Interdisciplinary Curriculum Projects at the Confluence of Science and Art: Project Development Experience and First Results

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The article presents a review of interdisciplinary projects developed and implemented during the last 5 years at the National Research University of IT, Mechanics and Optics (NRU ITMO). The overall concept of such implemented projects fits into the 3D domain scheme "Science-Arts-Techne" as a basis in designing integrated subject ontology. The establishment of an on-line exhibition "Museum of Optics" embracing a harmonious blend of artifacts and art objects with a science frame and up-dated information communication technologies (ICT) furthered new possibilities and prospects which are described in the article below. Copyrighted programs and examples of student creative works in such courses as "Optics and Arts: in the retrospect of time" and "Optics and Arts: theatrical projection" are presented.

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Key words: Interdisciplinarity, educational projects, interactive expositions, optical science, visual arts, history of science, ontology, information and communication technologies.

According to the canonical definition, "interdisciplinarity" is creating something new by crossing boundaries and thinking across them and involving more than one academic discipline. If speaking about crossing the traditional boundaries between natural science and humanities, then the even relevant standard approach involves looking at different science fields (physics, mathematics, chemistry, biology, etc.) "backward", i.e. engaging historical sciences. In case of the harmonious merging of specific knowledge and an understanding of this / that process, then a remarkable educational response is accomplished. However, this response would be repeatedly intensified through knowledge application of current wide- range problems in popular art or sophisticated technology which today's student community is encountering daily, but not the application of abstract theories or technical devices. The proposed curriculum projects illustrate the possible implementation of interdisciplinary principles within the framework of optics, visual arts and media-technology.

The fundamental principle of the described projects is the ontologically-renewed classical concept "Triangle Space" – three integrated domains– Science, Arts and Techne (Fig.1). During the formation of European universities seven disciplines of the classical trivium
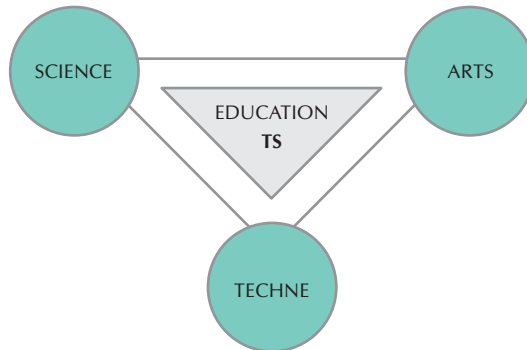
Fig. 1. Synthesis of Science, Arts and Techne as the Base for Interdisciplinary Curriculum Projects

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(grammar, logics, dialetics) and mathematical quadrivium (arithmetics, geometry, astronomy, harmony) were taught at "liberal arts" departments. Each of these science disciplines embraced elements of arts, where creative Muses were interlinked with specific rational knowledge. For example, arithmetics included the skill of counting, while music – science of chimes. Horoscopy was based on astronomy, while poesy was impossible without the science of grammatical forms.

Those sciences, investigating objects and phenomena irrespective of man, represent a logical investigation method of the world itself. Arts, inherently subjective and manifistated in the artist himself, not only reflect the irrational metaphysical aspect of knowledge, but also are bred by the most outstanding scientific theories and hypotheses. Besides, arts are continuously developing through more and more technological innovations. At the same time technology as such is regarded as the result of precise scientific computing and definite aesthetic perception.

Dating back to the so-called medieval concept: "Science of Liberal Arts," this diagram illustrates a linear dialectic interrelation of Science and Arts and finally Techne. This reflects the principal difference between previous hand-made activities and post-industrial society reality, where a wide range of advanc-

ing technological progress benefits exceed the real understanding of their applications.

On the other hand, the pattern Science-Arts-Techne (S-A-T) is practically optimal in designing interdisciplinary curriculum projects. The transfer of knowledge process (Translatio Studii — TS), as depicted in the following diagram, in both directions- clockwise and counter-clockwise (Fig. 2)- dynamically unites the three "top elements."

In the represented information stream 2a the following continuity can be observed: craftsmen achievements (technological innovations) reveal new possibilities for masters of arts, heritage of these masters become the source of inspiration for scientists, scientific discoveries become engineering process (technologies) in time. The 2b stream illustrates the following two facts: (1) the role of engineering problem-solving in ultimate research experiments and (2) the creation of individual and unique visual images under the influence of new scientific concepts. The fact is that aesthetic consideration is "the cornerstone" of the most brilliant engineering developments and there are numerous examples that prove this.

