



Industrial perspective on emerging risks and safety of nanotechnologies: Results from the EU projects

A. Jovanovic

EU-VRi / Steinbeis Advanced Risk
Technologies. Germany / University of
Stuttgart, Germany

Abstract

The paper deals with different possible perspectives onto the issue of emerging risks and safety of nanotechnologies, including the nano-toxicology-oriented perspective, the risk assessment oriented perspective and the industrial safety oriented perspective. The latter, is the perspective taken in the a number of EU projects dealing with nanotechnology, especially engineered nanomaterials, on industrial scale. The following issues are tackled more in detail:

- (a) recognizing emerging risks, incl. early warnings and managing the available information and knowledge
- (b) interdependencies among the risks related to nanotechnologies and other emerging risks, incl. to risk-risk tradeoffs, application of precautionary principle and identification of possible gaps in the research and safety improvement activates related to nanotechnologies
- (c) exploring public acceptance and the possibilities model it upfront

The approaches applied in the research projects are reviewed and demonstrated in the presentation. Standardization aspects are tackled in the context of transfer of the research results towards innovation.

Main message:

1+1 could be more than 2!

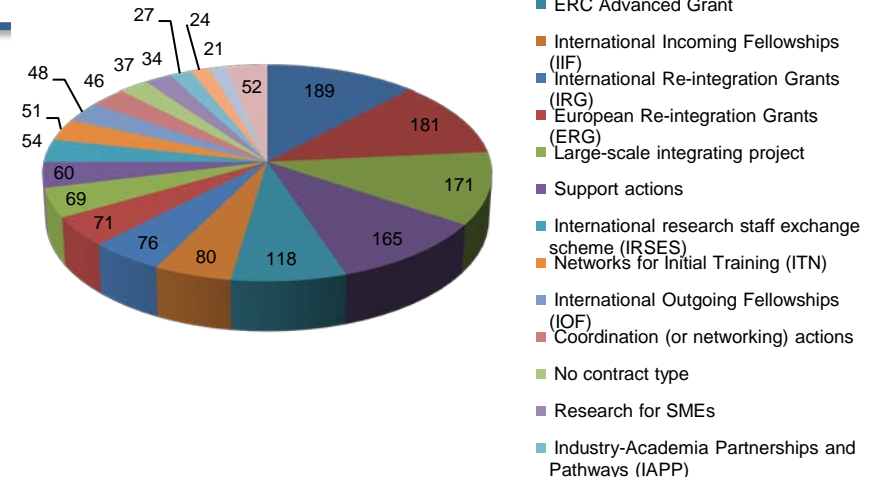
- a. The great investment in nanotechnology R&D projects in the EU should payoff not only in terms of single projects but also at the level of “swarm intelligence”
- b. There has not been a “master plan” of R&D projects and/or of the investment in nanotechnology projects, projects approved on case-by-case basis
- c. There is no such a thing as “100% nanotechnology project”

ContractType	counts
Intra-European Fellowships (IEF)	189
ERC Starting Grant	181
Collaborative project (generic)	171
Small or medium-scale focused research project	165
ERC Advanced Grant	118
International Incoming Fellowships (IIF)	80
International Re-integration Grants (IRG)	76
European Re-integration Grants (ERG)	71
Large-scale integrating project	69
Support actions	60
International research staff exchange scheme (IRSES)	54
Networks for Initial Training (ITN)	51
International Outgoing Fellowships (IOF)	48
Coordination (or networking) actions	46
No contract type	37
Research for SMEs	34
Industry-Academia Partnerships and Pathways (IAPP)	27
Collaborative Project targeted to a special group (such as SMEs)	24
Coordination and support actions	21
Other	52
Support for training and career development of researcher	8
Research for SME associations/groupings	5
Joint Technology Initiatives - Coordination and Support Acti	5

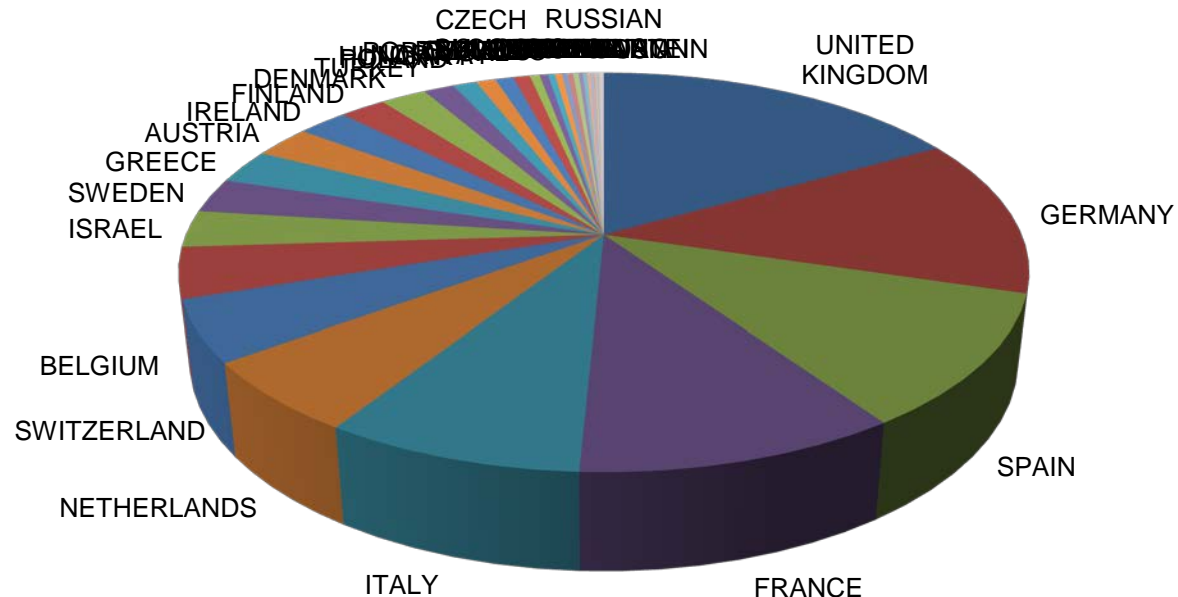
Baseline

- d. There are over 1,500 projects in CORDIS dealing with of at least partly tackling nanotechnologies (“value”: ~ 3,000 M€?)
- e. We have extracted the information about these projects from CORDIS and analyzed it by means of:
 - conventional statistics
 - data mining and
 - semantics

"Nano" FP7 Projects by contract type



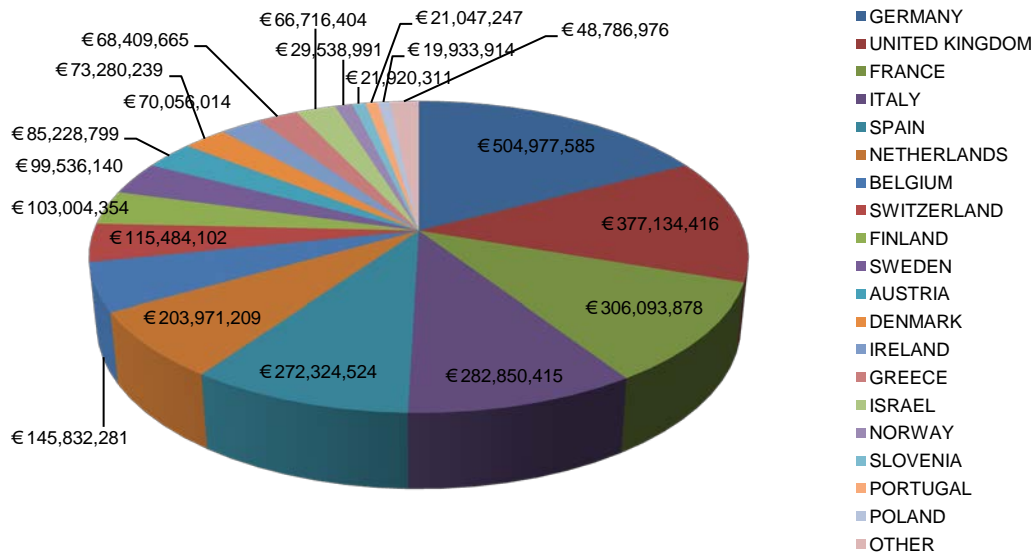
"Nano" FP7 Projects by Country (coordinator/host institution only, 1574 projects considered)



