Smart Clothes for People in Smart Cities:
New Challenges in Education of Future Designers

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Abstract

The rapidly changing requirements of society for the competencies of fashion designers make it necessary to regularly transform and correct the curricula of the respective universities.

One of the important challenges in this area is the active introduction of smart clothing components into everyday life, which allows every resident of a modern city to enjoy all the benefits of an intelligent environment.

The need for smart clothes especially increases during a pandemic time, since these clothes allow continuous monitoring of the state of the human body and the observance of social distance.

However, the traditional approach to education of the clothing designers does not support sufficiently studying the mathematical foundations of developing algorithms for the functioning of such clothing.

The educational process should provide in-depth knowledge of artificial intelligence methods and understanding the principles of operation of complex information systems including the special features and characteristics of software and hardware.

Particular attention should be paid to the possibility of smart clothes interacting with other devices in the urban environment through the Internet of Things.

The Department of Clothing Design Technologies of the Ufa State Petroleum Technological University has accumulated some experience in adapting curricula for clothing designers to new conditions of creating clothing for people in smart cities.

The educational programs include disciplines, united in three modules:

- a module of mathematical foundations for constructing algorithms, on the basis of which the components of smart clothes solve the assigned tasks,

- a module for studying the properties and characteristics of software and hardware of smart clothes,

- a module that provides an understanding of the network interaction of smart clothes with an intelligent environment in the framework of the Internet of Things.

The combined curriculum can be considered as the result of information technologies incorporation into the interdisciplinary education focused on the balance of functionality and visual art.

The authors believe that the completed adaptation of curricula can be considered as the first steps in forming the educational system for fashion designers of the future.

Keywords: *smart clothing, Internet of Things, curricula adaptation.*

1. Introduction

Traditional approach to planning the educational trajectories for fashion designers is not typically focused on the new trends in clothing transformation such as harmonizing its use with the possibilities provided by the intelligent environment in smart cities. This is a serious omission. The needs of society are increasingly forcing designers to think about creating the so-called "smart" clothes able to solve a significant number of the problems for the wearer.

Smart clothing is essentially a fabric in which a variety of smart accessories (SAs) are embedded. The SAs can include sets of textile and / or non-textile sensors, electronic assets for processing their signals, means of audio or visual display of the information obtained in this way and, if necessary, decision support tools [1,2]. In turn, SAs can be classified as passive ones (they can only record the characteristics of the external environment and the parameters of the human body), active (forming the reactions to measured values) and very active or intelligent SAs (performing adaptation to changing external conditions) [2].

Today, many SAs transmit the data over computer networks or mobile networks. For this reason, we can talk about the appearance of the "Internet of Smart Clothes" as an important component of the "Internet of Things" (IoT) [3]. Items of such clothing communicate with each other and with other objects, including remote servers, in a common digital environment. As a result, the use of smart clothing produces unprecedented opportunities for solving global problems in a variety of areas:

monitoring of health status [4], age-related changes and rehabilitation [5], occupational safety [6] and others.

