EU COMMUNICATION OUTREACH IN NANOTECHNOLOGY: A FOCUS ON YOUNG AUDIENCES

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The QUESTION:

How can nanotechnology be effectively communicated to European young audiences?

1. INTRODUCTION

In order to identify an intellectual context to frame an overview of communication outreach in nanotechnology focussed on young audiences, it is important to carry out a literature review to screen what has been written, done and explored on communication of nanotechnology to young audiences so far. Accordingly, a set of documents, sources and works are analysed, to identify areas of agreement and areas of disagreement among scholars on this issue. This analysis will allow to identify what is known and what is not, and what are the areas of research and action on communicating nanotechnology to young audiences that can be explored.

1.1 NATURE of THE TOPIC

From a general point of view, "Nanotechnolgy" is the new frontier of technology in Europe and in the world: Nanotechnology is the development and application of materials and processes at the nanoscale – the scale of individual molecules. Nanomaterials are particles, tubes, membranes and other materials measured in nanometres. Nanotechnology gathers the scientific principles and properties of nanoscience, that can be understood and managed when operating at the nanoscale dimension, and applies them at technology level. Some nanotechnology applications have already emerged and many others are under development. Together, they are expected to impact the life of every citizen, perhaps as much as other technologies as electricity and electronics have done over the last century. However, as in any other field, some nanotechnology applications may be harmful as well as benefits. Therefore, informing and engaging the public about nanotechnologies are essential for the responsible development of this new frontier: as nanotechnology is mainly projected in the future, it is expected to involve young people, thus communicating to them is a priority. In fact, this early stage of development, when just a few applications have reached the market: therefore this is a critical moment for potential communication on nanotechnology. In fact, outreach, open dialogue and debate are declared to be key elements of the European approach to science and technology, where nanotechnology takes a very special place. In fact, information, communication and fostering societal debate on nanotechnology have already become an important part of many European policies. Therefore, it will be shown that: (i) communication on nanotechnology is critical for Europe and particularly European institutions, and (ii) young audiences are a priority. In this light, this paper will aim at **identifying how nanotechnology can be effectively communicated to young audiences.**

1.2 PARAMETERS OF THE TOPIC

First, literature review will carried out. Analysis will be carried out to explore what has been studied and done on communication nanotechnology addressed to young audiences. Minor attention will be dedicated to communication efforts of nanotechnology towards other audiences. For doing that, the basis of the proposed selection of literature review has been focused on four axes, described as follows.

1.3 BASIS OF LITERATURE SELECTION

(i) **EC policy documents on communicating nanotechnology**;
(ii) **theory of communicating science and technology to young audiences**;
(iii) **key-areas of nanotechnology to be prioritised in communication**;
(iv) **EC-funded projects on communicating nanotechnology**.

All these sources will be analysed to identify what are the most effective ways, tools and activities to communicate nanotechnology to young audiences, enabling to shape how contributing to design and implement effective communication activities and products on nanotechnology for European young audiences.

2. BODY: ANALYSIS OF LITERATURE RESEARCH

Framing the intellectual context to carry out a good literature review requires exploring the relevant research carried out in the field until now. Thus this section will study what has been written, done and explored on communicating nanotechnology to young audiences. Therefore research studies are gathered according to common denominators, splitting quantitative from qualitative approaches. In our case study, it is possible to group the following sources:
- EC policy documents (on principles, strategy and policy actions essentially);
- methodological research papers (on communication theory of science and technology);
- on-field applicative research (on key areas of nanotechnology to be communicated);
- on-field experiences (projects/activities/exhibitions/products carried out so far).

All these documents, sources and works will be analysed, to identify areas of agreement and of potential controversy among authors, enabling to identify what are those areas of research and action that should be developed. For doing that, common definitions, discoveries, approaches, methods, questions and recommendations are explored and taken into account.

2.1 Analysis of:
EC POLICY DOCUMENTS ON COMMUNICATING NANOTECHNOLOGY

Generally speaking, little has been written on how to communicate nanotechnology to young people. Still, in May 2004, the European Commission (EC) adopted the Communication "*Towards a European Strategy for Nanotechnology*" [1]and in June 2005, the EC adopted the Action Plan "*Nanosciences and nanotechnologies: An action plan for Europe 2005-2009*" [2]. These policy papers have defined a series of actions for the immediate implementation of a safe, integrated and responsible strategy for nanosciences and nanotechnologies. These documents have declared that a responsible approach on nanotechnology must address citizens' expectations and concerns and have asked the EU Member States to create the conditions for an effective two-way dialogue with the public, making a specific focus on young people.
In fact, current surveys[3] show that a large majority of the Europeans is not informed or engaged on nanotechnology. In part this is because most schools' curricula do not yet cover well this subject. Although "nano" words appear frequently in the media, the nanotechnology is poorly understood; some think of nano as a form of "magic"[4], others fear mainly the risks. Unfortunately, these misunderstandings and misperceptions about science are not isolated phenomena[5]. Although some of