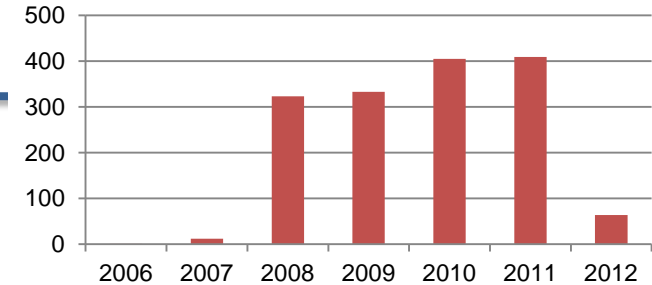
Baseline

- d. There are over 1,500 projects in CORDIS dealing with of at least partly tackling nanotechnologies
- e. We have extracted the information about these projects from CORDIS and analyzed it by means of:
 - conventional statistics
 - data mining and
 - semantics

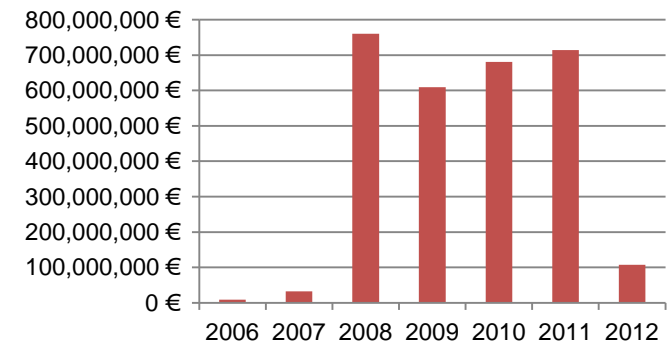
"Nano" FP7 Projects by Country (coordinator/host institution only), Funding Value



FP7 "Nano" Projects - Number of Projects Starting



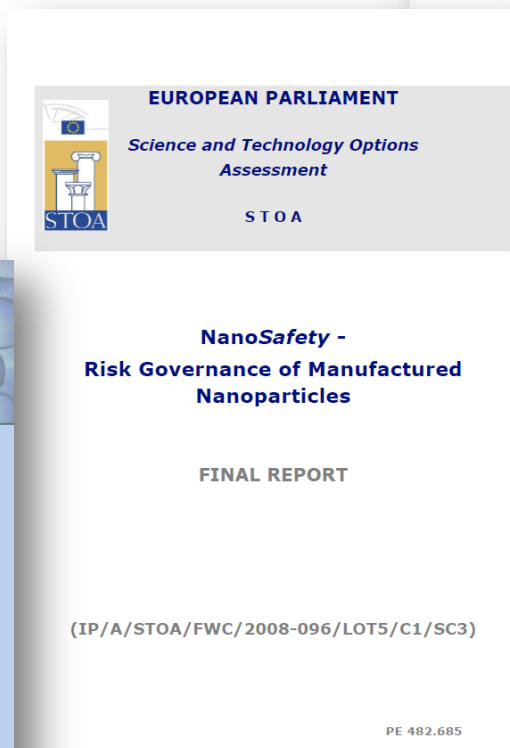
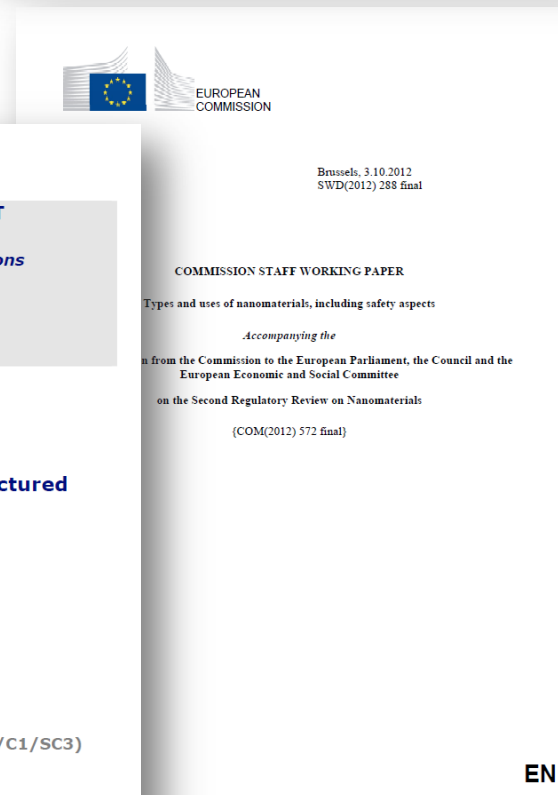
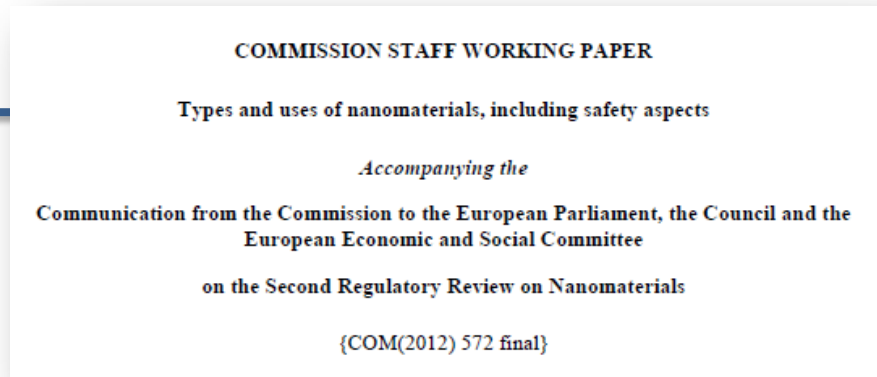
FP7 "Nano" Projects - Value of Projects Starting



Possible perspectives

Different Possible perspectives onto the issue of emerging risks and safety of nanotechnologies

