

**Lab of
Tomorrow**



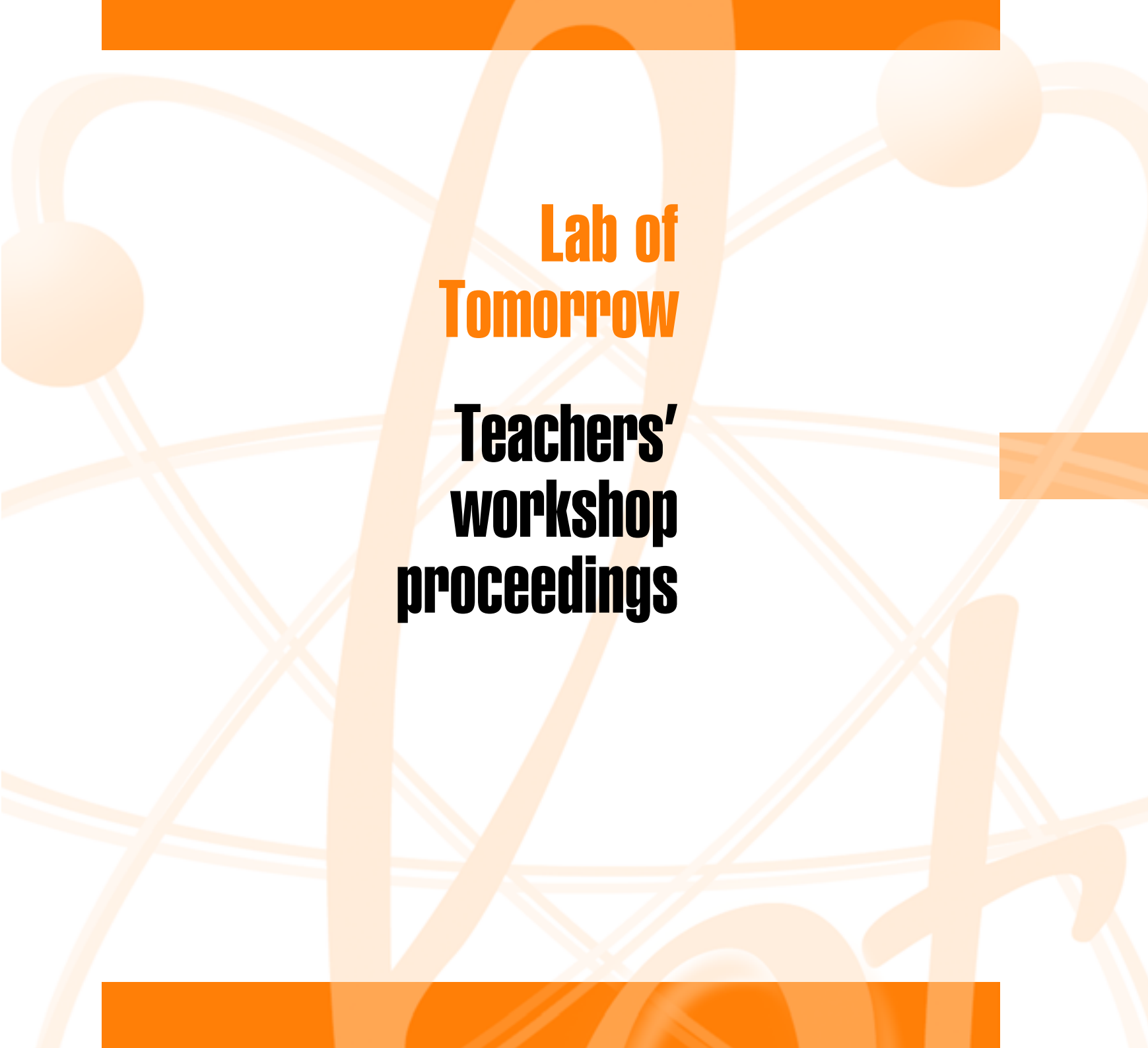
**Teachers'
workshop
proceedings**



**Ellinogermaniki Agogi
Pallini, Attica
April 6-8, 2002**



Supported by the European Commission

The background features a complex network of thin, light-orange lines that intersect and curve across the page. Several larger, solid orange circles and spheres are scattered throughout, some appearing as nodes in the network. Thick orange horizontal bars are positioned at the top and bottom edges of the page. The overall aesthetic is modern and abstract, suggesting a theme of connectivity or a network.

Lab of Tomorrow

Teachers' workshop proceedings



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Teachers' workshop proceedings



Ellinogermaniki Agogi

Pallini, Attica

April 6-8, 2002



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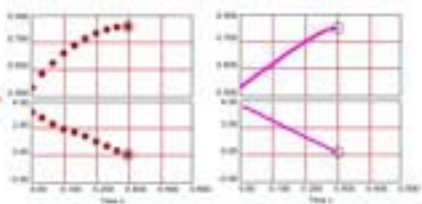
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Preface

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Lab of Tomorrow project represents an ambitious approach of implementing emerging technologies in secondary education science teaching. The main aim of the project is to utilize the capabilities of modern technologies, in order to allow students to link as much as possible science teaching with their everyday activities. As science deals with the study of nature and the surrounding world, teaching science cannot be separated from daily experiences. In the Lab of Tomorrow project the re-engineering of the school's lab is proposed by developing a new learning scheme based on the production of computational tools and project material that allow high-school students to use every day activities to conduct sophisticated experiments, experiencing the applicability of the theoretical background given at school. The objectives of the Lab of tomorrow project are the following:



- Development of a pedagogical framework that will allow the successful application of the emerging technology in everyday learning.
- Enhancement of constructivist approach in science teaching.
- Development of new educational tools and learning environments.
- Equal and parallel development of pedagogical and technological innovations.
- Development of a concrete evaluation scheme of the educational and technological aspects.