To deal with this new direction, modern designer has to understand specific architecture of smart clothing system. In particular it is described in [7] and represented schematically in Fig.1.
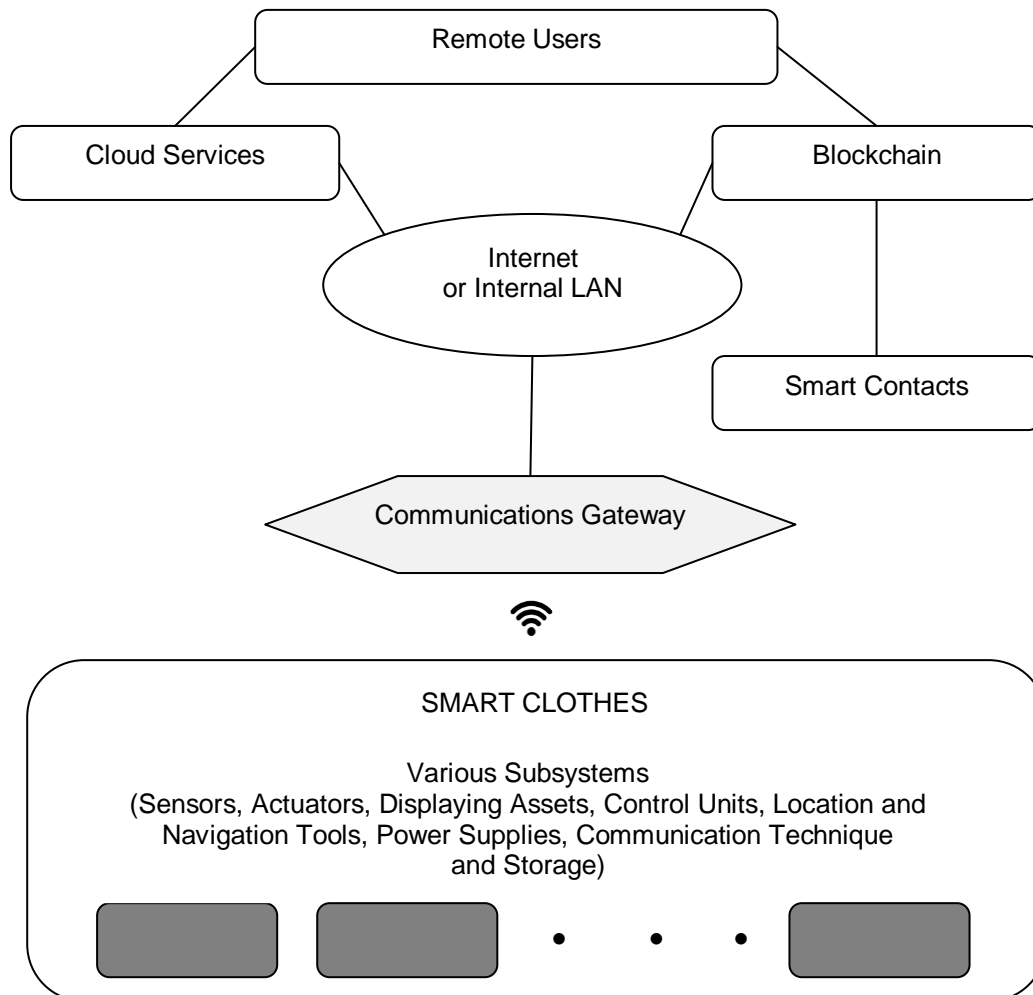
Fig.1. Architecture of a Smart Clothing System

Figure 1 demonstrates that developing smart clothing system requires universal knowledge not only of textile industry principles but also of IT-based (networking) structures combining definite hardware and software [8]. This is a challenge in education of future designers as the classical programs and curricula do not leave the place for such modifications.

We consider the possibilities of seeking a compromise in the matter.

2. Updating the educational process: towards new competences of designers

2.1. Procedure of a new curriculum development

When analyzing this problem at the Department of Clothing Design Technologies of the Ufa State Petroleum Technological University, we decided to apply three main methodologies of updating the educational process: the inclusion of new sections in the programs of existing disciplines, the inclusion of new disciplines in the curricula, and changes in the content of practical work of our students in industry (internship). Ultimately, the transformation was aimed at creating a new training profile for clothing designers.

The multi-step procedure of a new curriculum development is illustrated by Fig.2.