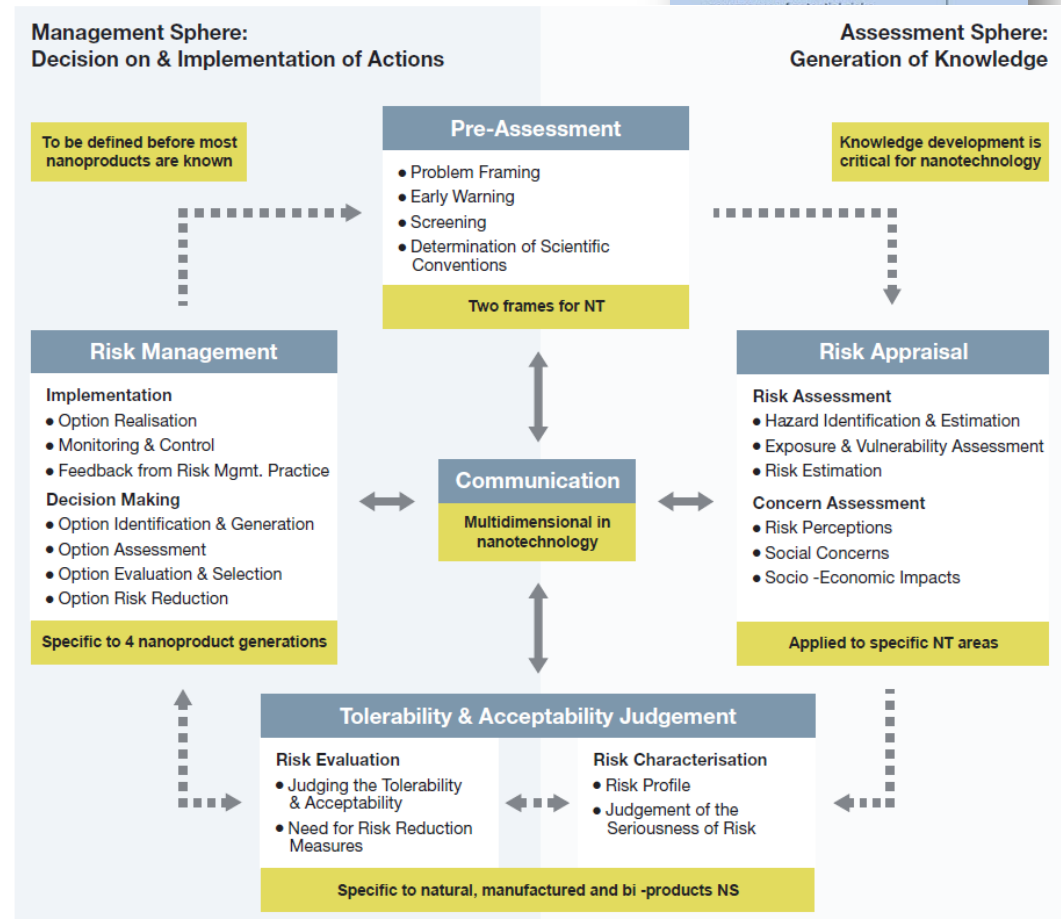
1. the nano-toxicology-oriented perspective
2. the risk assessment oriented perspective and
3. the industrial safety oriented perspective.



Possible perspectives

Different Possible perspectives onto the issue of emerging risks and safety of nanotechnologies

1. the nano-toxicology-oriented perspective
2. the risk assessment oriented perspective and
3. the industrial safety oriented perspective.



The industrial safety oriented perspective

The latter, is the perspective taken in the a number of EU projects dealing with nanotechnology, especially engineered nanomaterials, on industrial scale.

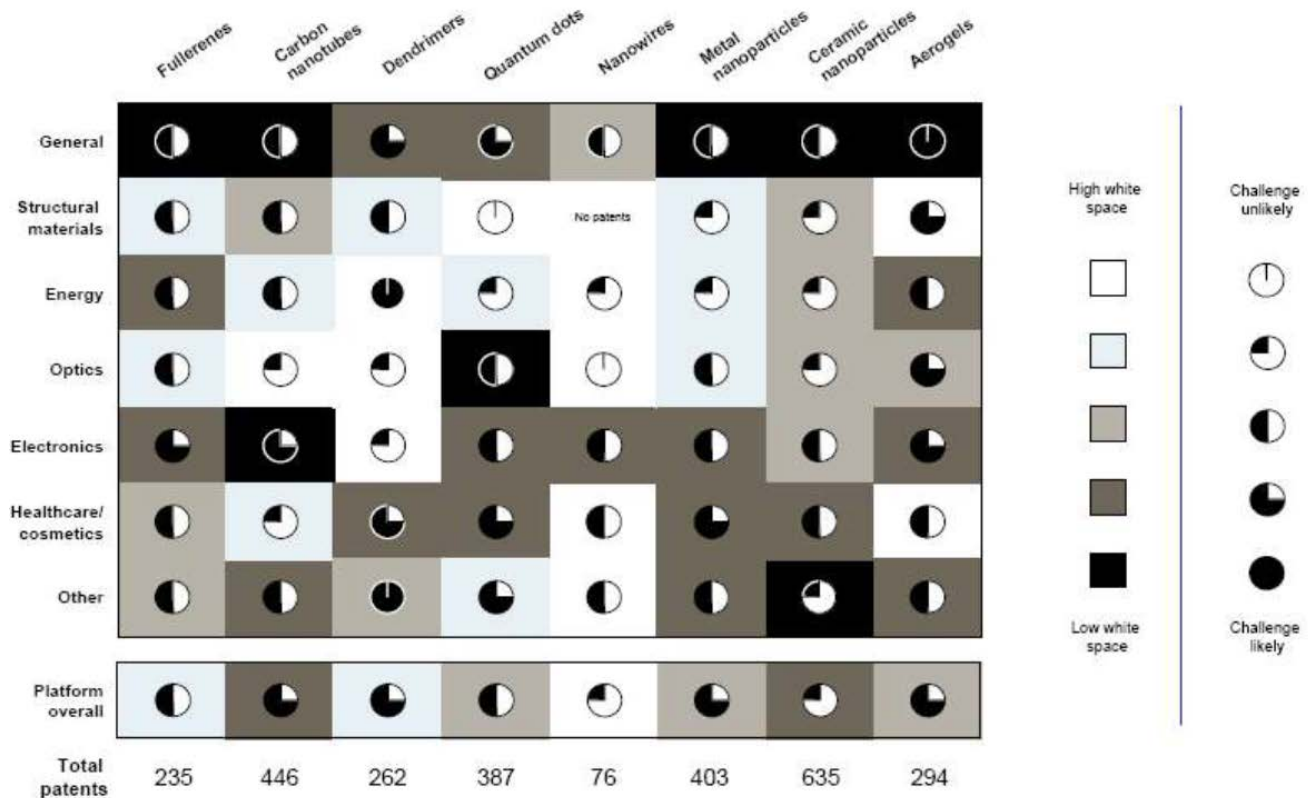
Examples:

iNTeg-Risk:	Early Recognition, Monitoring and Integrated Management of Emerging, New Technology Related Risks
Particoat:	New Multipurpose Coating Systems based on Novel Particle Technology for Extreme Environments at High Temperatures
MATRANS:	Micro and Nanocrystalline Functionally Graded Materials for Transport Applications
M-RECT:	Multiscale Reinforcement of Semi-Crystalline Thermoplastic Sheets and Honeycombs
MUST:	Multi-level Protection of Materials For Vehicles by Smart Nanocontainers
Fire-Resist:	Developing Novel Fire-Resistant High Performance Composites
HELM:	High-frequency Electro-magnetic Technologies for Advanced Processing of Ceramic Matrix Composites and Graphite Expansion
Exomet:	Physical Processing of Molten Light Alloys under the Influence of External Fields
NanoSTAIR:	A Platform to Support Standardization , Innovation and Research in the Field of Nanotechnologies
POEMA:	Production of Coatings for New Efficient and Clean Coal Power Plant Materials
NanoDEVICE	Novel Concepts, Methods, and Technologies for the Production of Portable, easy-to-use Devices for the Measurement and Analysis of Airborne Engineered Nanoparticles in Workplace Air
SCAFFOLD:	Innovative Strategies, Methods and Tools for Occupational Risks Management of Manufactured Nanomaterials (mnms) in the Construction Industry

All of them involve risks, but look at them from “PERFORMANCE point of view”...

The industrial safety oriented perspective

patent = (likely) industrial application?



... or, from a “WILL-I-HAVE-PROBLEM-THERE” point of view...

“MUST HSE Material Risk Data Sheets”



Based on:

Guidelines on the Precautionary Matrix for Synthetic Nanomaterials

Precautionary Matrix for Synthetic Nanomaterials

1 General Informations

It is recommended that the relevant accompanying documents be studied before using the precautionary matrix (www.nanotechnologie.admin.ch)

Matrix completed by / responsible contact person

Brief description of the considered nanospecific field (type of NPR, which surrounding, in which application)

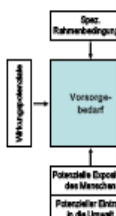
Brief description of the considered (process) step (production, packaging, transport, further stages of processing, disposal, use...), brief description

Calculation of the precautionary need for employees

Calculation of the precautionary need for consumers

Is a product requiring nanospecific disposal involved?

Are coated / functionalised NPRs involved?