Hi-tech instruments capable of conducting extremely demanding and sophisticated measurements are already available in the market. Unfortunately, there are not many cases where such technologies are used for educational purposes. The involvement of the pedagogical community in the development of innovative technology is relatively small. Lab of Tomorrow project introduces innovations in secondary school pedagogical practice in an attempt to fill the gap. The aim is to design technology with educational targets and criteria.

Within the framework of the project wearable technology, intelligent clothes and tools have been developed to serve this goal. Specifically a series of "artefacts", called **axions**, have been produced which will allow students to conduct specialized measurements, expanding the experimental capabilities of the school laboratory. The axions, embedded in clothes or objects are used for the recording of user's physiological parameters or other experimental data. The data collected by the axions are presented using advanced programming tools all integrated in Lab of Tomorrow's User Interface. The axion prototypes and the User Interface will be presented more analytically in subsequent sections

of this publication.

The successful realization of the project presupposes close cooperation between all technologists and pedagogues. The aim is the pedagogically effective use of technology in secondary education. The technology should meet the expectations of the educational community and in order to do so, the partnership believes in a parallel evolution of the technological and the pedagogical pathways and the close collaboration between educational and technological experts. The success of the project depends not only on the quality of the innovation proposed and the extent to which teachers can see direct benefits for their own work, but also on how well a working partnership between pedagogical and technological experts is established and fostered. Through the effective training, the pedagogical and technical support, the active involvement in the project's progress and results, the Lab of Tomorrow project aims at developing a productive collaboration between teachers and experts in the field of education and technology.

The above arguments indicate the significance of **Teachers' Workshop** in Lab of Tomorrow project's evolution. It was a major contacting event between the technological and pedagogical partners expressing their close cooperation and the ideas of productive collaboration that govern the implementation of the project. It took place at that time period where the initial version of the new tools, the axion prototypes, was available for testing in real pedagogical environments.

The aim of the **Teachers' Workshop** was to familiarize the teachers of the participating schools with Lab of Tomorrow's approach. It initiates the teachers' training phase of the project. During this workshop the axion prototypes and the User Interface were



presented to all participants and teachers had the chance to investigate and test these prototypes. Teachers had the chance to report appropriate modifications for the user-friendliness, adaptability and functionality of the systems. The evaluation methodology of the project was presented analytically and there were valuable discussions on the pedagogical aspects concerning the implementation of the project in the school.

Additionally in the workshop there was a detailed discussion on the proposed pedagogical framework and on the necessary adjustments to the curriculum of each of the participating schools. The pedagogical, technological and organisational aspects of the introduction of the axions in the classroom were discussed so that a draft methodology was formulated.

Among the forty attenders of the sessions of this workshop there were approximately fifteen teachers. These teachers represented the participating schools, namely the Helene Lange Gymnasium and the Phoenix Gymnasium in Germany, the Technical Senior Secondary School of Pininfarina in Italy, the Bundesgymnasium und Bundesrealgymnasium Schwechat from Austria and Ellinogermaniki Agogi from Greece.

The axion prototypes, the User Interface and the communication systems were presented to the participants by the technological partners from National technical University of Athens, University of Birmingham, COREP (Consorzio per la Ricerca e l' Educazione Permanente) and ANCO S.A. the pedagogical framework and the evaluation scheme of the project were presented by the University of Dortmund, while the implementation plan and the project's lesson plans by Ellinogermaniki Agogi. The detailed agenda of the workshop is available in the following pages

This booklet exhibits and is concentrated on the major aspects of the project that were presented in the workshop and it is considered to be a significant guide for the users who wish to experiment with Lab of Tomorrow's equipment.

Teachers' Workshop Agenda

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	Saturday	April 6, 2002
Morning Session	09.00	Welcome address <i>Prof. N. Uzunoglou</i> ICCS*
	09.10	Presentation of the Implementation Scheme <i>Dr. S. Sotiriou</i> EA*
	09.20	Presentation of the LPS <i>Dr. P. Tsenes</i> ICCS
	09.40	Presentation of the Communication System <i>Dr. F. Psomadellis</i> Anco*



Afternoon Session

- | | |
|-------|---|
| 10.10 | Presentation of the axion Ball
<i>Dr. R. Makri</i>
ICCS |
| 10.25 | Presentation of the Sensvest
<i>Dr. C. Baber, A. Schwirtz, J.</i>
UoB* |
| 10.50 | Break |
| 11.10 | Presentation of the User Interface
<i>Prof. G. Perona, S. Turso</i>
COREP* |
| 11.45 | Presentation of the Lesson Plans
<i>M. Orfanakis</i>
EA |
| 12.00 | Presentation of Teacher's Training Implementation Plan
<i>Dr. L. Viglietta</i>
COREP |
| 12.30 | Presentation of the Evaluation Scheme
<i>Dr. R. Tiemann</i>
UniDo* |
| 13.00 | Lunch Break |
| 15.00 | Axion Trials (1 st phase) |
| 17.00 | Discussion-Comments-Remarks |