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┌─────────────────────────────────────────────────────────────┐
│ Existing educational programs for future designers: in-depth │
│ consideration. Approaches to updating the programs for        │
│ 'smart clothes' oriented training profile: search and         │
│ comparison of alternatives                                    │
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│ List of topics to be included in transformed programs: choice │
│ and justification                                             │
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│ Disciplines which volume should be reduced and disciplines to │
│ be modified: selection and harmonization                      │
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│ New sections in programs of modified existing disciplines:    │
│ optimal inclusion                                             │
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│ Modules of new disciplines: introduction in curriculum taking │
│ schedule of academic cycles into account                      │
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│ Internship: improvement based on cooperation with industry    │
│ and potential customers of smart clothes                      │
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│ New curriculum: analysis and review of outcomes               │
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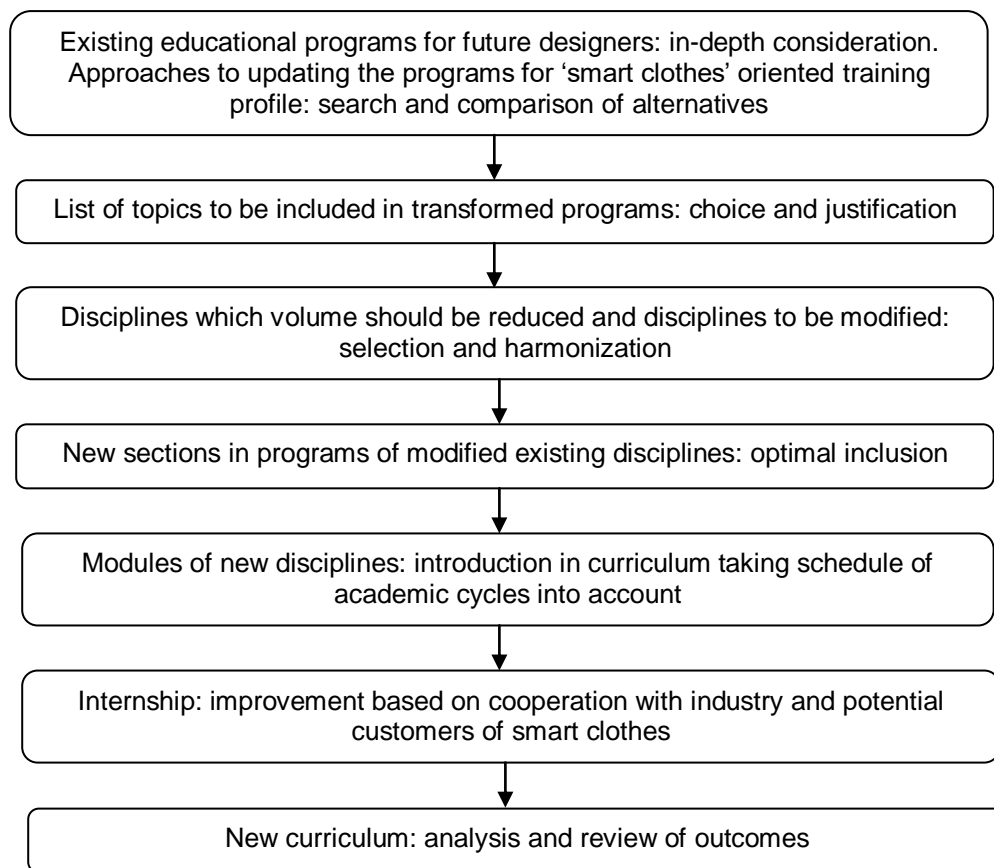
Fig.2. Procedure of a new curriculum development

All the steps of the procedure (Fig. 2) correspond to activities that involve a lot of methodological work. However the key point here is the close collaboration of fashion design educators and IT professionals. This is exactly the main answer to the challenge in the education of future designers.

2.2. New sections in the programs of existing disciplines
The traditional competences of a fashion designer should be based on a deep knowledge of the properties of materials that are typically used to produce the clothes, fittings and accessories. However smart (electronic) textiles are completely new kind of material, so their properties are not covered by existing academic disciplines. To fill this gap, it was proposed to include additional sections in disciplines related to materials science. These sections include a summary of the principles of operation of electronic devices (primarily sensors), implemented using smart textiles. Such an introduction helps students to understand further consideration of the features of the components of smart clothes that control the physiological parameters of a wearer, the characteristics of the external environment, as well as navigation / location of a human person in space.
Learning about smart textiles should be combined with information about the various ways of making garments - sewing, knitting, and others. Smart clothes should be fashionable, comfortable, and reliable. Thus, materials science disciplines need to be modified in order to educate future designers about the balance between the traditional properties of good clothing and its functionality as elements of the smart city environment.

2.3. Inclusion of new disciplines in the curricula
Adapting curricula for clothing designers to new conditions of creating clothing for people in smart cities requires more radical transformation of educational programs than simple inclusion of new sections in the existing disciplines.
The novel educational programs should include academic disciplines, united in three modules:
- a module of mathematical foundations for constructing algorithms, on the basis of which the components of smart clothes solve the assigned tasks,

- a module for studying the properties and characteristics of software and hardware of smart clothes,
- a module that provides an understanding of the network interaction of smart clothes with an intelligent environment in the framework of the Internet of Things.

At the same time, in order to meet the restrictions on the total number of academic hours in the program, it was necessary to reduce the volume of some existing courses. This approach was justified.

The first module contains such academic disciplines as "Fundamentals of Artificial Intelligence", "System Analysis and Data Mining" and "Mathematical Models of Intellectual System Components". The problem is that the students who study fashion design usually do not have a sufficient background in math. Thus, the new courses should include short introductions on mathematical methods and application – oriented sequels. In any case, here we are talking more about the outlines and concepts of modern methodologies than about the details of mathematical transformations.