SAFETY DATA SHEET MATERIAL SAFETY DATA SHEET

Last changed: 12/10/2004

Internal No.:

Replaces date: 04/02/2003

Ekofisk crude oil

3. HAZARDS IDENTIFICATION



Highly flammable



Toxic

HEALTH

Harmful by inhalation.
May cause cancer.
May impair fertility.
Harmful: may cause lung damage if swallowed.

FIRE AND EXPLOSION

Highly flammable.

ENVIRONMENT

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

4. FIRST AID MEASURES

GENERAL

Immediately move the patient from the source of exposure. If the patient is unconscious, but breathing, maintain open airways and place in stable position on one side. If breathing stops, provide artificial respiration.

INHALATION

Provide fresh air, keep the patient warm and at rest. See "General". Contact physician.

SKIN CONTACT

Flush with lukewarm water and wash with appropriate soap. Remove contaminated clothing and shoes. Use moisturizing skin cream to replace lost skin moisture. Get medical advice.

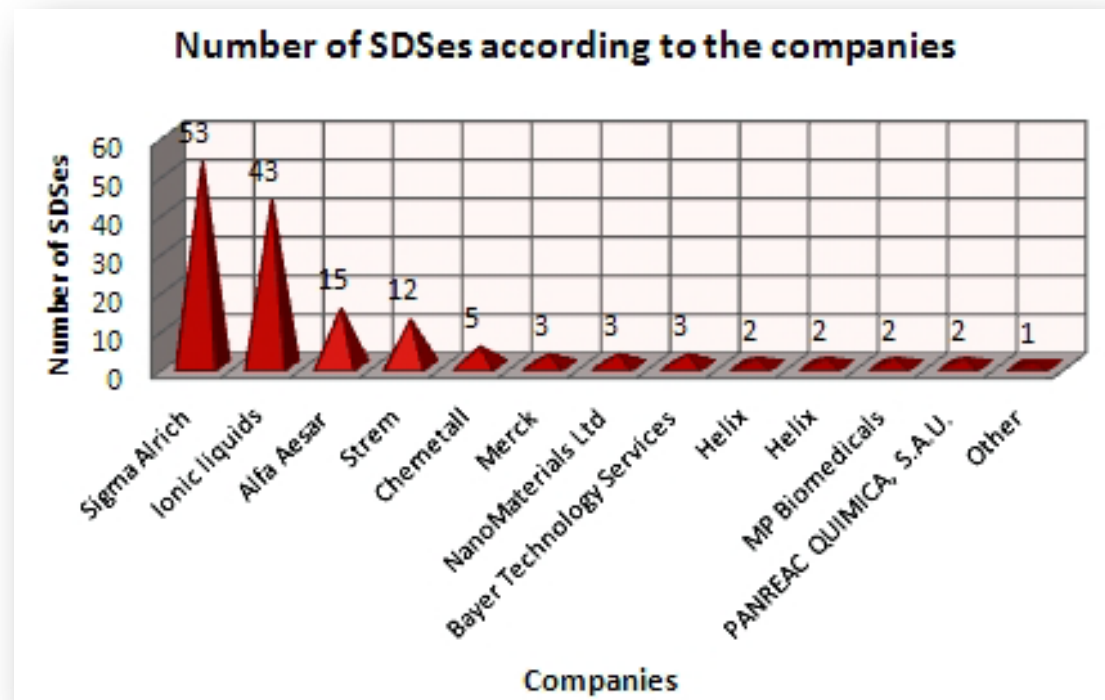
EYE CONTACT

Immediately flush with plenty of water. Keep the eyes wide open. Remove any contact lenses. Continue to rinse for



R-Tech MSDS information in the database

- MSDSs were obtained from 26 different manufacturers from 9 countries.
- Most of the European manufacturers implemented new classifications from the Regulation No.1272/2008 (CLP)
- There was a non-conformity issue in classifications and labeling statements especially in those originated from outside Europe.



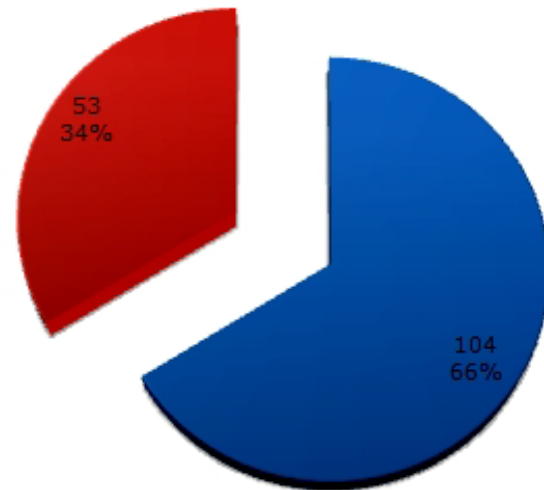


R-Tech MSDS information in the database

- 66 % of the materials in the database were classified as **hazardous**
- The most frequent hazard classification are for **known hazards**, e.g., for ENM was flammable solid-category 1 and 2 (H228) and health hazard category was serious eye damage/eye irritation (H319)

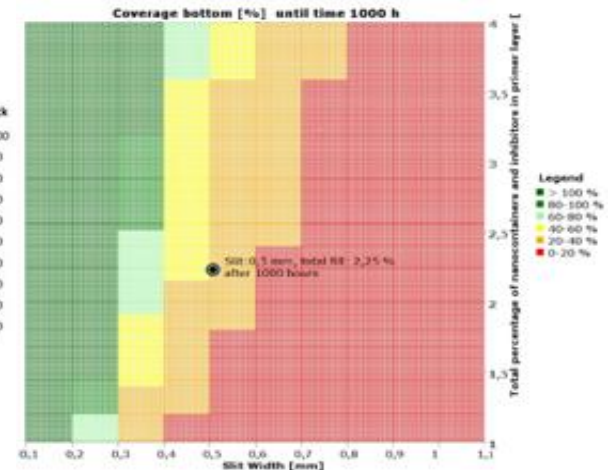
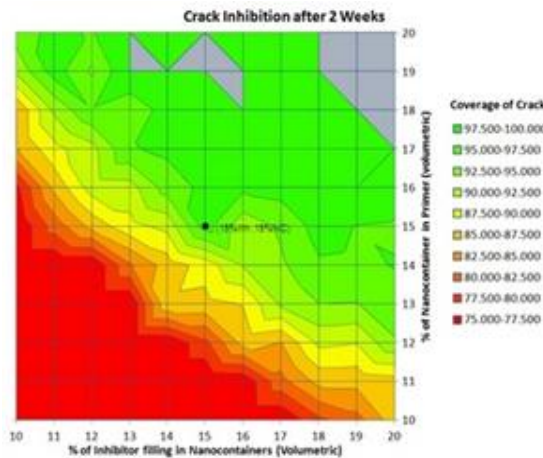
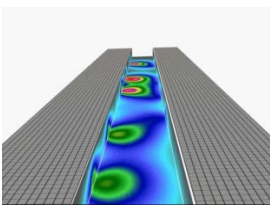
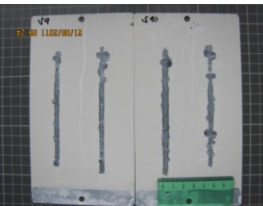
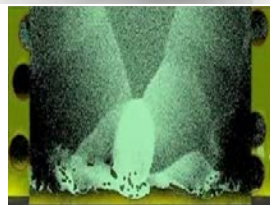
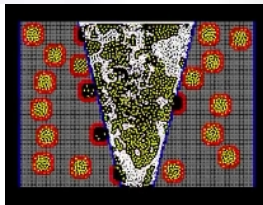
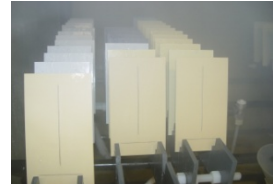
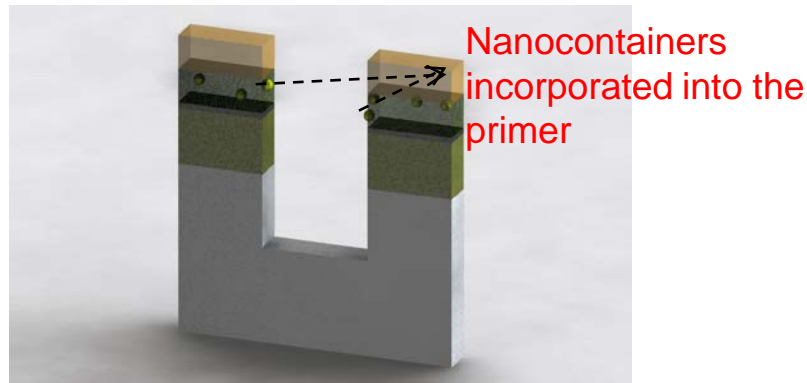
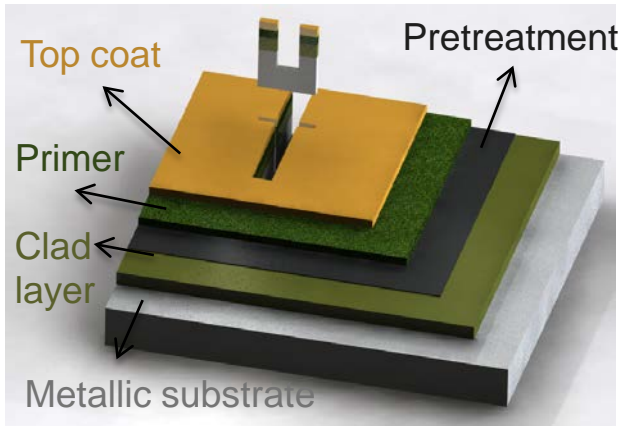
Percentage of the nanomaterials classified as hazardous according to the CLP classification