Morning Session

Sunday

April 7, 2002

09.00	Recording of Problems
09.30	Discussion
10.30	Break
10.50	Axion Trials (2 nd phase)
12.30	Discussion-Suggestions for Improvements
13.00	Lunch Break
15.00	Axion Trials (3 rd phase)
17.00	Discussion-Conclusions (Input for the 2nd Collaboration meeting)

Afternoon Session

Monday

April 8, 2002

Morning Session

09.00	Presentation of the Reviewers' Report
	ICCS
09.40	Discussion on the Report
	Action Plan
11.00	Break
11.20	Technical Aspects
	LPS, ICCS
	Communication System, ANCO
	Axion Ball, ICCS
	Sensvest, UoB
	User Interface, COREP
12.20	Pedagogical Aspects
	Lesson Plans, EA
	Evaluation Plan, UniDo
	Implementation Plan, EA
14.00	Closing



*** Abbreviations**

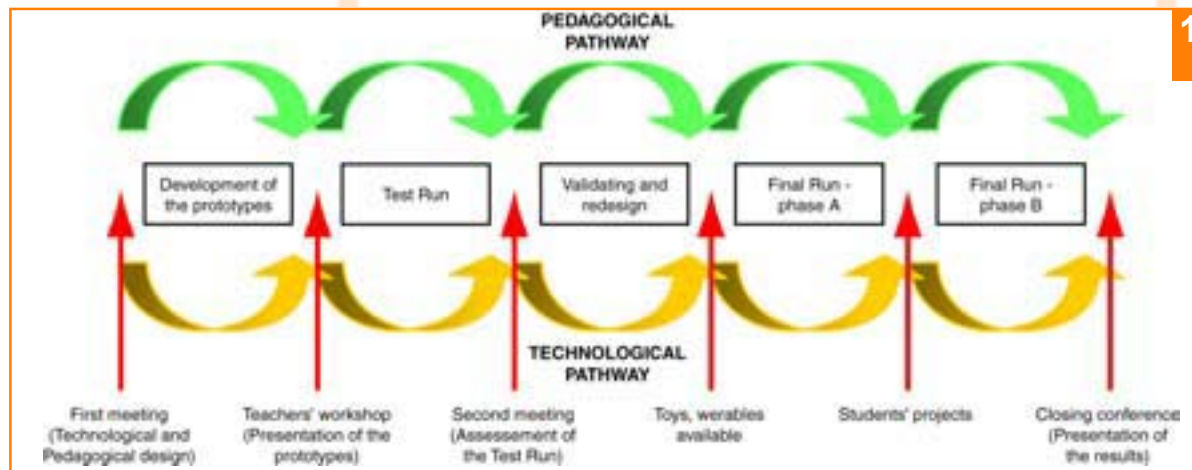
Anco	Anco S.A
COREP	Consorzio per la Ricerca e l'Educazione Permanente
EA	Ellinogermaniki Agogi
ICCS	Institute of Communications and Computer Systems National Technical University of Athens
UniDo	Department of Physics University of Dortmund
UoB	Electronic and Electrical Engineering Department University of Birmingham

Implementation Scheme

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According to the implementation plan as it is illustrated in Figure 1, the Prototypes development phase is followed by the Test Run phase. Teachers' Workshop was scheduled between the Prototypes development phase and the Test Run and it represents

Figure 1. Implementation Plan





Final Run - phase A

the project's major meeting between these two phases. Teachers' Workshop is part of the Teachers' training phase and thus Test Run is supposed to follow the workshop and the other training activities of the teachers.

After the Test Run phase that it is foreseen to last three months approximately, follows the period that the available toys and wearables are going to be redesigned according to the several recorded remarks of the users during the Test Run phase. The outcome of this validation and redesign period would be an improved version of axion prototypes that are going to be used for the Final Run phases A and B.

These phases are expected to be the core of the implementation of the project's philosophy. It is then when the developed tools and the educational approach of the Lab of Tomorrow project are going to be systematically tested and evaluated in the real school environment under real teaching and learning conditions.

During the Final Run phase A, students and teachers will follow the constructed lesson plans by using the already developed tools. The main purpose of this phase is to familiarize both students and teachers with the new approach and the new tools and prepare them for the final and most important cycle of the school-centered work, the five-month **students' projects** cycle (Final Run B). During the last phase the Final Run B students and teachers will be able to study any aspect they consider important by using the tools and the axions. Additionally, at this stage students will have the opportunity to propose new wearable sensors and ergonomic solutions, providing thus their input in the co-design of the toys and wearables. The capabilities of the axions and the User Interface will allow the adoption of the new ideas in short time. It is believed that students can come to view their involvement in this procedure as a craft, which rewards dedication and precision while at the same time encourages a spirit of creativity, exuberance, humor, stylishness and personal expression. Having been familiarized with the scientific method, students will have the chance to design and conduct scientific experiments, collect and display data, and write a report of their results. In this last phase constructivist approach is fully assimilated and the most valuable evaluation conclusions will be derived.