[1] European Commission (2004): *Towards a European Strategy for Nanotechnology*, COM(2004)338; EC, Brussels, 2004, at: http://cordis.europa.eu.int/nanotechnology/actionplan.htm
[2] European Commission (2005): *Nanosciences and nanotechnologies: An action plan for Europe 2005-2009*, COM (2005) 243 , EC, 2005, Brussels, at: http://cordis.europa.eu.int/nanotechnology/actionplan.htm
[3] European Commission (2005): *Nanosciences and nanotechnologies: An action plan for Europe 2005-2009*, COM(2005)243, Brussels, 2005
[4] European Commission (2001): "Europeans, Science and Technology" in *Eurobarometer* 55.2, Brussels, December 2001;
[5] European Commission (2006): "Europeans and Biotechnology in 2005: Patterns and Trends", in *Eurobarometer*, Brussels, July 2006

the problems of communicating nanotechnology depend on its special characteristics – for example, the invisible nature of nanotechnology and its novelty and revolutionary approach- the experience of communicating other new technologies shows that their introduction to the public needs to be presented in a clear and simple way, taking into account public needs and interests, preferably from the beginning of the development of this technology.
Therefore, there is now clear agreement among communication experts that traditional approaches to communicating with the public about science and technology, called the “deficit model": this model says that the public must understand science to accept it. This model is no longer working well[6], and seems completely obsolete[7]: this can be summarised saying that for communicating science and technology is more important the "*scientific understanding of public*" than the "*public understanding of science*"[8]. Consequently, it is possible to see how European institutions such as the European Commission has moved from top-down to bottom-up communication approach on nanotechnology, promoting a "dialogue" model[9] promoting science communication as a multi-way model between specialists and non-specialists[10]. This dialogue is defined as multi-way exchange of information rather than a one-way communication[11]. It describes a process that enables each party to share, listen, be listened in full respect of the other's points of view. This dialogue model of communicating nanotechnology is based on an interactive approach for involving many audiences in the discussion, providing various points of view and perspectives[12].
Additionally, a clear message has been sent to communicate and dialogue with young audiences about nanotechnology. Among young audiences, a very important segment consists of pre-adolescents, adolescents (or "teens") and young adults. If they can be informed about nanotechnology in a balanced way on its exciting prospects and potential risks, these young people may become well informed and engaged on this subject and contribute in the future to the public debate and decision-making on nanotechnology[13].

On the institution side, clear actions and indications are coming from recent activities set up by the European Commission. The EC launched a three-year long process articulated through two different workshops intercalated with an open web-based consultation on communication outreach in nanotechnology: (i) the first workshop (organized on 6th February 2007) focused on the main issues to frame a strategy[14]; (ii) the open web consultation (from May to October 2007)[15] provided a fundamental input in terms of comments and questions to be addressed in the (iii) second workshop (organized the 25-26th October 2007), identifying a set of potential actions to be developed by the EC [16]. These events have been carried out with the participation of 48 international experts from the fields of opinion-making, science communication outreach, social engagement, design, arts and nanotechnology.[17] A crucial input on these issues has been provided from the web consultation open during six months on the nanotechnology website of the European Commission on the results of the first workshop. In fact, this has enabled to collect hundreds of comments from the lay public,

[6] European Commission (2004): *Nanotechnology: views of the general public* (2004), EC, Brussels
[7] European Commission (2007): *Communication outreach in nanotechnology: from recommendation to action*, EC, Brussels, 2007
[8] European Commission (2007): *Strategy for communication outreach in nanotechnology*, EC, Brussels, 2007
[9] European Commission (2007): *Open consultation on a strategy for communication outreach in nanotechnology*, EC, Brussels, 2007
[10] Cobb, M.D.; Macoubrie, J, J.Nanoparticle Res., 2004, 6, 395-405;
[11] Cobb, M.D., J.Nanoparticle Res. 2002, 4 , 561-570
[12] BMRB international (2007), *Public perceptions about nanotechnology: risks, benefits and trust*, London, 2007, in www.nanotech.org.uk;
[13] European Commission (2007): *Communication outreach in nanotechnology: from recommendation to action*, EC, Brussels, 2007
[14] European Commission (2007): *Strategy for communication outreach in nanotechnology*, EC, Brussels, 2007
[15] European Commission (2007): *Open consultation on a strategy for communication outreach in nanotechnology*, EC, Brussels, 2007
[16] European Commission (2007): *Communication outreach in nanotechnology: from recommendation to action*, EC, Brussels, 2007
[17] European Commission (2009): *Art and Science: creative fusion*, EC, Brussels, 2009.

especially young people, gathering a wide variety of views, opinions, expectations and concerns to be integrated into the second workshop.