■ Hazardous ■ Non hazardous



The industrial safety oriented perspective

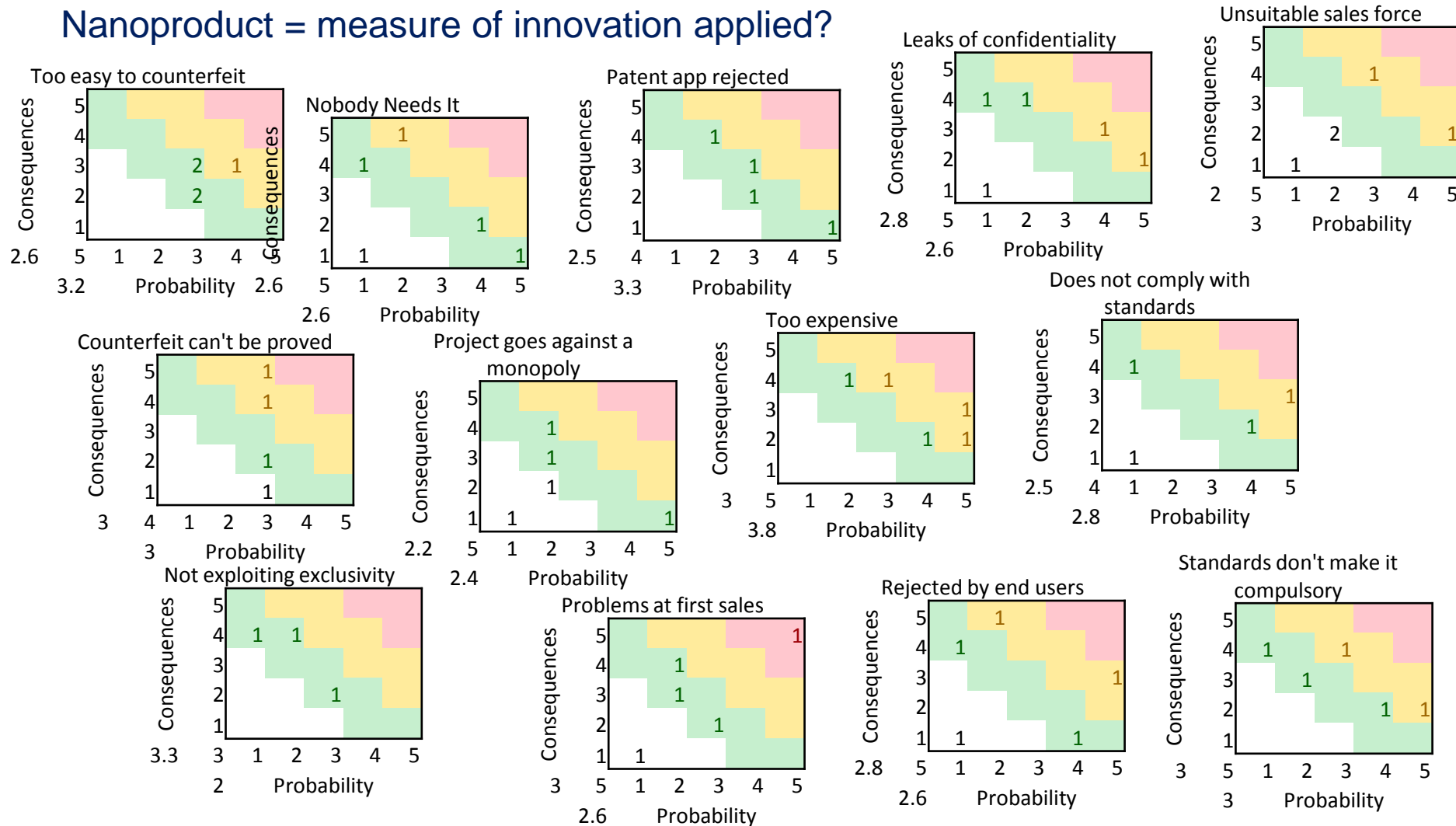
Upscaling = measure of real innovation and industrial applicability?



... or, from a “WILL-IT-WORK-AT-ALL” point of view...
And, often, it does NOT!

The industrial safety oriented perspective

Nanoproduct = measure of innovation applied?




... or, from a “CAN-I-SELL-IT” point of view.

The issues

The following issues are tackled more in detail:

- (a) recognizing emerging risks, incl. early warnings and managing the available information and knowledge
- (b) interdependencies among the risks related to nanotechnologies and other emerging risks, incl. to risk-risk tradeoffs, application of precautionary principle and identification of possible gaps in the research and safety improvement activates related to nanotechnologies
- (c) exploring public acceptance and the possibilities model it upfront

Early Recognition, Monitoring and Integrated Management
of Emerging, New Technology Related, Risks



iNTeg-Risk




Grant agreement number: CP-IP 213345-2

RISK NOTIONS

☒ Allow Paging ☒ Display short texts
 Please enter a term or terms to find:

Records Found: 38

[+ Add New Notion](#)






NotionID	Title	Short Name	Status	Description	Ed
813	Data fraud/loss			Major accidental loss of data or fraud triggers backlash aga...	
812	Nanoparticle toxicity			Studies reveal health impairment due to exposure to widely-u...	
689	(b3.14) Lack in current legal/regulatory systems may involve increasing of emerging environmental, social and technological risks.	Lack of regulation - advanced materials		Since the market of new materials developed very rapidly the...	
688	(b3.13) Advanced materials produced using new vacuum coatings processes including side products with a strong face on materials with dimensions in the nanometer scale	Lack of measurement techniques		The risk is emerging because of lack in measurement techniqu...	
684	(b3.09) Lack of data on environmental impacts of nanomaterials and nanoproducs might cause serious problems.	Lack of data - nano materials & products		Existing standards for carrying out Life Cycle Assessments a...	
683	(b3.08) Mechanisms of nanomaterial induced DNA damage	Nanomaterial induced DNA damage		The nanomaterials coming in contact with the nucleus interac...	
682	(b3.07) Effect of size, shape and surface area of nano-materials on human health	Nano-based advanced materials		The sub-100 nm size of nanomaterials is one of the primary f...	
680	(b3.05) Use of Advanced material which has new physical and chemical properties may cause undesired results	Unknown use cases of advanced materials		Engineered nanomaterials raise particular concerns because o...	
	(B3) Emerging risks related to development and use of	Risks - advanced			