Axion Prototypes

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In the framework of the project wearable technology and intelligent electronics are used to introduce a new learning scheme in the secondary school science education. A series of artefacts, called **axions**, have been developed in order to achieve this goal. Each axion will consist of three main parts: a sensor interface, a main board (microcontroller) and a communication system. Two categories of artefacts have been developed: **toys**, axions that can be embedded in (and connected to) everyday objects and **wearables**, axions embedded in clothes. Both have communication capabilities, interacting with a base station.

The axions embedded in every day objects or in clothes are used in order to collect data during students' activities. The axions consist of sensors measuring specific physical quantities and communication units which allow data collection over extended periods of time. Important factors of their design are ergonomics and economy. Sensor data from all axions are transferred



wirelessly via the communication board to a base station for their storage. The stored data are presented by Lab of Tomorrow's User Interface, which is compatible with graphing and analysis software components so that students can easily investigate trends and patterns and correlate them with the theory taught at school. Artefacts like a ball with a 3D accelerometer embedded, represent innovative technological development within the framework of the project. A T-shirt (sensvest) with several wearable sensors is another state of the art deliverable of the product. Finally an LPS (Local Positioning System) system based on two CCD cameras is used for the location of 3D coordinates in space of chosen objects with high accuracy.

Local Positioning System

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The LPS (Local Positioning System) system is used to determine the position coordinates of an object in real space. The system is based on two digital cameras situated in perpendicular planes. The analysis and combination of the position information by each frame of both cameras results to the determination of the three dimensional position in space of the chosen object (Figure 2.)

Description of the system - specifications

The idea is to install the two cameras in a typical school environment in order to record some everyday school activities. The cameras should be installed in perpendicular planes in order to be able to observe the whole test area. Both cameras are connected to the parallel ports of a PC, which should be located nearby, in the premises of the school. The test area could be situated indoors or



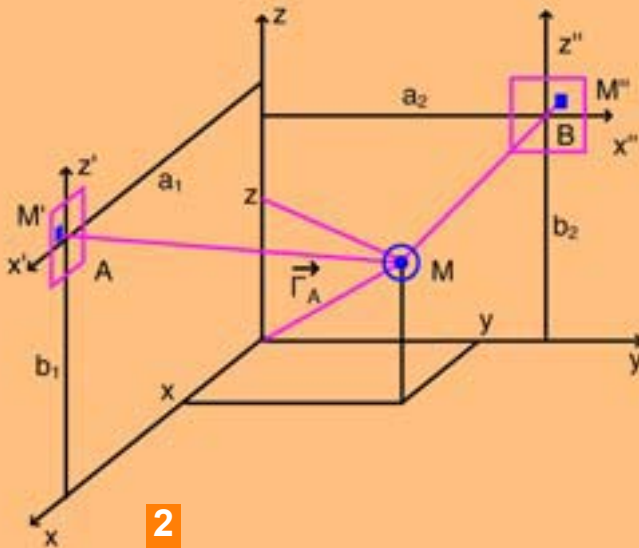
outdoors.

The inspection area of the LPS system is more than 5mX5mX3m. This means that the system is able to identify and record the position of an object at least within this area. The pixel analysis for the proposed cameras is 768X512 pixels. The accuracy of the system given the above field of view and the specific pixel analysis is approximately 10-15cm. Of course as the field of view increases, the actual accuracy of the system is deteriorating because the pixel size of each camera is constant. Target objects with diameter around 10-15cm can be successfully traced by the LPS. Better inspection accuracy and consequently tracing of small objects can be achieved by using cameras with higher resolution.

Figure 2. The two cameras are situated in two perpendicular planes. Basic geometry arguments as well as the information given by the images A and B, are combined to provide the real space coordinates of the object (M).

For indoor applications, the system could be situated in a sportshall. Alternatively any closed recreation ground with the above minimum dimensions could be used for the first series of experiments. It is advisable to start the series of experiments indoors since there would be better illumination conditions for the camera system. Such systems that involve these kind of experiments require constant illumination conditions for the field of view. Preliminary a sportshall should be used in order to be able to control as precisely as possible the illumination conditions. Once the system is tested and it is proven functional and within the required specifications, then all the series of experiments could be transferred outdoors (e.g an open court or generally the school playground). The outdoor experiments will be affected by the climatic conditions, which of course involve the illumination parameter.

More specifically, the system functions as following: The two CCD cameras should be positioned on the x-y, x-z or y-z levels. The cameras must preferably form a right angle between them in order to achieve the best accuracy. At least 2-3 meters between the cameras and the field of view are required for the proper focusing of the test area. Both cameras are connected to a PC, preferably the base station PC (Figure 3), which should be located nearby.



Authorized personnel (a trained teacher) should be operating the PC. When the target object enters the test area (field of view of the cameras), the teacher should activate the recording system. The system records the trajectory of the ball and the relevant players and the whole procedure is controlled by the authorized personnel who activate or deactivate recording at any time.

Two frame grabber PC cards are used for the recordings. Each camera has the ability to record 50 frames/sec. It is advisable to capture with the current system 25 active frames per second. This is due to the parallel frame grabber's architecture that should be utilized this way. Since both cameras must be synchronized and each frame must be recorded at the same time, the final capacity of the system will be reduced from the 50 frames of the individual camera to the 25. Additionally to the position of the observation object, the relevant time parameter will be recorded simultaneously for each frame.

