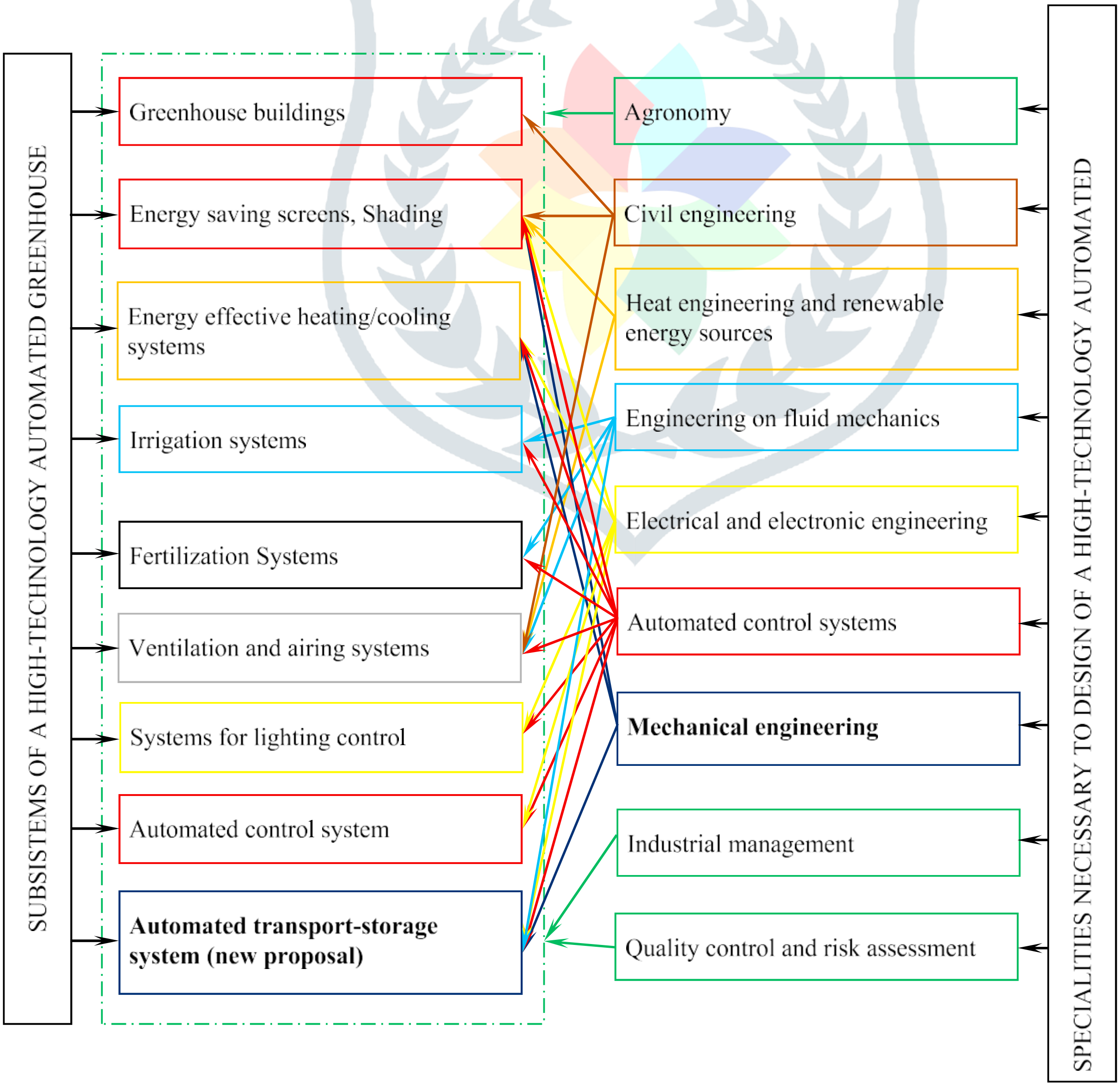

Figure 2. Subsystems of a Modern Greenhouse and the Specialists Involved In Its Creation.