The issues

The following issues are tackled more in detail:

- (a) recognizing emerging risks, incl. early warning and managing the available information and knowledge
- (b) interdependencies among the risks related to nanotechnologies and other emerging risks incl. to risk-risk trade application of precautionary principle and identification of possible gaps in the research and safety improvement activates related to nanotechnologies
- (c) exploring public acceptance and the possibilities model it upfront



SEVENTH FRAMEWORK PROGRAMME

iNTeg-Risk

Early Recognition, Monitoring and Integrated Management of Emerging, New Technology Related, Risks

Gran

Toggle

- Home
- Notions
- Submitted
- Risk Spark Candidate
- ERI
- ERI & ERRAs
- ERRA
- Super ERRA /WEF
- Watch list
- Backlist (processed)
- All Notions
- Enter New Notion
- Data Matrix

Edit
Export Page
PDF

CARBON NANOTUBES

SUBMITTED BY: MARTIN WEYMANN, SWISS REINSURANCE COMPANY LTD., ON 11/8/2010

LAST UPDATE BY: ALEKSANDAR, S. JOVANOVIC, STEINBEIS ADVANCED RISK TECHNOLOGIES, ON 3/1/2011

Status: ERI - Emerg

SHORT DESCRIPTION

Carbon Nanotubes (CNTs) are nanotechnology materials with needle like shape.

RISK STORY

Carbon nanotubes (CNTs) are nanotechnology materials with needle like shape. They have high tensile strength and are used in various applications. However, they may have health effects if inhaled. If CNTs are used in food, they may have health effects. If CNTs are used in construction, they may have health effects. If CNTs are used in medicine, they may have health effects. If CNTs are used in electronics, they may have health effects. If CNTs are used in energy, they may have health effects. If CNTs are used in transportation, they may have health effects. If CNTs are used in agriculture, they may have health effects. If CNTs are used in industry, they may have health effects. If CNTs are used in defense, they may have health effects. If CNTs are used in space, they may have health effects. If CNTs are used in other applications, they may have health effects.

ASSESSMENT

Business/Industry Areas	Economic Impact	Positive (beneficial) Impact	Negative (adverse) Impact

Importance / Emergence

Maturity

Applicable/Recommended Methods

Applicable/Recommended Frameworks

- (IRGC) IRGC Risk Governance Framework
- (iNTeg-Risk) Early Recognition, Monitoring and Integrated Management of Emerging, New Technology related Risks
- ((new) EFSA) Scientific Colloquium on Emerging Risks in Food: From Identification to Communication

IMPACT SCENARIOS

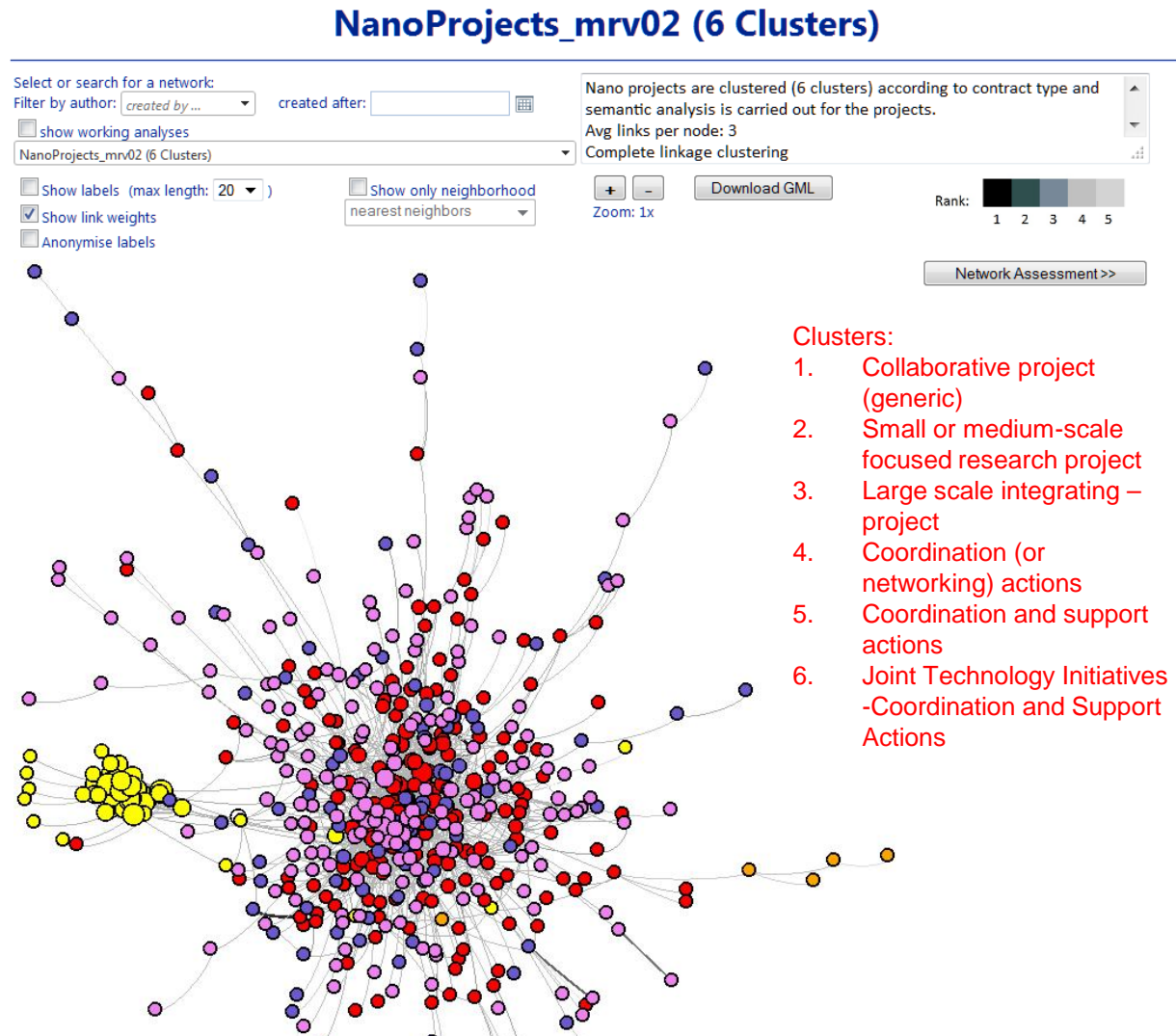
1. Workers who are exposed to and ill-protected during carbon nanotubes production could develop similar health effects as with asbestos. Small and medium sized enterprises might have less funding to protect their workers than big multinational companies.
2. Workers involved in disassembling and recycling material containing CNTs could have similar health effects as above.

RISK PERCEPTION BY STAKEHOLDERS

While nanotechnology at broad is well known mostly for its vast opportunities related carbon nanotubes risks are so far only discussed in expert journals. The nano related industries are fast growing and CNTs are already widely used in applications across industries. While the opportunities are leveraged risk research is still lacking. Therefore only a few studies exist on CNTs potentially harmful effects which are not yet discussed on a broad scale.