For the presentation of the recorded frames a user-friendly software program has been developed. The software's basic concept is the following. The students are able to recover to the PC screen the frames from both cameras (Figure 4), which are referring to the same time parameter. Then the student will identify the target object in each frame and with the help of the mouse will mark the ball producing the relevant set of coordinates (x_1, z_1) , (y_2, z_2) . With the use of these coordinates, a simple software program based on mathematical analysis will produce the absolute coordinates (x_0, y_0, z_0) of the object. The coordinates are written on a file along with the time parameter. Having recorded all these parameters, the students are able to reconstruct the trajectory of a ball or the movements of a player or any other target object, through out the observation period.

Other parameters such as velocity and acceleration can be also calculated indirectly, based on the data recorded by the LPS system, with the use of other small independent software programs. These calculations will be very useful and they will be



Figure 3. Determining position in the workstation using the LPS cameras' frames.



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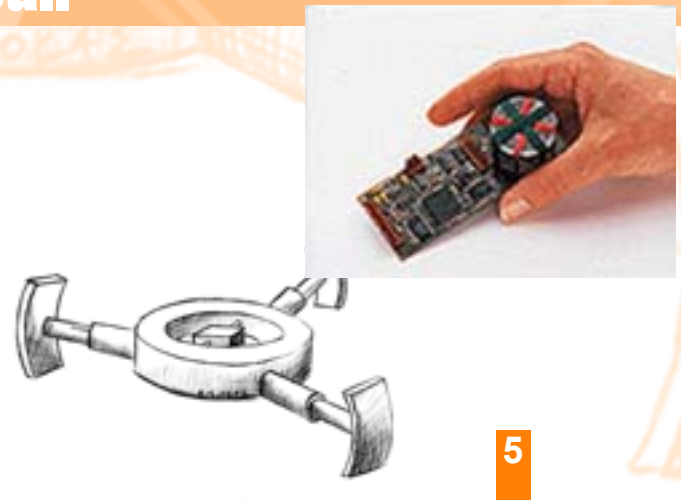
Figure 4. LPS cameras.

used as a reference for the same measurements that will be conducted through the axions embedded in the foot anklet and the ball. The LPS software program is not only able to reconstruct the trajectory of the observation element, but it can also be able to calculate and present graphically the other related parameters (time, velocity, acceleration etc.). The software program could be functionable autonomously or as a part of the whole software (User Interface) that has been developed in the framework of the project.

Presentation of the Axion Ball

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One of the most interesting axions that has been developed in the framework of the Lab of Tomorrow project is the axion ball. The ball has a three dimensional accelerometer embedded inside and it provides the magnitude of the acceleration of the ball. The design and the construction of such a ball with the relevant equipment embedded has plenty of peculiarities. The use of springs was the first design concept for the construction of the ball and the embedding of the accelerometer (Figure 5). Instead of the spring mechanism a foam type material could be used in order to keep the accelerometer and communication units in the centre of mass of the ball. The ball could be filled with this material and the axion would be placed in the centre protected and isolated from any external hazards. This design, although it had many advantages was proven to be very difficult to realise. The essential parameter that needs to be taken into account for the development of the axion ball is the stabilisation of the embedded systems in the centre of mass of the object. The ball must also be able to absorb



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Figure 5. Axion ball initial construction concept.



any imposed external forces. The ergonomics of the whole construction is very important for this specific toy because the ball will be extremely mechanically strained. In addition the axion systems embedded into the ball should be easily accessible by the manufacturer. This means that after the development of the ball, the manufacturer or any authorised end user should be in the position to extract repair or replace the axion without causing any serious damage to the ball itself.

The former requirements led to the choice of placing the axion systems within a plastic tube. As it can be seen in Figure 6, a hole has been opened from the one side of the ball to the other passing from the gravity centre of the ball. A rubber tube has been inserted into the hole and inside the rubber tube a plastic tube with a smaller length. The tube is placed and adjusted within the ball while a switch is used to activate or deactivate the data transmission process from the ball. After the installation of the axion into the tube the remaining open space will be filled with an anti-vibrating material (possibly a foam-type material) and the ball will be inflated. By inflating the ball, the two ends of the rubber tube are shielded and the accelerometer axion is secured inside the ball. This procedure does not affect the plastic tube because this tube has a smaller length than the rubber one.

The axion ball is able to transmit reliable acceleration data packets to the base station (Figure 7) every ten seconds. The manipulation of them in the user's interface provides information concerning the trajectory and the velocity of the ball.

Figure 6. Aspects of the axion ball prototypes, the tube inserted to the Ball can be clearly recognized.

Figure 7. The ball in this picture represents the latest version of the axion ball, the communication base station is shown at the right as well.