This exercise has pinpointed several recommendations for shaping future communication activities, identifying (i) which audiences are crucial, (ii) which messages are appropriate, and (iii) which vehicles, techniques and outcomes are appropriate to attain target audiences, especially **young people**. Assessment of current communication and insight of desirable outcomes have been outlined, exploring appropriate participatory mechanisms promoting dialogue with the broad civil society, which are specific to nanotechnology.
Synthesizing, the importance of identifying and **segment** young people **key-audiences**, key-messages and communication **multipliers** have been identified and underlined as crucial outcome of this process. As a consequence, **multipliers** as **science centers** and **school teachers** are identified as main recommended target for future communication on nanotechnology addressing young audiences. Additionally, **expressive languages** and **art** should be a priority channel to reach young audiences, and the way to stimulate their curiosity and participation should be based on **games, contests or competitions**.[18]

2.2 Analysis of:
THEORY OF COMMUNICATING SCIENCE AND TECHNOLOGY TO YOUNG AUDIENCES

Generally speaking, the conventional "deficit model" to communication of science and technology, developed in the '80s, says that public negative attitudes towards modern science and technology is caused mainly by a lack of adequate knowledge. Therefore, by providing the public with sufficient scientific information it is possible to manage this "knowledge deficit" (from here the name "deficit model") and obtain a greater public support for science and technology[19].

Following the recommendations of the mentioned policy documents, communication of nanotechnology should be addressing the target audience of young people, and especially "children and younger people"[20]. Various age segments are chosen on the basis of the cognitive theories of Piaget[21] and Kohlberg[22] on cognitive and moral development. The theory of Piaget on epistemology; the philosophy of science, concerns the growth of intelligence, which Piaget means the "ability to more accurately represent the world and perform logical operations on concepts grounded in interactions with the world".
This theory concerns the emergence and construction of schemata - which are schemes of how one perceives the world - in the "developmental stages", when children are learning new ways of mentally representing information23.
From the mentioned sources, it is possible to say that Piaget identifies four stages in cognitive development:
(1) Sensori-motor period (years 0-2) which marks the development of basic spatial abilities and understanding;
(2) Preoperational period (years 2-7) in which children have an intuitive catch of some logical concepts in some areas, but there is still a tendency to focus attention on only one aspect of an object;
(3) Concrete operational period (years 7-11), when children gain a better understanding of mental operations and begin to think logically about concrete events. However, they still have difficulty in understanding abstract or hypothetical concepts;
(4) Formal operational period (year 11 and up), characterized by acquisition of the ability to think abstractly, reason logically and draw conclusions from the information they have gathered.

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[18] European Commission (2009): *Art and Science: creative fusion*, EC, Brussels, 2009.
[19] European Commission (2004): *Nanotechnology: views of the general public* (2004), EC, Brussels
[20] European Commission (2007): *Strategy for communication outreach in nanotechnology*, EC, Brussels, 2007
[21] Piaget, J. (1932): *The moral Judgment of a Child*
http://www.archive.org/details/moraljudgmentoft005613mbp
[22] Crain, W.C. (1985): Theories of Development. Prentice-Hall. pp. 118-136.
[23] Gilligan, C. (1977). "In a Different Voice: Women's Conceptions of Self and Morality". Harvard Educational Review 47

The theory of Piaget on moral judgment is framed in two stages:
- children younger than 10 or 11 years regard rules as fixed, absolute and that cannot be changed;
- children older than 10-11 are more relativistic and they understand that rules are not absolute but are tools that people use to live cooperatively.
On the other side, Kohlberg proposed a theory which goes beyond the view of Piaget. It has three levels, which are therefore divided into six stages.
Level 1: 4-10 years old (stage 1 and stage 2): At stage 1, children think of what is right is what authority says is right. Doing the right thing is being obedient to authority and avoiding punishment. At stage 2, children are no longer so impressed by any single authority: they see that there are different sides in all issues.
Level 2: 10 – 13 years old (stage 3 and stage 4): here, young people think as members of conventional society with its values, norms, and expectations. At stage 3, they emphasize being helpful towards people that are near to them. At stage 4, they show more preoccupation of obeying laws to maintain the society as a whole.
Level 3: 13 and over (stage 5 and stage 6): here young people are more concerned with the principles and values that can make a good society. At stage 5, they emphasize the basic rights and the democratic processes that give everyone the right to say his/her opinion, and at stage 6 they define the principles by which agreement will be obtained as the most right thing to do.