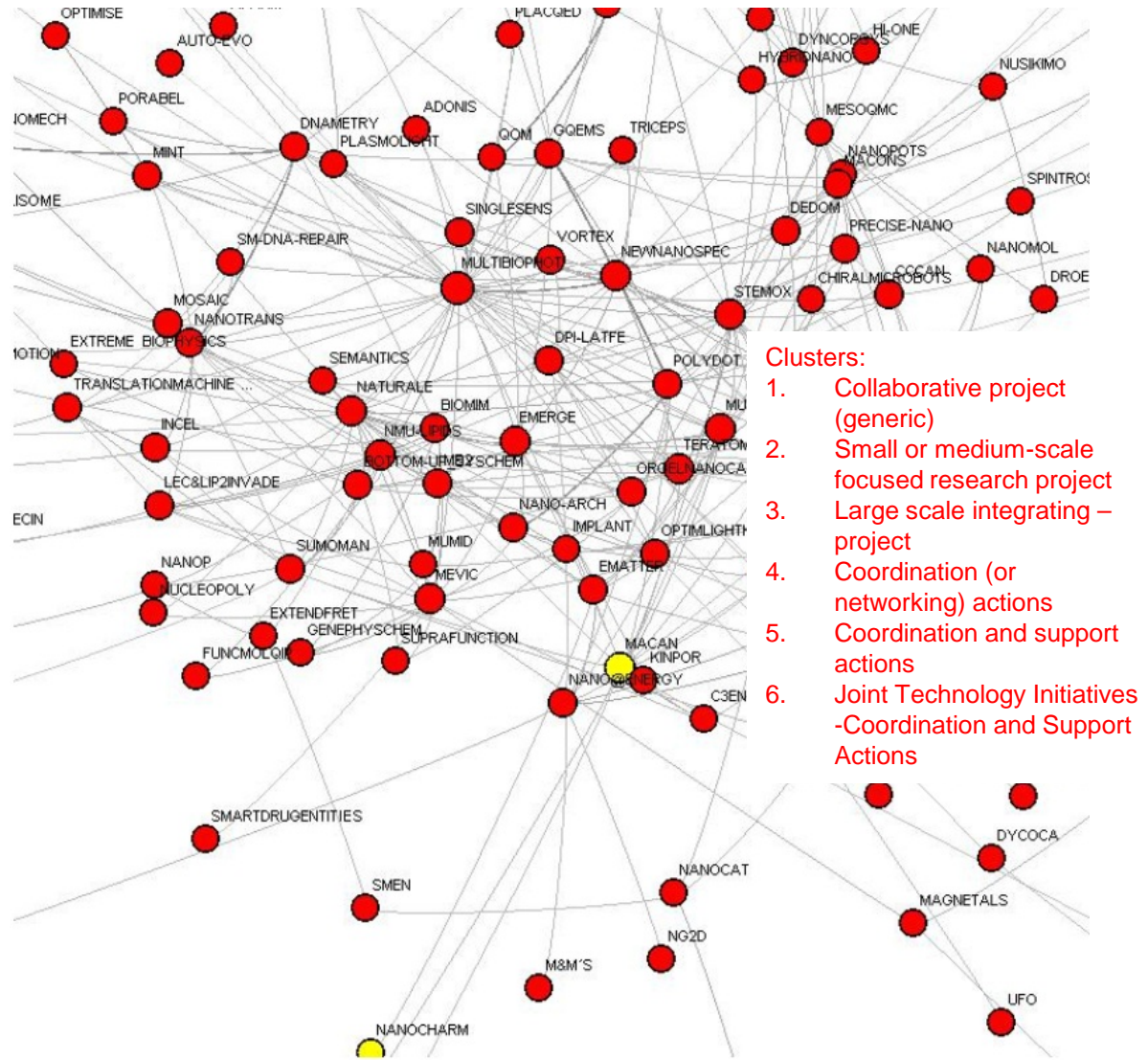
Multi-risk, interdependencies & tradeoffs

- Interdependencies among the risks related to nanotechnologies and other emerging risks
- Risk-risk tradeoffs
- Application of precautionary principle
- Identification of possible gaps in the research and safety improvement activates related to nanotechnologies

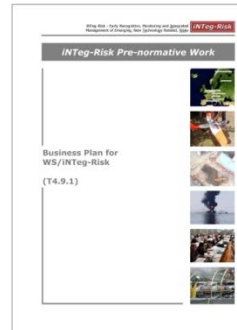


Multi-risk, interdependencies & tradeoffs

- Interdependencies among the risks related to nanotechnologies and other emerging risks
- Risk-risk tradeoffs
- Application of precautionary principle
- Identification of possible gaps in the research and safety improvement activates related to nanotechnologies



From R&D to innovation (via standardization!)



Main document

“Managing emerging technology-related risks”

based on the iNTeg-Risk Emerging Risk Management Framework

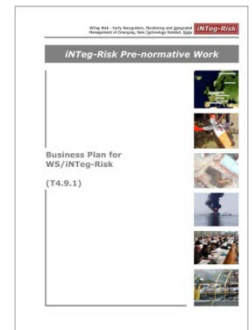
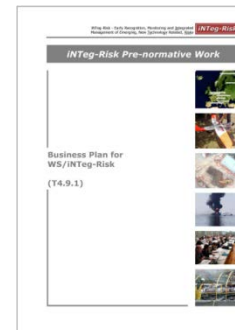
Informative Annex A :
*Emerging Risks
in New Technologies*

Informative Annex B:
*Emerging Risks
in New Materials
and Products*

Informative Annex C:
*Emerging Risks
in new Production
Networks*

Informative Annex D:
*Emerging Risk
Policies*

Informative Annex E:
*Emerging Risks
in Testing
Procedures*



Structure and content of the CWA 67

Main document

Application examples are:

- Materials & Products: **Carbon Nanotubes (CNTs)**
- Policies: Risk of changing and/or unstable **Nano-Regulation** in Europe

risks”

based on the INteg Risk Emerging Risk Management Framework

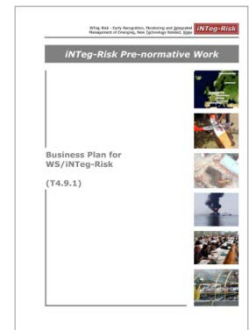
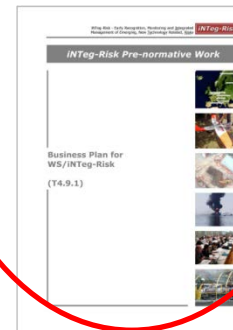
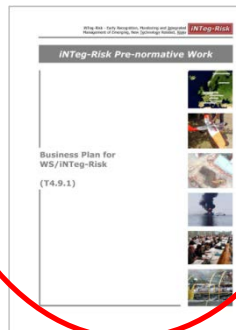
Informative Annex A :
*Emerging Risks
in New Technologies*

Informative Annex B:
*Emerging Risks
in New Materials
and Products*

Informative Annex C:
*Emerging Risks
in new Production
Networks*

Informative Annex D:
*Emerging Risk
Policies*

Informative Annex E:
*Emerging Risks
in Testing
Procedures*



Conclusions – for nano, it's much about (public) acceptance; Will perceived benefits outweigh?