Presentation of the communication system

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The radio network architecture of the Lab of Tomorrow project is presented in this section. The main units of the communication system are the base station and the peripheral units. Namely all the components:

- a. The sensvest module, for the collection of the sensors data.
- b. The leg accelerometer module, which measures the acceleration and transmits its data to the sensvest via an infrared link (IR).
- c. The student transmitter module (Figure 8), for the collection of the sensvest data and their transmission to the base station via the radio network. The radio link communication with the base station is in the 433 MHz frequency band
- d. The ball accelerometer module, which transmits the acceleration data to the base station. The ball accelerometer sensor module (BASM), is inserted in the plastic tube



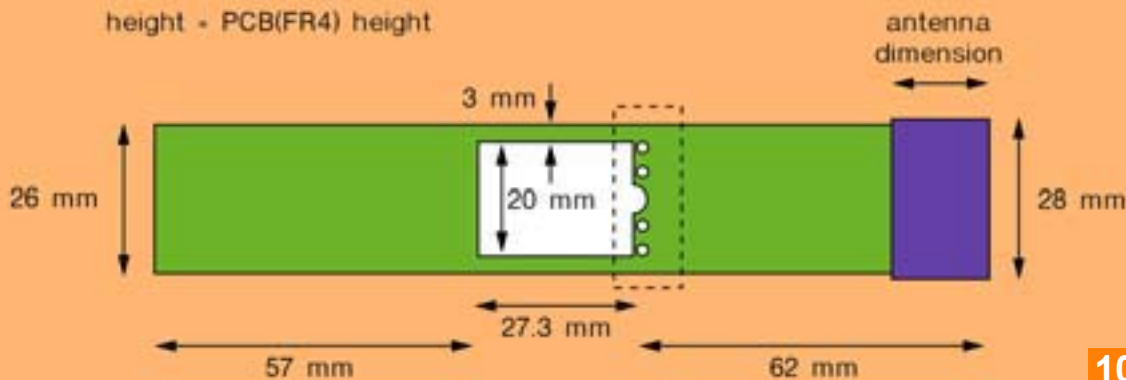
Figure 8. The student's transmission module (STM).

embedded in the ball (Figure 10). It comprises a 3-axis accelerometer, which measures the ball acceleration and a transceiver for the radio link communication with the base station in the 868 MHz frequency band.

- e. The base station which is responsible for the initialization of the system, the collection of all transmitted data from the peripheral units, the proper formatting of this data and subsequently its dispatch to the system workstation. The Base Station, as shown in Figure 9. is the master controller of the radio network
- f. The workstation, (PC) which collects and processes all system data. The workstation is connected via a serial port with the base station and it is used to retrieve the stored data from a database.



Figure 9. Base Station Module



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Figure 10. Aspect of the tube with the communication board embedded inside the axion ball.

Presentation of the Sensvest

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Intelligent clothing has a series of basic capacities that can be brought together in a flexible way to realize particular functions, with or without the use of add-on modules. In the framework of the Lab of Tomorrow project an intelligent T-shirt, named Sensvest, has been developed (Figure 11). The Sensvest is worn by the users and several sensors are used to record physiological parameters during the users' activities.

Various sensors are embedded on the Sensvest. A temperature sensor situated under the armpit, is used to record the body temperature of the user. A heart pulse meter sensor, attached at the user's wrist, is used for recording heart rate (Figure 12). In addition the Sensvest consists of accelerometers that provide high accurate body acceleration, arm acceleration or jumping rate measurements (Figure 13). The sensors are easily detachable from the cloth and thus the configuration of the sensors can be altered according to the specific experimental conditions. The Sensvest can be also

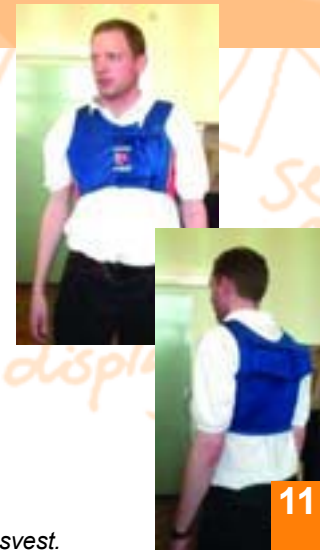
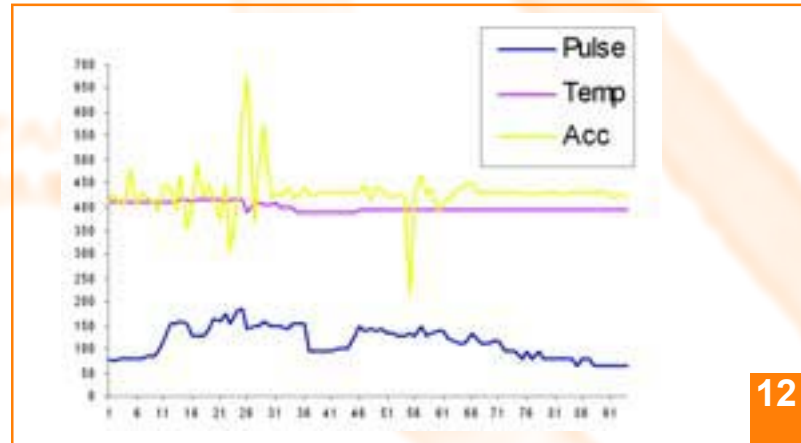


Figure 11. The sensvest.