The mid-position within the framework of this Education Space furthers the possible new conception in designing interdisciplinary courses based on the ontological integrated understanding

Fig.2. Two-Direction Transfer of Knowledge Process within Pattern S-A-T
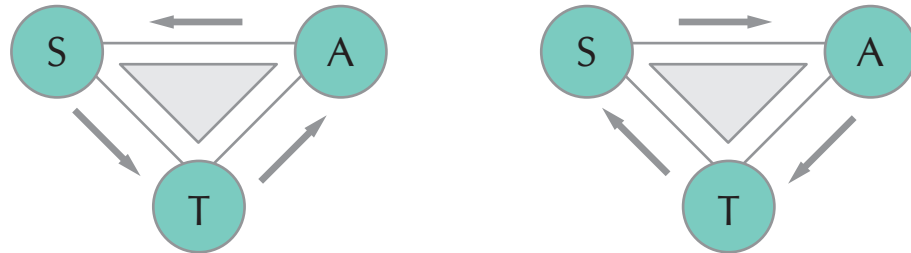
of the three elements (science-techne-media). Domain ontology itself as an up-dated tool of knowledge engineering generates the development of educational standards, curricula and course programs [1,2]. According to ontology, the maximum number of typological dichotomies of objects-concepts facilitates the integrated pattern S-A-T as the central core in an interdisciplinary curriculum project.

Ontologically designed interdisciplinarity involves numerous ideas and approaches inherent in different sciences and arts, and, at the same time, excluding chaos within this   framework, but, conversely, generating an absolute knowledge breakthrough. In this case, interdisciplinarity is the advanced interaction mode between science-arts-techne during ontological perception of our surrounding reality.

Another important issue is the implementation of the game-model approach (on-line, competitive) within the framework of educational interdisciplinary projects (EIP). Thus, in designing EIP a balance between cognitive, emotional and technological aspects should be observed.

Examples of ontologically designed EIP are "Optics and Arts: in the retrospect of time " and "Optics and Arts: theatrical projection" which are included in the portfolio of the National Research University of IT, Mechanics and Optics (NRU ITMO). The dominant in the first project is the historic-scien-

tific element, while in the second one (Fig.3) – the interaction between optics and visual art technologies. Both pilot projects have been executed not only in NRU ITMO but also at St. Petersburg State Academy of Dramatic Art.

The historic-scientific element in both projects embraces a description of Euclid emission (vision) theory which became the fundamental principle in Greek scenography- "design" of a performance event (such as light, environment, costumes, etc.). The so-called architectural corrections – entasis columns (Classical columns), curling of stylobates, distortion of well-proportioned statues and other artistic devices – were based on the emission (vision) theory. It should be noted that the Roman author, architect and civil engineer, Vitruvius wrote in his well-known work "De Architectura" (known today as "The Ten Books on Architecture") the following: "An architect should not only be an architect, but also an optician" [3].

A good share of the cognitive and research activities, described in EIP, is conducted in the NRU ITMO Museum of Optics. The cornerstone of this Museum was the first Russian educational exhibition in optics created within the framework of an innovative curriculum (http://www.optimus.edu.ru/ru) in 2008. The Museum exhibit displays are unparallel in their scope and uniqueness. The museum guide at a snap of his / her finger can "wake up" any exhibit display, and one can not only touch it but also conduct one's own experiment.

The Museum of Optics embraces the fundamental concept of creating an interactive interdisciplinary educational setting based on the Edutainment'a (education + entertainment) principle which would rekindle student and enrollee interest in the areas of laser physics, photonics and classical optics. Choosing such an interactive technology was based on world analogue museums of optics. Definitely, this technology of presenting instructional materials generates keen interest and is easily understood [4]. The exhibition display could be considered interdisciplinary as it includes not only elements of physi-

ology, anatomy, biology, information science, but also involves a classical scientific base which becomes available for students through interactive information communication technologies (ICT) and is illustrated in the exhibition of popular art and audio-visual objects [5].

This exhibition has been awarded prizes of the RF Government and St. Petersburg and two grants from the "Dynasty" fund. Numerous visitors of the Museum, representatives of American and European optical communities, have noted that this Museum is the best in the world [6].