In this light, the communication activity of nanotechnology to young audiences should focus on ages that correspond to the stages 3-6 of the theory of Kohlberg, and will provide them with dilemmas adequate to their developmental level. For example, a role-play will give an opportunity to learn how points of views are different and how to coordinate them in a cooperative way. As the participants will show their differences, they will develop conceptions of what is fair and just. Two variations of the role play should be developed: one for 11-13 year olds, who are in stages 3 and 4, and one for 14-18 year olds, corresponding to stage 5 and 6 of the theory of Kohlberg.
Other authors have addressed the importance of gender in moral development. For example, Gilligan observed that for males, the moral thinking is about rules, rights, and abstract principles and on an ideal of formal justice, in which claims are evaluated in an impartial way. The morality of women is more contextualized; it depends on real, current relationships rather than abstract solutions to hypothetical dilemmas. As a consequence, these findings should be considered in future communication projects, also addressing both ways of thinking of females and males on moral reasoning.

2.3 Analysis of:
KEY-AREAS OF NANOTECHNOLOGY TO BE PRIORITISED IN COMMUNICATION

According to key-policy documents explored in section 2.1, it is possible to say that nanotechnology is a broad field with many potential application areas, with great potential benefits and risks for society. Still, it is possible to explore in existing scientific literature on communication of nanotechnology which are the areas where more efforts are needed for reaching young audiences. This analysis has identified three sub-areas for urgent communication to young audiences: nanomedicine[24], nano-energy and -environment[25], nano- and information and communication technology (ICT)[26]. These areas are chosen following the indications of several authors, who demonstrate that they are a priority as they involve already urgent, important, specific and identifiable problems.
In fact, the nano-medical area is one that all individuals can relate on a personal basis, assuring high interest; the nano-energy/environment area clearly touches sustainability, one of the issues of major public and policy concern. Finally, nano- and ICT shows a vast possibility of gadgets and entertainment to make everyone's life better, easier and fun, which should be of particular interest to

[24] Capurro, R., (2004): "EGE Opinion No. 21: "Ethical Aspects of Nanomedicine", in *EURONANOFORUM 2007*, March 2007; Brussels, 2007
[25] The Royal Society, (2004) "Effects of nanotechnology on the environment", *Nanotechnology Applications* (http://www.understandingnano.com/nanotech-applications.html), London, 2004
[26] NANODIALOGUE (2007) "Nano-technologies and Nanosciences: A discussion of ethical, legal and social aspects", *Nanodialogue final Conference*, 5th February 2007, Brussels, 2007

all young people. All three areas involve benefits and risks and are expected to generate lively debate and discussion.

2.3.1 Nanomedicine

This area has the potential to realize significant innovation in diagnosis and treatment of diseases and other health-related problems. Nanomedicine is defined by the European Science Foundation as "*the science and technology of diagnosing, treating and preventing disease and traumatic injury, or relieving pain, and of preserving and improving human health using molecular tools and molecular knowledge of the human body*.[27]"

Several important areas of nanomedicine are expected to improve, where nanotechnology is expected to prove: (i) more sensitive analytic tools and portable diagnosis devices, (ii) more accurate imaging instrumentation, (iii) materials based on nanotechnology, (iv) new therapeutics and drugs, (v) clinical protocols, regulation and toxicology.

2.3.2 Nanotechnology for energy and the environment.

Nanotechnology can be used to enhance a wide range of energy technologies, including solar technologies, hydrogen production, hydrogen storage, and fuel cells. Novel batteries and super-capacitors with improved power, battery lifetime and safety properties are under study by using nanotechnology. Nanotechnology is expected to provide cheaper chemical and drug products by improving industrial catalytic processes. Also energy-saving is another important area where nanotechnology could provide improvements, developing new materials with more efficient properties for energy-saving, light-weight materials for reducing energy consumption.

The application of nanotechnology to the environment may produce significant advancements, such as the superior water and air quality, by more efficient filters, remote environmental detection, more environment-friendly materials and “green manufacturing", improving the efficiency of some industrial processes in the chemical and mechanical industries.

2.3.3 Nanotechnology and Information & Communication technologies

In the field of information and communication technology (ICT), nanotechnology is expected to constantly improve information processing systems, leading to increasingly powerful hardware. New nanotechnology recording concepts will combine various advantages: large memory-storage capacities, very fast access and conservation of data without constant power supply. These concepts are based on new technologies such as: transistor based on one single electron, memory-storage in nanocrystals, spintronics. Thanks to nanoelectronics, a single device of the size of a credit card could be used as a tape recorder, camera, video player, television, mobile telephone, GPS, translator, and as a credit card (of course!).