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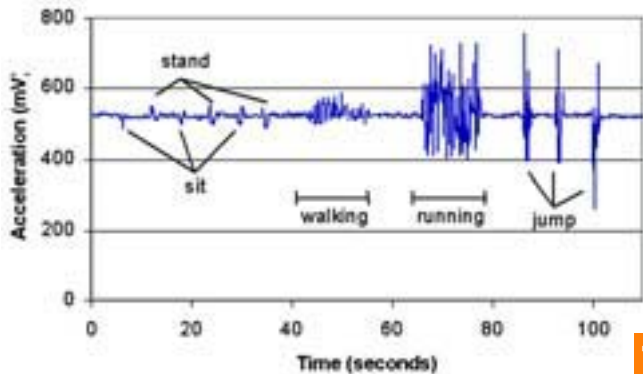
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Figure 12. Sample data of the temperature, heart pulse and temperature sensors

enriched with new sensors to expand the experimental possibilities. The data from the sensors are locally processed and stored by a microprocessor development board and then the appropriate communication system is used to transfer them to the base station. The last is interconnected with the workstation (PC) and the user's interface software is used for the manipulation of the experimental data by the students.

The communication board and local storage of data module that are used for the data transmission from the vest sensors to the base station are situated at the back area of the shoulders of the users.

Such choices for these modules as well as the exact positioning of the sensors on the vest are dictated by an ergonomic study. During the development of intelligent clothes, usability is an important issue. Intelligent clothing should not in fact disturb the user, but help him and expand experimental possibilities. The user should therefore fully understand them. The user interface should fulfil this usability item, by its design. Another important item is of course the



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Figure 13. Sample data recorded by the body accelerometer of the Sensvest. Several qualitative conclusions regarding specific activities can be derived by observation and analysis of such data.

user itself. He has to be protected and should not take any risk on wearing these clothes. The integration of the electronic parts needs a lot of research in order to make them completely safe.

An ergonomics survey investigated various parameters that are considered to be important concerning such a construction. By the analysis of the study six parameters, (Figure 14.) emotion, attachment, harm, perceived change, movement, anxiety is considered to play the most significant role in the development of the Sensvest. The aim is to increase comfort assessment of the Sensvest and thus in every new version of it much effort is put on improving the indications of these six parameters.

The research aims at making the product to become as much ergonomic and functional as it can be.

Clearly the prototypes of the project will be grounded in contemporary technology. However, it is proposed that the Lab of Tomorrow project might stimulate exploration and research beyond the current limits of software engineering and systems development, and continue the debate as to what is meant by the term wearable computer.



Figure 14. Ergonomics Study of the six parameters: emotion, attachment, harm, perceived change, movement, anxiety



Presentation of the User Interface

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The User Interface (Figure 15) is considered to be one of the most valuable Lab of Tomorrow's components. It aims at acting as an interconnection between the real world of the axions and the students' activities with the classroom environment. The User Interface encloses a database where all the data coming from the various sensors are stored and synchronized. It is the integrating unit of the axions since it correlates the data deriving from the different sensor components.

Apart from organizing and storing the incoming data the User Interface has another even most valuable role to serve. It is its role as a pedagogical tool that provides the links between science teaching in classroom environment and the real world. The User Interface must be designed in the most pedagogic functioning manner. The User Interface should reflect the pedagogical approach of the Lab of Tomorrow project. Students through a sequence of steps (Figure 16) involving data accessing, plotting



Figure 15. Aspect of the User Interface



Figure 16. Manipulating data with the User Interface.

data on a graph, creating a mathematical model to fit the data and relating the graph with the motions of the axions provided by the User Interface will have a deeper inside of the phenomena. The User Interface will help students recognize that the scientific method can be used to solve problems or to study phenomena in their everyday lives.

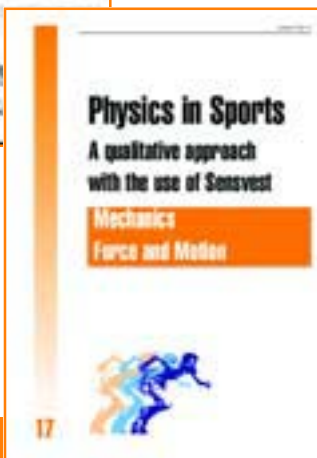
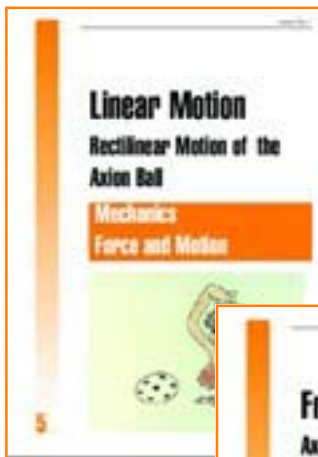
Presentation of the Lesson Plans

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A series of lesson-plans has been developed to be implemented in classroom during the first two cycles of the school-centered work. The lesson plans are in accordance with the science curriculum of the participating schools and are designed to utilize the experimental capabilities of the axions. The aim is to implement these lesson scenarios for the familiarization of the students with the idea of scientific investigation in order to reach the last stage of the work in the school environment. At the final cycle of the school-centered work students and teachers will have the opportunity to design their own scenarios for exploring phenomena in their everyday lives. These new ideas will provide input for the development of new artefacts.

A specialized structure for the Lab of Tomorrow lesson plans have been developed for the needs of the project (Table 1). Each lesson plan consists of two main parts; the first part of the lesson plan gives general information concerning the lesson. It is based on the





curriculum and provides details for the implementation in classroom. In this part information about the time duration, vocabulary, the tools and materials necessary for the experiment are given.

The educational aims of each lesson activity are specified and categorized in general and more specific didactical objectives. Finally the usual students' misconceptions on the teaching subject are presented to teachers in order for them to have a better notion on what students believe.

