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Nanosmile: a Safety of Nanomaterials Website for Professional Training, Education and Public Dialogue

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For sustainable and responsible development of nanotechnology, the risk issues in nanomaterials must be properly addressed despite the lack of relevant knowledge and regulations. In this paper, 'Nanosmile' as an example of web-based tool for education and dialogue for the risk issues, is introduced. First developed at Atomic Energy Commissary (CEA) for in-house training, Nanosmile was integrated to European project NanoSafe2 in 2006 and evolved into an interactive website opening to the public at large. The feedback during the training process, perspectives and limitations of the website are also presented.

Keywords : Nanotechnology, Occupational and consumer safety, Environmental protection, Professional training, Education, Public dialogue and ethics issues

1. What is new with the "regulated" risk governance framework today?

For years scientists and engineers have explored innovations without concretely consulting Society. Quite recently, economic, cultural and political fac－tors have changed our risk perception and our envi－ronmental protection awareness. Consequently the way that risk and environmental issues are addressed has dramatically evolved over the past twenty years. Regarding regulated risks as well as emerging risks [1], risk producers and innovation makers nowadays have to engage a governance process requiring con－sultation and dialog with all involved stakeholders.

As indicated on Fig. 1, regulated risk governance involves an interaction between different types of actions in order to control risk:

－ Risk assessment and Life Cycle Analysis research has defined hazard and exposure knowledge for

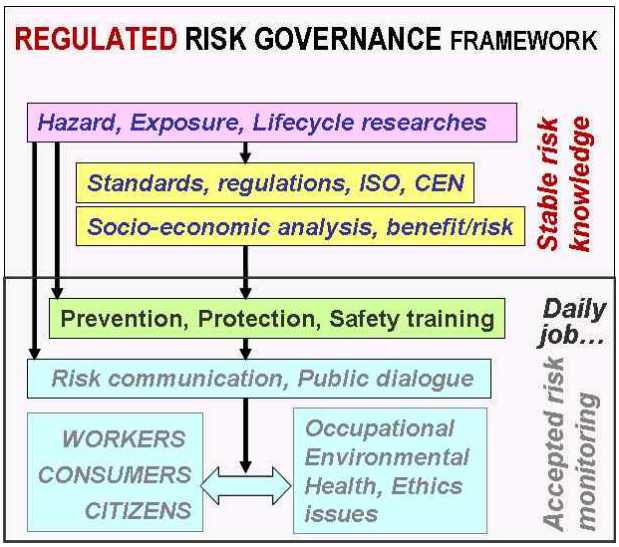

Figure 1. Regulated risk governance framework.

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the production, use and recycling phases.

- Regulations restrict or limit exposure values, such as for example the number of fiber per cm^{-3} in the case of asbestos. Socio-economic analysis has provided risk-benefit balance and tolerability conditions.
- Risk producers must strictly observe these regulations and demonstrate their good will everyday in order to induce confidence.
- Public risk perception has changed. Stakeholder's confidence requires more information transparency and more understandable risk management actions. A socially accepted risk with a high level of safety could be suddenly considered insecure because of inadequate communication or failure to address claims. Communication and public dialog should be monitored.

2. What is specific with emerging risk governance?

Emerging risk supposes uncertainties. As indicated on Fig. 2, an emerging risk [2, 3] governance framework is similar to the precedent. But a more complex interaction between tasks input and output should be considered:

- Long- and short-term effect of actions such as Risk assessment and Life Cycle research should be planned in order to define hazard and exposure knowledge for production, use and recycling phases,
- Then should follow regulation definition and socio-economic analysis for risk-benefit balance [4],
- To deal with uncertainties, implementing very short term effect actions is required: applying the precautionary principle! In the case of nanomaterials it could be limiting exposure to potentially dangerous engineered nanoparticles.
- Short and middle term effect actions such as interactive information and public dialog have also to be considered in order to reconcile diverging interests e.g. employee vs. employer, consumer vs. producer, citizen vs. politic vs. industrial interest.