**Fig. 3. Upper Ontology Structure of Interdisciplinary Course
"Optics and Arts: theatrical projection"**

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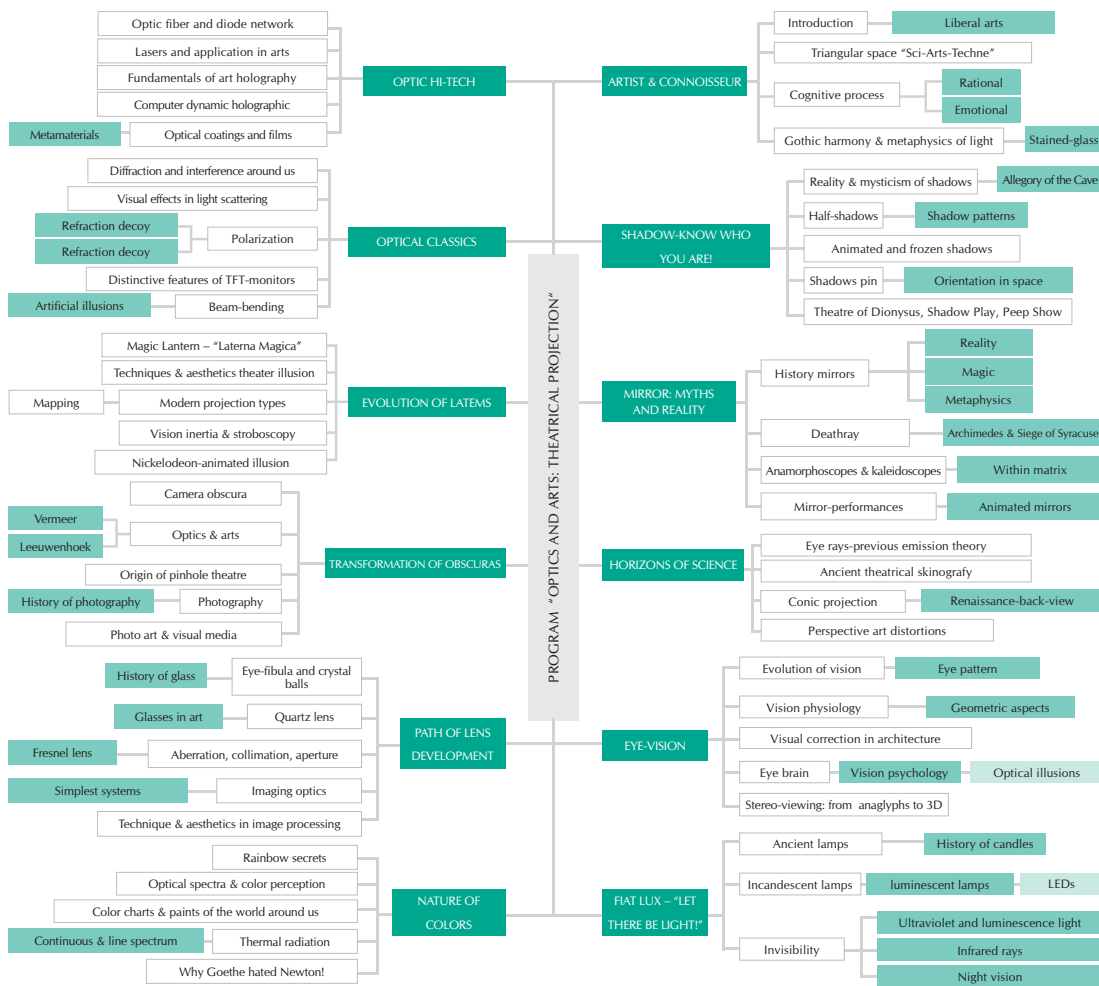
Interdisciplinary projects can include the creation of two interactive scientific-entertaining centers- "Intellect Labyrinth" and "Erudites". The first interactive entertaining museum "Intellect Labyrinth" was established on December 25, 2010 in St. Petersburg (http://www.labirint-um.ru/about/). There were more than 80 exhibit displays which vividly illustrated the function principles of different physical laws and explained the nature and origin of the most amazing and attractive phenomena of the surrounding world. All exhibit displays were designed in Russia in collaboration with various St. Petersburg universities and enterprises. Core exhibition "Intellect Labyrinth" was the projection of the concept "House of Entertaining Science" established in Leningrad in 1935 under the supervision of J. I. Peremann. Without doubt, these historically intertwining and high-quality exhibit displays made a breakthrough in the implementation of EIP. The second interactive scientific-entertaining center "Erudites" was opened in St. Petersburg in 2011(October 18) with the direct involvement of NRU ITMO experts . The major goal of this center was to submerge students into the amazing world of science, i.e. to prove that science does not simply consist of complex formula and terms but includes fascinating experiments which in an easy-to-understand way illustrate how our world is created and what miracles sophisticated technology can perform; how self-perception of objective reality is shaped and how the aesthetic diversity is associated with science studies.

At present, the National Research University (NRU) ITMO is implementing an interdisciplinary project under the Federal target program "Culture of Russia" in collaboration with the Russian Museum and State Hermitage. Within the framework of this project an IT Support Center for cultural institutions will be established on the basis of NRU ITMO . This Center will embrace all the outstanding achievements of modern arts, science and technology in one. The project concept involves the combination of a modern twist and historical retrospect of arts, science and crafts domains through sophisticated ICT, applying digital images of valuable amenities and holographic images for museum artifacts. The project target is to create an outreach culture environment based on an expansive presentation of cultural object within an education and popular science context. This Center will be equipped with the most sophisticated laser and multi-spectral equipment for continuous monitoring, fact-based certification and restoration of object d'art.

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