The second part of the lesson plans provides information about the pure educational phase of the lesson. This is the part where ideas to stimulate students are proposed and the experimental activities are described. Discussion, observation and analysis of data are proposed as well, while the expected conclusions that should be the outcome of the lesson are listed. In order to assist consolidation, a series of exercises and questions and further activities are proposed that are included in worksheet for the students.

A booklet containing the lessonplans that has been developed to cover the needs of the project. There are two main aspects taken into account for the development of these lesson plans. Firstly, the lesson plans have been developed based on simple experimental activities that are expected to be able to be carried out even with the first version of the axion prototypes. Secondly it is even more important that the lesson plans are adapted, as much as possible to the school curricula. Four lesson plans have been developed so far, namely:

- a) Rectilinear Motion with the Axion Ball
- b) Free Fall
- c) Horizontal Throw
- d) Physics in Sports

A draft version of worksheets based on the prementioned lesson

plans have been produced for the students as well. These worksheets contain proposed exercises, questions and tasks for the students and are going to be an assisting tool during the implementation of the project in the school environment.

Lesson Plans' General Structure

I.General Info

Duration:

- i) *Conventional Lesson*
- ii) *Experimental Activities*

Vocabulary

Tools and Materials

Aims and Objectives

Student's usual Misconceptions

II. Lesson Plan

Stimulation

Experimental Activities

Observation - Discussion

Conclusion Drawing

Consolidation

Questions

Exercises

Integration with other subjects

Table 1

Table 1. The general structure of the lesson plans.



Presentation of the Evaluation Scheme

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The evaluation scheme of the Lab of Tomorrow project was presented in detail to the teachers during the workshop. The evaluation of the project is going to be performed on three aspects: evaluation of student's learning, evaluation of the underlying pedagogical framework and ethnographic evaluation.

Evaluation of the student's learning. In assessing student's learning, student's engagement in science as inquiry is going to be primarily examined. It is believed that the activity of designing projects and experiments provides a powerful way for students to become meaningfully involved in scientific inquiry.

Evaluation of the pedagogical framework. The major theoretical issue underlying the project is whether the implementation of the emerging technologies (e.g. wearables) could offer a qualitative upgrade to the science teaching at the high school level. In such a case the introduction of technology would not act as a substitute of



the conventional teaching but rather as an add-on that has to justify its introduction in the everyday school practice.

Ethnographic evaluation. The project will take advantage of the different school environments across Europe and is going to investigate the attitudes of students and teachers of different cultures towards the implementation of IST in education.

The evaluation of the Lab of Tomorrow approach is based on well defined methodologies accepted by the educational community. The basic assessment tools that are going to be used for the evaluation procedure are the TIMSS videotape classroom study and ICT tests to record the attitude of students towards new technologies, computers and software tools. Two group of students are going to be used as an experimental group and a control group. The aim is to compare the tests' results between the two groups and thus investigate the degree in which the Lab of Tomorrow's approach contributes to an upgrade in Science teaching.

Figure 17 illustrates explicitly the time schedule of the evaluation plan of the project that was presented to the teachers. The evaluation of the project proceeds in parallel with the two final phases of the school-centered work. Several evaluation tests will be applied during these phases that will be combined with the video documentation material resulting to the evaluation report of the project.



Figure 17. The evaluation scheme, evaluation will proceed in parallel with the final run (phases A and B), valuable conclusions are expected to be the outcome of project's evaluation

Pedagogical Aspects

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Several sessions of the workshop aim at demonstrating the axions's use and capabilities to the teachers. The lesson plans with the certain experimental activities were presented to the teachers as part of their training.

In the framework of the Teachers' Workshop, participants had the chance to examine the axions and the systems themselves. The idea was to investigate axions capabilities and record their remarks, comments and suggestions on what they have been presented. The aim was to initiate a dialogue on the pedagogical aspect of the project. The feedback from the teachers and the users of the systems in general is considered as a very important parameter for the progress of the project and thus teachers' contributions are valuable. Lab of Tomorrow is an educational project and one of its most innovative characteristics is that advanced technological tools are designed and used for educational purposes. The former indicates expressively the weight that pedagogues' concepts have in the project.



In this spirit teachers were distributed with remarks sheets to fill. This input of remarks, comments and propositions, from all partners, concerning all the axion systems that were presented at the workshop, can be summarized to the following Remark Sheet

Usability

The ball should be easily used in an area with the size of a basketball court.

The set up time of all the axion systems should be less than 10 minutes.

The LPS must be able to cover a normal volleyball area.

All axion systems must be usable indoor and outdoor.

Data of all axion systems must be synchronized.

Wiring embedded on the vest.

The systems must be mobile (local storage of data).

Usefulness

The accelerometer of the ball must stand at least 25g.

The accelerometers should have an accuracy of 0.1g at least.

More than 25 frames per second are needed to measure position.

LPS should have zooming capabilities.

The interface must show the main data outputs.

Desirability

The ball must be usable in normal game conditions.

All LOT devices and systems should be acceptable by students and teachers.

The interface must be user friendly.

User Interface should provide multiple access configurations.

Integration in the User Interface of the objects' borders identification software, used for center of mass location.

User Interface should have a modeling section for theory and experiment comparison.

Moments of the workshop

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