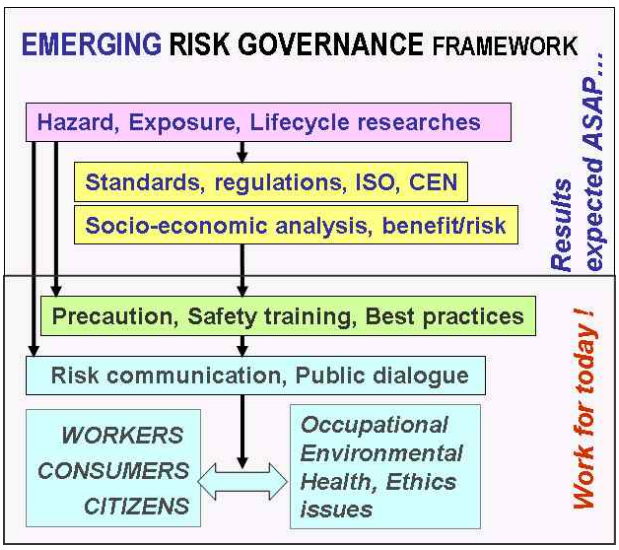

Figure 2. Emerging risk governance framework.

3. What kind of emerging risk is represented by nanomaterials production and uses?

Nanomaterials are finding new industrial applications every day in such various fields as electronics, biomedicine, pharmaceutics, cosmetology, chemical catalysis, new materials, and others. New types of nanomaterials that up to now were under laboratory development are on the brink of mass-production. Economists are now speaking about the dawn of a

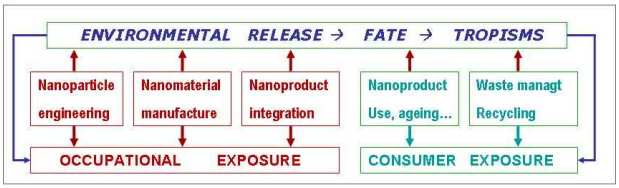

Figure 3. Life Cycle, Environmental release and Exposure scenarios.

new industry for the 21st century that could rank with the automobile and microelectronics industries in terms of turnover. To summarize, on the benefits side, potentialities seem very promising in various fields.

On the risk perception side, first we should consider numbers of nanoproducts are already on the market.

Second, the safety and environmental issues must be addressed for the entire lifecycle. Research on potential hazards, exposure scenarios, and environmental release are in progress for nanoparticles engineering, nanomaterials manufacturing, nano-products fabrication, consumer uses, waste management and recycling (Fig. 3). Until now hazard uncertainties, exposure knowledge gaps, lack of information on lifecycle have persisted. Reasonable prognosis suggests that at least 10 years will be necessary to define appropriate regulations and differentiate safe and suspicious applications.

4. Why make nanomaterials emerging risk issues understandable?

The nanomaterials economy will only develop if two critical conditions are met. First, the safety and environmental issues must be addressed. Second, but not least, nanotechnologies must be accepted by the public at large. Important work, both scientific and technical, is under way to reduce as much as possible the risks for humans as well as for the environment. In parallel to this technical work, there is a need for accompanying educational and dialog actions (Fig. 4):

- Maintaining exposure levels in workshops and laboratories As Low As Reasonably Achievable (ALARA) implies training the potentially exposed workers and their associated management.
- Feeding the societal debate, and informing the public at large about the potential risks, but also the potential advantages, of the nanomaterials.

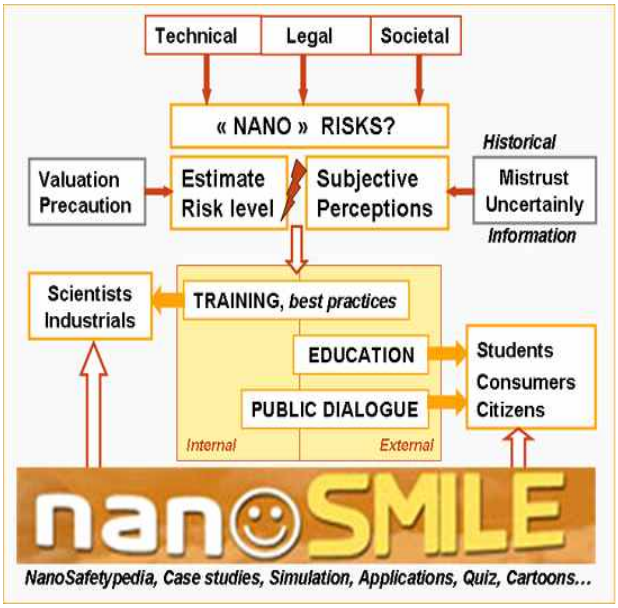

Figure 4. Training, education and public dialogue needs.