NEW TECHNOLOGY ACCEPTANCE MODEL

iNTeg-Risk



Steinbeis
Advanced Risk Technologies

Benefits outweigh risks

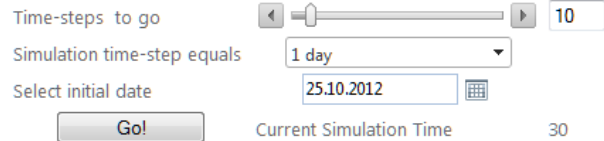
[Help!](#)

Risk-benefit specification



apply

Simulation Control



Resources:

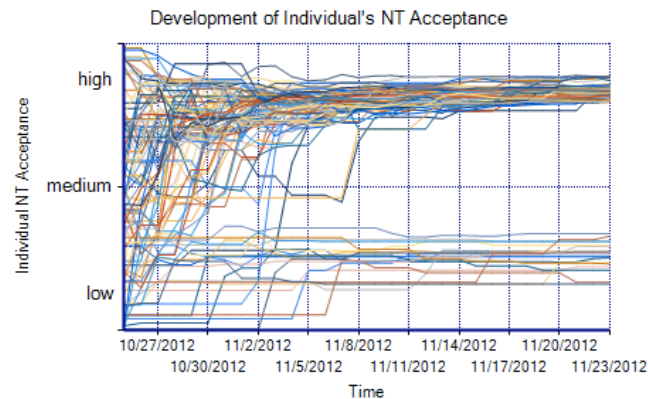
[iNTeg-Risk 1-stop-shop](#)

[RiskEars](#)

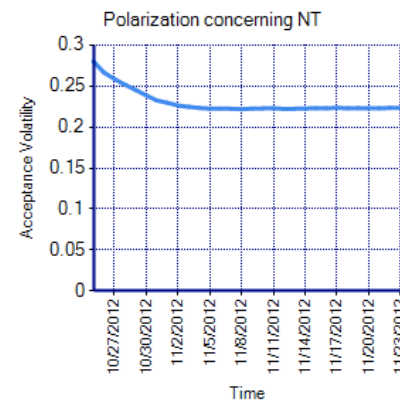
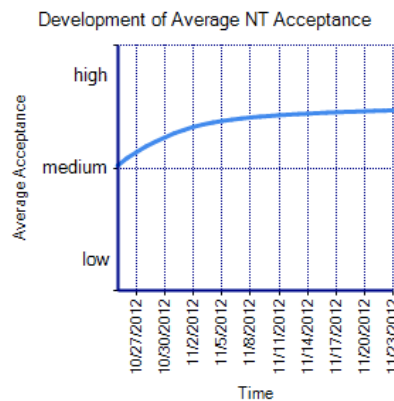
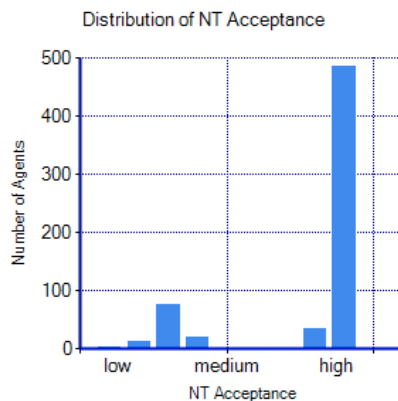
Reset

Save

Load/Delete



Trajectory of the agents
New Technology
acceptance. They are
initialized with random
acceptance values. As
time progresses, they
may cluster in one or
more groups of the same
acceptance level.



Conclusions – for nano, it's much about (public) acceptance; Will perceived benefits outweigh?

NEW TECHNOLOGY ACCEPTANCE MODEL

iNTeg-Risk



Steinbeis
Advanced Risk Technologies

Risks outweigh benefits

[Help!](#)

Risk-benefit specification

Benefits (expected)



Risk (perceived level)



Public awareness



apply

Simulation Control

Time-steps to go



Simulation time-step equals

1 day

Select initial date

25.10.2012

Go!

Current Simulation Time

30

Resources:

[iNTeg-Risk 1-stop-shop](#)

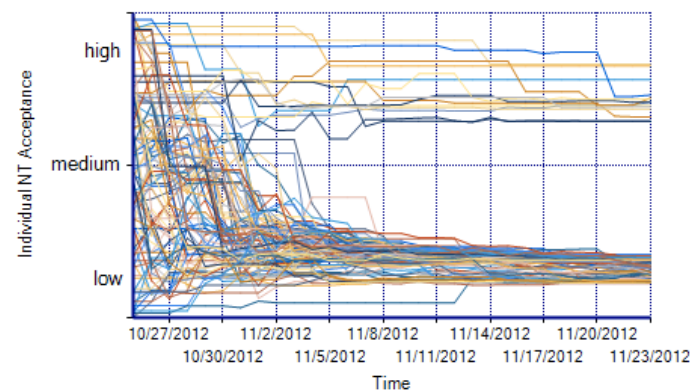
[RiskEars](#)

Reset

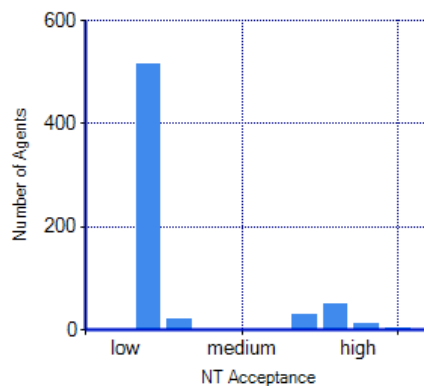
Save

Load/Delete

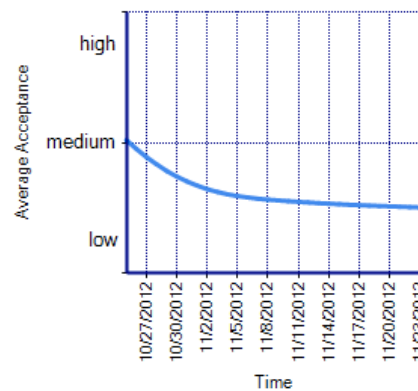
Development of Individual's NT Acceptance



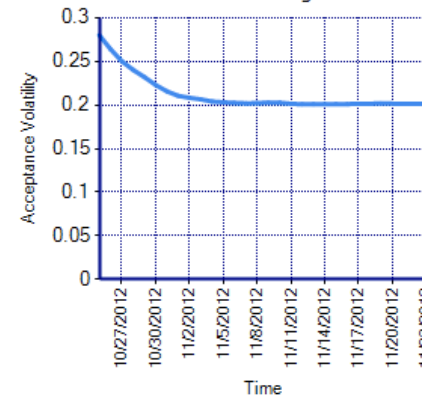
Distribution of NT Acceptance



Development of Average NT Acceptance



Polarization concerning NT



Data from: experts, articles, feed, tweets, ...

The screenshot displays the iNTeg-Risk website interface. At the top, the header includes the iNTeg-Risk logo, the text "of Emerging, New Technology Related, Risks", the EU-YRI logo, and the grant agreement number "CP-IP 213345-2". Below the header is a navigation menu with links: Home, News, Partners, Events, Results, Legal Notice, Member Area, Project Calendar, ERRAs & ERIs, 1StopShop, Risk-Ears, Risk Atlas, MethodsMart, Forums, Search, jovanovic_s, and Logou. A secondary menu includes QMS, QMS Records, and Help.

The main content area is titled "Map View: Tweets" and features a map of Europe. A legend is visible on the left. A map control bar at the top right of the map area includes buttons for "Map", "Satellite", and "Terrain", along with a "Show labels" checkbox. A zoom control is on the left side of the map.

A tweet is displayed in a callout box over the map, dated "17/Jul/12 10:53". The tweet text is: "#MIT @TechReview: how lessons from #nanotech may help #synthetic #biology mature, by David Rejeski: http://t.co/p712P30O".

On the right side of the map area, there is a "Map Views" sidebar with a list of categories and links:

- NaTechAll
- Shale Gas/Fracking/NaTech/LNG
- Countries
- Social Unrest worldwide (as in Dec, 2009)
- Tweets**
- iNTeg-Risk Home
- Shale and natural gas
- Fukushima
- iCSR reporting practices
- Critical risk distances
- Sample refinery vulnerability
- Arab Spring 2011 - Social Unrest
- iNTeg-Risk Expertise
- Tradeoffs
- Power Plants
- Earthquakes
- Volcanoes
- Sample Incident
- Nature protection areas
- RBI
- Refineries vs. earthquakes
- Risk Analysis in a Refinery

Conclusion

- Analyzing life cycle behavior and potential risks of nanotechnologies and products is an ever increasing factor of sustainable success of nanotechnologies and products. This analysis should be comparable among different projects.
- Nanosafety issues for nanotoxicology, nanorisk governance (including regulation), nanorisk assessment and for industrial safety are different, but compatible. Sustainability of the nanotechnology will be ensured only within an integrated approach.
- Ensure that the research related interests of RTD projects match those of industry

Conclusion – “Expertology” of “extended nanosafety”?