A second area where nanotechnology could play an important role is the interface between computers and the physical world such as “smart” environments in which objects of daily use are permanently interconnected. In this area, Radio Frequency Identification tags (RFID) are expected to play a crucial role in communicating high amount of information: more advanced than the bar code, and collated to textiles or devices, these complex chips react to radio waves and transmit their information without contact.

2.3.4 Uncertainty of impacts and ethical, legal and societal aspects

For all nanotechnology applications, the key concerns are the potential health and environmental hazards of nanoparticles, together with the associated ethical, legal and social issues (ELSA). Because of the novelty ofnantechnology, there may be real difficulties to identify, estimate and manage the risks that may be involved, and especially the long term risks, which may be different from short term risks[28].

For example, it is possible to identify short term, medium term and long term (5, 10, and 20 years) ethical issues associated with **nanomedicine**.

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[27] EURONANOFORUM (2004) *Ethical Aspects of Nanomedicine*, http://www.capurro.de/nanoethics.html,

[28] The European Group on Ethics in Science and New Technologies (EGE) advisory of the EC President, (2007): *Opinion on Nanomedicine* at: http://ec.europa.eu/european_group_ethics/avis/index_en.htm

- In the short term the ethical questions arise mainly from the lack of knowledge about the risks of interventions using nano-based products and tests[29].
- In the medium term perspective, nanodevices and nanomedical products are expected to be used in all medical fields. This raises the ethical questions of responsibility at a local and global level: sensitive questions like data protection and privacy are expected to arise, as with genetic testing.
- In the long term, nanotechnology might make possible the enhancement and even transformation of the human body and human nature and identity[30]. The European Group on Ethics in Science and New Technologies (EGE), an advisory body to the EC President, published an opinion document on nanomedicine in January 2007[31]. It recognizes the "*potential of nanomedicine in developing new diagnostic, treatment and preventive methods and places emphasis on conducting research both into its safety and its ethical, legal and societal aspects*". It proposes to set up a European network on the ethics of nanomedicine and suggests that further monitoring of the current legal situation should be carried out, although it does not call for a specific legislation at this stage.

Regarding the long term **environmental** impacts of nanomaterials, many authors assume, correctly or not, that nanoparticles will definitely pose a risk for the environment, although there is no clear scientific evidence until now. In fact; nanoparticles could accidentally enter into the food chain, initially causing damage to plants and animals and eventually becoming a hazard to humans. A second risk related to nanoparticles is their possible reaction with other elements producing new harmful substances in the environment.

In the area of **Information and Communication Technologies**, the main issues related to nanotechnology are related to privacy, data protection, governance and regulation. In this light, the EC has initiated public consultation on draft recommendations on the implementation of principles for privacy, data protection and information security in applications based on Radio Frequency Identification (RFID)[32]. In addition, national organizations, such as the CNIL in France, are warning stakeholders and the public at large about the potential negative consequences for privacy and personal freedom of the application of nanotechnology in information and communication Technologies.[33]

A number of other ethical, legal and societal issues are often raised with regard to nanotechnologies: these include (i) how to balance potential benefits versus potential costs, (ii) the distribution of benefits and costs among the population, (iii) the concerns about personal freedom, control of the development of nanotechnologies, and ethics of human enhancement.

In this light, there is a clear room for research on communicating nanotechnology: clearly, the future communication projects should also try to raise awareness of the complexity of ethical, legal and societal issues associated with policy-choices about specific nanotechnologies.

From this analysis, it appears that there are clear indications to set up specific programs of communicating nanotechnology that will address all these areas, with a different level of challenge adapted to young audiences according to various age groups previously examined.

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[29] Capurro, R. (2004): "Reflections on Benefits, Risks, Ethical, Legal and Social Aspects of Nanotechnology", *Nanoforum* (2004).

[30] EURONANOFORUM (2004) *Ethical Aspects of Nanomedicine*, http://www.capurro.de/nanoethics.html,

[31] (La) Commission Nationale de l'Informatique et des Libertés (CNIL) has named its 2006 annual report: "*Alerte à la société de surveillance*" ("Alert to the Surveillance Society" http://www.cnil.fr/fileadmin/documents/La_CNIL/publications/CNIL-27erapport-2006.pdf).

[32] Lemoine, P. (2006), *Nanotechnologie, Informatique et Libertés, Communication du 12 janvier 2006* - special report on Nanotechnology, privacy and data protection, CNIL, Paris, 2006 http://www.cnil.fr/fileadmin/documents/approfondir/dossier/technologies/Com-phl-Nanotechnologies.pdf)

[33] The Royal Society (2007) *Towards an RFID policy for Europe* (http://ec.europa.eu/information_society/policy/rfid/index_en.htm), London, 2007

2.4 Analysis of:
EC-FUNDED PROJECTS ON COMMUNICATING NANOTECHNOLOGY

Few are the relevant projects already funded by the EC that are of significance for communication of nanotechnology to young audiences, i.e. **Nanodialogue** and **Nanologue**. Others have been very recently funded, and are examined too. All of them are discussed below.