In this context, the governance process supposes to address very complex issues like: risk/ benefit balance, lifecycle analysis, ethical consequences, social utility…

A first paradox appears: how is it possible to anticipate such thinking? What are the conditions for a large stakeholder panel to exchange and contribute to this thinking?

For us the first necessary condition is to make nanomaterials risk issues attractive enough to enlarge this panel and understandable enough to allow for constructive participation.

5. What can we expect from risk communication studies?

Most studies [5,6] show that risk acceptance depends more on the perception than on the rational understanding of actual data. VALUES such as social equity, individual freedom, environment protection, concerns regarding the irreversibility of applications,

etc. seem more relevant to the average people. Chris Toumey appropriately notes: "*(we) are knowledgeable because (we) are supporters, instead of being supporters because (we) are knowledgeable*" [7].

Humbly, Kahan and Rejeski [8] warns us: "*As formative as our understanding of nanotechnology's risk might be, our understanding of how to communicate scientific evidence of those potential risks to the public is even more primitive*". Hence, he investigates a very interesting communication strategy, relating Cultural Risk Cognition, communicator credibility and cultural message context.

In addition, several authors [9,10] try to investigate the sensitivity of various social groups regarding the issues of emerging risks. Based on such statistics, Currall et al. [5] suggest setting up scores of acceptance for monitoring innovation perception. The diversity and the number of "nano" applications would suppose computing several hundreds of scores, each one divided into specific scores related to social groups, etc. These initiatives reveal a quantity-related state of mind when facing an intrinsically quality-related problem. From our point of view, information regarding the emerging risks should be above all an ethical duty [11] for risk producers, not a tool for manipulation, propaganda or marketing.

In brief, scientists, safety engineers, innovation experts are required to participate in a dialog whose conclusions will depend on values such as emotion, confidence, listening, consensus, ethical values, etc. The issue is not simply to be "right" in making a decision, but to share one's point of view, aiming at converging on a consensus shared by the largest number possible.

To ease this dialog, the ideal information device needs to be: neutral, transparent, accessible, easy to understand, non-exclusive, clear about all of the uncertainties, favouring neither the risks, nor the profits.

Consequently, in 2006, in addition to the technical work performed at the CEA in the framework of the European project NanoSafe2, we first designed and implemented an interactive website, initially as an e-learning support and gradually opening out to the public at large within the EU FP7 iNTeg-Risk, NanEX [13], NanoHOUSE [14] and NanoCode [15] projects.

6. What is the first nanosmile user feed back?

1. Professional training process

At the end of 2007, the training process was tested and validated through two test sessions. In 2008, five one-day long real sessions were conducted for a total of 80 days in training. In 2009, 10 one-day or two-day sessions including 4 sessions for external industrials, were performed for a total of 200 days.

The website is used both before the training sessions as a preparation step and afterwards in order to keep in touch with the trainees: invite them to have a look at the knowledge evolutions and request their contribution for improving the system (Fig. 5).

A survey reveals strong overall satisfaction, in particular regarding the pedagogical animations.

The likely increase in training demand requires that we rapidly improve both the quality and the productivity of the training process.

2. E-learning & public dialog

With 60,000 to 120,000 connections each month in

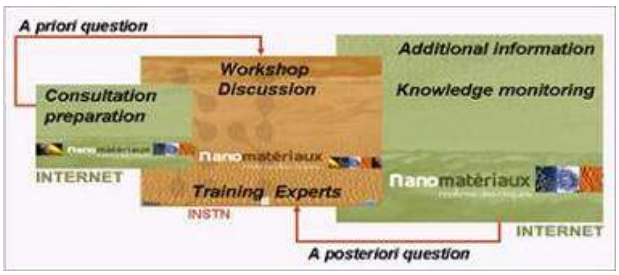

Figure 5. Emerging risk knowledge management.