The second module covers a set of hardware and software functions used in smart clothing. We consider various sensors, actuators, memory devices that are used to measure the necessary parameters, collect and store the desired information and present it in a suitable format. Since most of hardware components are now implemented as smart textile devices, the disciplines of the second module have many links to the material science courses supplemented by sections on smart textiles.

Study of software for smart clothing applications has a special place in the educational programs for future designers. It should be noted that basic courses on information technologies included in the traditional curricula for fashion designers are often too limited, so there is the necessity to start by expanding the general knowledge of the students in formation of the structure of the information / control systems, and then consider specific methodologies and tools for practical programming.

The third module aims to introduce smart clothes as part of the networks that can be found in smart cities and smart houses. The students learn the principles of web interaction and communication of the devices that make up smart clothes and other components of the network.

All the modules of new academic disciplines are supported by laboratory practice that allows the students to observe the functioning of smart accessories in real conditions.

2.4. Changes in the content of internship

Internship plays a very important role in the training of fashion designers. The students join the teams at industrial enterprises or organizations and contribute to the projects performed by professional companies. Such a form of education strengthens the theoretical base with practical skills and enriches students with adaptation to the real conditions associated with their future work. Also, in the process of practical work, students get the opportunity to assess the completeness and relevance of the achieved knowledge level, identify possible gaps and determine the trajectories of further study.

However, unfortunately, there are still few enterprises that develop or manufacture all the components of smart clothes.

For this reason, there is a problem with finding good places for practical training.

We have proposed the following two ways to overcome the obstacles.

(i) The internship is planned to be arranged on the basis of two organizations. The main place of internship has been chosen by a company meets the criteria of advanced technologies supporting the production of classic (traditional) clothes or accessories. The additional (second) place is IT-oriented institution where the student spends a certain part of the time. The assignment for the practice supposes individual work of the student under joint supervision of the specialists from both organizations.

(ii) The university creates special small innovative company that aims at producing smart clothes of the given type (for example, able to control the health parameters of the wearer) and involves the students in the implementation of various stages of the projects. This way requires some financial basis and the efforts of university staff, but it is very effective and allows forming the teams of students and their teachers who have a valuable experience of research and development.

Currently, we are actively working towards improving the content of internship for our students. We want the practice to give the students possibility to apply their knowledge of design, materials science and information technology in a real-world setting.

In addition, we are in the contact with potential customers of smart clothes, taking into account their requirements and desires.

2.5. Other enhancements of the educational process for future designers

The students who come to study in the new educational profile related to smart clothes are mostly highly motivated young people. They want to become professionals of the new type, combining the knowledge of fashion design principles with benefits of IT. Such a situation leads to the need to make many changes in the very nature of the implementation of the educational process. This process should be more dynamic, open up prospects for creativity.

We have concluded that updating the list of disciplines is not enough to create the new educational profile. It was necessary to choose more progressive forms of student's work and their contacts with the lecturers.

Among these forms, project-oriented classes and creative workshops were proposed.

Students were asked to form teams and start a project on a specific topic. The project assignments provided involvement of knowledge of both conventional clothing design and smart clothing hardware and software. The results of the project had to be defended before a commission of experts.

Within the framework of creative workshops, students themselves generated ideas for future projects.

The proposed new forms of implementation of the educational process were met with interest by the students. They are undoubtedly useful in terms of achieving high quality education.

3. Conclusion

In today's rapidly changing world, many approaches to the education of specialists, whose professions are very important for society, require revision. This idea fully relates to the education of fashion designers, as it is associated with a fundamentally new functionality of the product of their activity: the transition from clothing in the traditional sense to smart clothing. As a result, a fashion designer must not only have the skills and abilities for designing clothes and accessories themselves, but also be able to use the advanced achievements of information technologies.

This paper describes the authors' experience of modifying the curriculum for training designers to focus on developing smart clothing. In the modification procedure, three main methodologies were used: the inclusion of new sections in the programs of existing disciplines, the inclusion of new disciplines in the curricula, and changes in the content of internship. In addition, it became necessary to adjust the forms of the educational process in order to provide more conditions for the progress and creativity of students.

The authors believe that the experience they have gained can be generalized and used further to adapt a wide range of curricula to new requirements dictated by life.

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