2.4.1 Project NANODIALOGUE

The overall objectives of the **Nanodialogue**[34] project (http://chicoineau.blogspot.com/2007/12/nanodialogue-expo-nano-2-faons.html) were to raise curiosity and stimulate debate on nanotechnologies and nanosciences. The main target groups can be grouped in three clusters: schools, families (general public) and young people related to industry/university. The project centred on an interactive exhibition module, which was displayed in eight countries, a program of events and participatory activities in each location, and a survey of public perceptions and expectations with 800 questionnaires and a multimedia polling station at each location. This project provides useful insights on how to reach effectively young audiences, especially during their **school time**, when classrooms are taken to the **exhibit** in science centres where teachers and communication professionals act as **multipliers**.

2.4.2 Project NANOLOGUE

On the other side, **Nanologue**´s objective[35] (http://www.nanologue.net/) was to bring together current leading research on the social, ethical and legal implications ofnantechnology. The project provided a common ground for public discussion on the technological benefits and risks by assessing ethical, legal and social aspects ofnantechnology with the help of literature studies, stakeholder interviews and workshops. The results provide guidance for stakeholders on how to address the issues to the wider benefit for both society and the economy. The outcomes of the project were (i) a background paper on the ethical, legal and social aspects (ELSA) of several nanotechnology application areas (energy and environment and medical diagnosis), (ii) a study on opinions on the ethical, legal and social aspects of nanotechnologies, and (iii) the development of three detailed scenarios on the future of nanotechnology and its applications.
The project stressed the importance of **high quality, professional and effective** communication as a first priority.

In addition to these two communication projects already finalised, four other projects have been recently launched under the EC funding scheme of Seventh Framework Program for Research, i.e. NANOTV, NANOTOTOUCH, NANOYOU and TIMEFORNANO. A final project, an EU event gathering all these communication activities and projects into a specific session is examined at the end, i.e. EURONANOFORUM2009, a follow-up of previous events held in 2003, 2005, 2007, including art as a major tool to communicate nanotechnology to lay public and more specifically to young audiences.

2.4.3 Project NANOTV

The **NANOTV** project (http://www.eurovision.net/net/content/youris.php; http://www.youris.com/) will contribute to the development of public awareness on European nano research in all European countries through television media and the internet[36]. In particular, NANO-TV will create a series of 14 high-quality free-of-rights **Video** News Releases for the general public and young people on the basis of the key results of the research. These project audiovisuals will be conceived in to adapt easily to the needs of a wide range of European TV channels. These videos will be included into the

[34] NANODIALOGUE (2007) "Nano-technologies and Nanosciences", *Nanodialogue final Conference*, 5th February 2007, Brussels, 2007
[35] NANOLOGUE (2006) , *Europe-wide dialogue on benefits, risks and social, ethical and legal implications of nanotechnology*. at: www.nanologue.net/
[36] NANOTV *Annex I, Description of Work*, contract n°, NMP-CSA-2-233486, EC

www.youris.com **video internet portal** associated to **on-line newspapers**/**media** to be broadcasted in the scientific and news of major national **television channels** in all European Member States. Key issues of nanotechnology, as nanomedicine, nano-energy/environment, nano- and information technology, will be presented providing **high quality** information in a **balanced way**, addressing both positive and negative impacts of nanotechnology.

2.4.4 Project NANOTOTOUCH

The **NANOTOTOUCH** project (http://bridge8.wordpress.com/2009/04/12/europe-showcases-innovative-approaches-to-nano-education/) aims to create innovative environments for the broad public to learn about and to discuss nano research by directly involving the actors of research themselves[37]. It proposes to do this by taking the laboratory environment and the research work out of enclosed academic campuses and relocating them right in the midst of the public in science museums and science centres. Three science museums and three science centres will closely cooperate with local university partners to create three permanent Open Nano Lab locations (in Munich, Milan and Gothenburg) and three Nano Researcher Live areas (in Mechelen, Tartu and Naples). In these places the visitors will experience "live" the day-to-day practices and processes of nano research conducted by young scientists. This peer-to-peer dialogue on an equal basis between lay public and nano-researchers not only creates a bidirectional feedback, it also minimises the expert-to-lay bias ("top-down" approach) inherent present science communication processes with authoritative top researchers.