2009, the website consultation has been stimulated by mails posted about its evolution and new items:

Quizzes, examples of secured typical nanowork-shops and updates on new scientific results. The de-signed feedback procedure has also increased hits. An impact study carried out on students at the end of 2008 has shown that a first version of the site was very satisfactory with regard to pedagogical content, structure and ergonomics, but not with regard to at-tractive value for the general public. Therefore, nine 3 minute cartoons have been produced in order to ac-company different public dialogue actions (Fig. 6).

The raw website data are also used for conferences, workshops, debates, university classes and lectures in high-schools. Every opportunity to introduce the site and boost its independent use is welcome.

7. What are the limitations and the perspectives?

This website is now structured on three levels of knowledge:

- DISCOVER for consumers and citizens in order to facilitate the nanomaterials potential risks understanding and contribute to public dialogue.
- EXPLORE for students and scientists in order to stimulate their academic education
- KNOW HOW for scientists and industrials in order to conduct nanomaterials potential risks pro-fessional training.

This site has to be brought to life, kept continually up-to-dated and has to be tested in different conditions. That requires an operational and open human organ-ization in charge of the site maintenance.

Figure 6. Cartoon view examples.

Regarding training at workplaces, regular sessions are organized with in-house staff members and in-dustrials or partners from outside the company. This enables a dynamic and fruitful feedback to the site, thanks to a relatively small but highly interactive group.

Regarding web Communication with the public at large, the audience is wider, but the contact is more difficult to establish. Members of the scientific com-munity, our European partners in particular, are ob-viously more than willing to interact, to offer their opin-ion, and help the site to evolve. In order to explore impact on the general public, debate workshops target-ing a "youthful" audience will soon be implemented. Protocols for observations and collecting feedbacks will be used to examine how to orientate the site evolutions.

Regarding the professional stakeholders, Nanosmile is an efficient tool to share information, develop new contacts and produce or improve a common knowledge.

8. Conclusion

The Nanosmile website initiative proposes an original learning system as well as an open and innovative dialog experiment with continuous evaluation. Feedbacks on the training tool are very positive. Regular information to stimulate awareness of an emerging risk allows main-taining the good practices at the workplaces. An easy-upgrading training website appears to be well suited for a domain in fast evolution.

Regarding communication, Nanosmile team is ready to learn from other initiatives with similar objectives through the different European projects in which we are involved [3,13-15], and is aware about the limits of this initiative.

Nanosmile is an opportunity to share at worldwide

level nanosafety data between all the stakeholders: exposed workers, managers, safety engineers, medical officers, industrials, consumers, NGOs, marketers and investors for protection of the public and the environment, and ethical issue specialists. A project of Korean-French collaboration between KIST and CEA should in particular develop Nanosmile concept in the Korean context.

Welcome to Korean public on http://www.nanosmile. org and please give your feedback to improve the quality and the accuracy of the website. This is your tool!

Acknowledgement

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나노스마일: 전문적으로 나노소재의 안전성을 위한 훈련, 교육 및 대중소통 웹사이트

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나노물질의 위험성에 관한 지식과 규제가 부족하지만, 지속가능하고 책임있는 나노기술의 발전을 위해서는 나노물질의 잠재적인 위험을 언급해야 한다. 이 논문에서는 이러한 문제를 해결할 수 있는, 웹에 기반한 교육 및 소통 도구인 '나노스마일'을 소개한다. 원래 프랑스 원자력청 내부 교육을 위해 개발된 '나노스마일'은 2006년 유럽 과제인 '나노세이프'에 포함되면서 그 대상을 일반 대중까지 포함하고 서로 작용하는 웹사이트로 발전되었다. 웹사이트 운용 중 수집된 훈련과정에서의 반향과 웹사이트의 전망 및 한계도 서술되어 있다.

주제어 : 나노기술, 직업 및 소비자 안전, 환경보호, 전문적 훈련, 교육, 대중 소통과 윤리적 문제

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