Transport and storage devices and systems:

The reference summary shows that the emphasis in recent years has been on the design of greenhouses with high density, Fig. 3. The authors' idea is to extend the advantages of these facilities by moving some of the transportation and storage devices installed in production systems to automated greenhouse systems. The concept of the new product is developed on the basis of the input data as an aggregate of technological properties and parameters. The following must be taken into account for the effective solution of the task:

• Information on the devices that will interact with the new product;

• Information on the required changes and adjustments to the devices (subsystems) that will interact with the new product;

• Degree to which the parameters of the new product will influence the process parameters with which the new product is to be used.

Figure 3. Two vertical carousel rack systems

(a) Patented high density vertical growth systems; b) Three-story greenhouse built on the side of a public parking garage.

There are two acceptable types of arrangement for the transport-storage system. They're the first to break, Fig. 4a: The pallets are packed in racking (1) and fitted with the necessary slave equipment. A conveyor can also be added which supplies pallets to the working zone (3). The other one, shown in Fig. 4b, is of the carousel (1, 2), coupled with the position of service (3). Such moving up and down systems make effective use of the available space and can be used modularly as well.

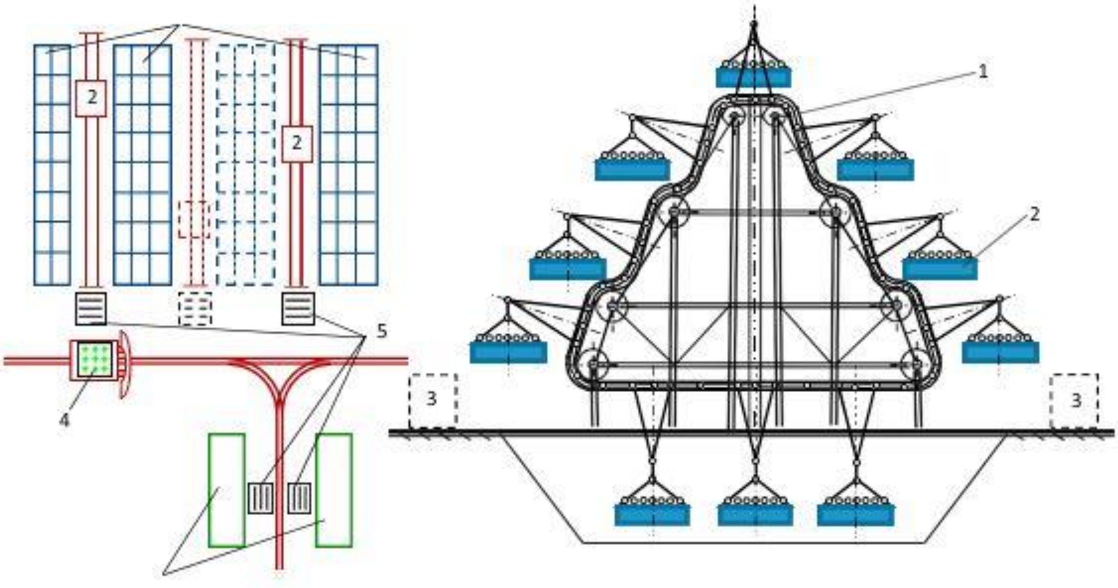

Figure 4. Transport-storage system arrangement:

(a) Separated transport-storage system: 1 - Racking system, 2 - stack cranes, 3 - working zone, 4 – automatic vehicle; 5 - automatic loading-unloading devices; (b) Vertical carousel rack system: 1 – Carousel conveyor, 2 – pallets, 3 - working zone

CONCLUSIONS

The modern method discussed above has marked the introduction of intensive farming to the idea world over. Greenhouse processing has become a modern industry focused on technology, requiring different forms of scientific equipment capable of reliable performance and profits. Based on the analyses performed by the authors, it can be inferred that developing ground-breaking projects is a complex process that involves specialists from different fields of engineering and science. The concept of a smart greenhouse with high productivity is provided as an example of innovative creation of a project. The authors reveal the ties between these subsystems and the specialists involved in their creation, after a detailed analysis of the subsystems that may be included in a high technology greenhouse.

The authors have suggested in the project discussed in the paper the inclusion of a new transport storage device that is lacking in the smart greenhouses of high density built up to now. After a very detailed economic analysis and risk evaluation it is seen that the final decision on the degree and application of developments should be made. The paper has shown that the transfer of expertise and skills used in manufacturing systems design is also possible in other sectors of the industry. While the participation of the students in multispecialty projects will improve their preparation, versatility and ability to address the demands of their potential engineering realization.

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