2.4.5 Project NANOYOU

The project **NANOYOU** (http://www.nanowerk.com/news/newsid=10262.php; http://www.zsi.at/en/projekte/laufend/5206.html) will design and carry out a communication and outreach program in nanotechnology aimed at European young generations[38]. The project will reach teenagers through school programs to take place in at least 20 EU Member States and Associated States. Additional programs aimed at young adults over eighteens will be offered in science centres. The school programs are planned to involve at least 400 schools and reach more than 25,000 students. The science centres program is expected to reach an initial 4,000 young adults and many more subsequently as more science centres adopt the program. Communication will be developed by differentiating the activities for targeting **segmented audiences**. The expectation is to raise understanding and awareness on nanotechnology, and its potential benefits and risks. The main products will be **games and competitions**, and **hands-on** approaches such as: (i) temporary exhibitions, (ii) innovative computer games, (iii) experiments and other online content, all supported by dedicated workshops aimed at promoting dialogue to raise participants' awareness of ethical, legal and societal aspects of nanotechnology. The contents will be **balanced**, **high quality and up-to-date**. Teachers will be used as main **multipliers** to whom are addressed specific training materials to equip them accordingly.

2.4.6 Project TIMEFORNANO

The **TIMEFORNANO** project (http://www.timefornano.eu; http://www.timefornano.org/) aims at engaging the general public, with a special attention to young people, on benefits and risks related to nanoscale research, engineering and technology, through specific informal education products, namely the nano-kit and the web platform[39]. This will be the basis for the realisation of events and debates for the society even outside the consortium countries and collecting opinions and feedbacks from the participants. The products will use an inquiry-based learning approach, specifically developed in science centres/ museums, where people understand by doing. The **nano-kit** could contain e.g. small exhibits, nano-objects and materials, scripts for experiments, role/team game cards, pc animations, etc.

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[37] NANOTOTOUCH *Annex I, Description of Work*, contract n°, NMP-CSA-2-233473, EC
[38] NANOYOU *Annex I, Description of Work*, contract n°, NMP-CSA-2-233433, EC
[39] TIMEFORNANO *Annex I, Description of Work*, contract n°, NMP-CSA-2-233481, EC

It will also contain tools for engaging in debate scientists, stakeholders and the public in general. The web platform will be a resource centre and an attractor for the whole community of science communicators, through its contents (**cookbook** and activities description, continuous addition of new information etc), its innovative tools (not only forum, newsletter, but online community tools such as blog, podcasts, **videocasts**, **e-museum**) and online feedback collection. A great added value of the project is that of "growing" a community of people engaged in communication on nanotechnology, through the realisation of training courses in each of the participating Science Centres (at national level) and by Ecsite (at European level) intended to reach audiences on a **broad scale** targeting a number of at least 450 **multipliers** (experts working in outreach and education efforts), carefully chosen among three main target groups: (i) explainers in science centres and PhD students in science communication; (ii) teachers from primary and (iii) teachers from high schools, enabling to differentiate a communication activity targeting **segmented audiences**. The main products will be **a EU-wide contest** based on **expressive languages and art**, supported by a **nano-kit**, a key **hands-on** approach to attract young people attention and interactivity. The project will culminate with the organisation of some specific events in Europe, NanoDays and young contests, intended as occasions for (i) informing/educating, and for engaging citizens, for (ii) collecting perceptions and opinions and (iii) to stimulate debate and dialogue.

2.4.7 Project EURONANOFORUM-2009

This **EURONANOFORUM-2009** event (http://www.euronanoforum2009.eu/) is launched by the Czech Presidency as a crucial milestone in the history of communication nanotechnology40. It is the fourth conference of a set of international nanotechnology conferences organized within the framework of national Presidencies of the European Union, held in Prague next June 2009, under the auspices of the Czech Ministry for Education Youth and Sports and with the support of the Industrial Technologies Programme of the European Commission. Focusing on "Nanotechnology for sustainable economy", this event will address the contribution and challenges of nanotechnology research for a sustainable development of European industry and society, addressing the most important ways nanotechnology could provide sustainable solutions. Different sessions, thematic workshops, and various exhibitions with award attribution will be put in place, supported also by a unique set of communication activities devoted to the general public and young generations: among them, the mentioned projects will have a prominent place and are supposed to play an important role.

2.4.8 Recommendations for future communication from EC funded projects

All these communication activities are indicating that more communication efforts are needed to reach effectively young audiences on nanotechnology. General recommendations can be drawn from these projects:

- **high quality, professional and effective** communication is a priority, as it has to compete for young people's attention, targeted by all sorts of information;
- communication should be carry out a **broad scale**, using **multipliers** (teachers, science centres, communicators, opinion-leaders, opinion-makers, influencers, media in general);
- the growing interest for young audiences as main target of communication efforts pinpoints that **segmenting** young audiences becomes a crucial issue;
- bringing researchers to science centres and schools is necessary to complement the conventional approach to bring schools to the laboratories;
- communication via **videos, television, web** should be developed;
- **games, competitions and contests** should be promoted as an effective tool to challenge young people imagination and engagement;
- **hands-on approaches, expressive languages and art** should be strengthened as promising ways to attract and dialogue effectively with young audiences.

[40] *EURONANOFORUM 2009*, in http://www.euronanoforum2009.eu/

3. CONCLUSIONS

This analysis identifies two main aspects for communicating nanotechnology to young audiences. Different sets of recommendations from literature review on EC policy documents and activities, communication theory and EC funded projects can be identified, as follows.

I. Strategic: use multipliers and target professional/school time

- First, the key importance related to **multipliers**, meaning target publics that have an important role in communicating with a larger public, such as journalists or teachers. As they have the potential to reach so many more individuals, they should be the primary audiences to reach, without however excluding the need to address the broad public with appropriate actions.
- Secondly, some audiences are best reached during their "**professional" (or school) time**, while others would be best reached during their **leisure time**. Though **agreement** is clear on addressing young audiences in **professional/school** time, a certain **disagreement** emerges on addressing them in **leisure time**[41].

II. Crucial: segment audiences and use interactivity

In fact, this analysis pinpoints that it is really hard to effectively target all the young publics, especially on a continental scale, as it is necessary to compete for attention in leisure time and spaces. The information deluge on any young public is so huge now that it takes a big effort just to break the attention barrier. Any effort by the European Commission on all these targets risks being spread far too thin to have a significant impact. As a consequence, it is not by chance that communication projects start by choosing a specific **target audience** in professional/school time: thus, the more specific the target, the better, and all subsequent decisions depend on that. Appropriate **segmenting** by age the young audiences will be a crucial issue in shaping the project. Additionally, **videos, television, web should be developed, using expressive languages** and **art** to reach young audiences: the way to stimulate their curiosity and participation should be based on **hands-on approaches, games, contests or competitions**.[42]

III. Needed: high quality information and trained multipliers

Therefore, the most appropriate answer to the "to whom" question emphasizes the crucial importance of **multipliers and influencers** – scientists, journalists, policy-makers, and among them **teachers and science centre communicators** are pivotal[43]. Clearly, if the multipliers and influencers are not ready to play their role, communication projects aimed at the general public will lack a key resource. Apparently, scientists are particularly important to work with multipliers as scientists are: (i) competent in this extremely technical and complex field, providing reliable information, (ii), the most trusted by the public when it comes to explaining the impact of technology on our life[44], being also visible in professional and lay press, in interviews, in expert opinions panel, debates.

All sources agreed on **the need to guarantee high quality** of information as an essential point. In order to deliver a message you need to create **attention and awareness** to begin with. Taking into account that especially the youngster target groups are overwhelmed and "spoiled" with an abundance of information[45], advertisements, immersive games and virtual worlds every day, all communication actions should be chosen very carefully (e.g. the attempt to compete with a multimillion dollar professional immersive pc or console 3D game for communicating nano is likely to fail). The focus should be set on an **outstanding quality in design, implementation and content of each**

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[41] Cobb, M.D.; Macoubrie, J, (2002): "Public attitudes towards nanotechnology" (2002): Bainbridge, W.S., *J.Nanoparticle Res*. **2002**, *4* , 561-570;

[42] European Commission (2009): *Art and Science: creative fusion*, EC, Brussels, 2009.

[43] Cobb, M.D.; Macoubrie, J, (2004): "Public perceptions about nanotechnology: risks, benefits and trust". *J.Nanoparticle Res*., **2004**, *6*, 395-405;

[44] BMRB international *(2004): Nanotechnology: views of the general public* (2004):, in www.nanotech.org.uk;

[45] Gaskell, G.; Allum, N.; Stares, S. (2003): *Europeans and Biotechnology in 2002*: *Eurobarometer 58.0*; Methodology Institute, London School of Economics, London U.K.

project/action[46] rather than creating a large quantity of output with an average appearance that does not stick out of the mass.

Finally, this analysis has enabled to identify clear recommendations for communication activities addressing young audiences in both professional/school and leisure time, although the first line should be prioritised. All these recommendations – specified from point I to III - will be taken onboard for future communication outreach research. In this light, this is expected to better shape appropriate outreach and communication approaches to communicate and engage European young people into a dialogue on nanotechnology.

[46] TA-Swiss project (2006): *Swiss publifocus on nanotechnologies*, (2006), in TA-SWISS, the Centre for Technology Assessment

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