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Gender and *Nanosciences, nanotechnologies, materials and new production technologies*

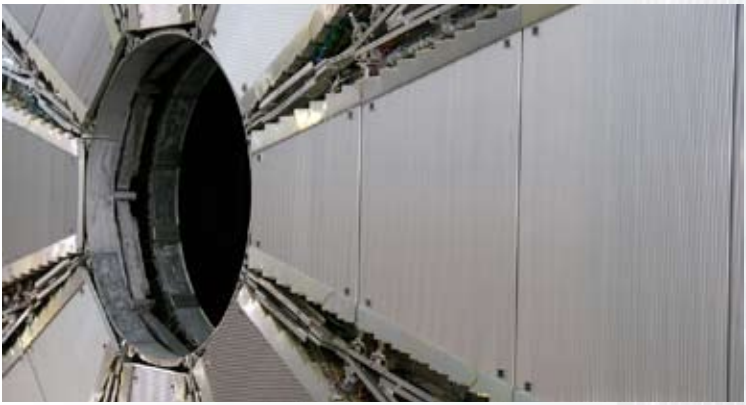
INTRODUCTION

In this part of the toolkit, we take a closer look at how gender is relevant in the specific field of *Nanosciences, nanotechnologies, materials and new production technologies* in FP7.

A first section briefly points out the broad **relevance of gender within the field**. The toolkit continues with a more specific discussion of the topics which have been put forward by the European Commission in the field's work programme. This is followed by suggestions regarding gender-relevant issues which may be taken up by the research teams.

To illustrate how planned research in the field of *Nanosciences, nanotechnologies, materials and new production technologies* can be made gender-sensitive, **three real-life examples** of projects are included. Each case consists of a short text presenting the project and a discussion of the gender-relevant issues in relation to the planned work, both in terms of equal opportunities and in terms of the content of the work. These examples are based on project summaries as they can be found on the CORDIS FP7 website[1] and relate to different topics within the field's work programme.

Finally, a selection of **useful references** dealing with gender in the field of *Nanosciences, nanotechnologies, materials and new production technologies* is provided.



[1] http://cordis.europa.eu/fp7/projects_en.html

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GENDER AND THE *NANOSCIENCES, NANOTECHNOLOGIES, MATERIALS AND NEW PRODUCTION TECHNOLOGIES* RESEARCH FIELD

FP7 *Nanosciences, nanotechnologies, materials and new production technologies* objective

The core objective of the 'Nanosciences, nanotechnologies, materials and new production technologies' theme is to improve the competitiveness of European industry and generate the knowledge needed to transform it from a resource-intensive to a knowledge-intensive industry.

NMP research also aims to strengthen the competitiveness of European industry by generating 'step changes' in a wide range of sectors and implementing decisive knowledge for new applications between different technologies and disciplines.

Funding the NMP research theme will benefit new, high-tech industries and higher-value, knowledge-based traditional industries, with a special focus on the appropriate dissemination of research results to SMEs.

How is gender relevant to this field?

The purpose of the NMP programme is to do research that fosters European competitiveness by creating products and technology applications that can satisfy a wide diversity of needs that citizens have, in their roles as producers, consumers, workers, or simply individuals. These needs include safety, comfort, health care, housing, mobility and satisfactory environmental quality.

We therefore need to keep an open mind, both as to the interests different people have, and to a wide spectrum of disciplines which include both natural and social sciences. One very powerful idea, for instance, is that of product customisation, which means paying more attention to the specific needs of each individual user. These individuals are not necessarily average white males, but can be women, children or people with disabilities, and can have all sorts of ethnic and genetic make-ups, cultural and social backgrounds, etc. They all still have the right to see their specific needs addressed.

The main difficulty seems to get the right message across, both to researchers and to Commission staff, by using the open definition of gender relevance.

This is not limited to strictly biological differences and discrimination at work, but takes social, cultural and biological diversity into account. It thus encompasses many more factors, thereby improving the quality of the technologies and of the product.

Nanotechnology is a subject of public debate. In order to foster dialogue in society, people must be informed about the advantages as well as the risks for health and environment with regard to diverse needs. Gender differences mean that communication and information must be formulated in a gender-sensitive way. Adequate dissemination of results helps to avoid gender-biased research policies.

Nanosciences, nanotechnologies, materials and new production technologies work programme

Emphasis will be given to the following activities:

- Nanosciences and nanotechnologies - studying phenomena and manipulation of matter at the nanoscale and developing nanotechnologies leading to the manufacturing of new products and services.
- Materials - using the knowledge of nanotechnologies and biotechnologies for new products and processes.
- New production - creating conditions for continuous innovation and for developing generic production 'assets' (technologies, organisation and production facilities as well as human resources), while meeting safety and environmental requirements.
- Integration of technologies for industrial applications - focusing on new technologies, materials and applications to address the needs identified by the different European Technology Platforms.

How is gender relevant to these topics?

In general, research results which focus on gender aspects in the field of nanosciences and nanotechnologies are rare. One reason for this may be that in many ***applications*** *nanotechnologies can be regarded as cross-cutting technologies. So gender aspects in applied nanosciences and nanotechnologies intersect with other research fields such as healthcare, food, agriculture and biotechnology as well as energy, information and communication. Also research on new production technologies focuses on a wide range of industrial sectors.*[2]

In dealing with ***nanomaterials****, it is the fields of health and environment that are mainly concerned. The possible toxicity of* ***nanoparticles*** *concerns women and men in different ways:*

- *Women and men are affected differently by the environment owing to their social and biological conditions;*
- *Women and men show different behaviour with regard to dealing with environmental problems and solutions;*
- *Gender-dependent user behaviour and circumstances of life may cause differences in material exposure.*

Implementing ***new technologies*** *should adopt the gender approach at a very early state of research in order to include a wide cross-section of society in discussion about acceptance and benefits. In order to increase female empowerment in research and technologies, energetic efforts must be made to encourage more women at all levels of scientific research.*

[2] Caprile, M., Sánchez, B., Vallès, N., Gómez, A., Potrony, J., Sixto, E., et al. (2008), *Synthesis Report: Aeronautics and Space - Nanotechnologies and nanosciences - Sustainable Energy Systems - Euratom - Sustainable Surface Transport.* European Commission.

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THREE EXAMPLES

Case 1
Personalised skin care

Project outline

Recent years have seen an increasing interest in 'personalised health care', based on personalised diagnoses and treatments, especially concerning the biocompatibility of drugs. This evolution has been accompanied by the development of innovative technologies capable of identifying specific biomarkers.

Existing research shows that subjects diagnosed with the same skin syndrome respond differently to given treatments. As a result of the understanding of high skin type variation among the population, the possibilities of 'personalised skin care' are considered. The underlying idea is that each person should be treated based on his own "epidermal personality", defined by his unique and specific set of skin features, characteristics and conditions.

Recent molecular studies have provided evidence that specific biomarkers can be identified as molecular signatures associated with a certain skin syndrome. Characterising these molecular biomarkers per person should lead to a better diagnosis along with the selection and preparation of more effective treatments. The project aims to develop and implement such personalised skin therapy and will thus revolutionise skin treatment: for every individual client, the dermatologist will be able to identify the molecular-based skin specification, following which he can develop a unique remedy targeting the client's "one-man syndrome".

The project intends to develop and validate nano-chemical and biotechnologies to achieve an accurate matching of drugs, and drug delivery vehicles, for skin diseases and sub-pathogenic skin conditions in their individual context. Individual data on patients' histories, diagnoses and therapeutics will be considered for the development of a fully personalised skin treatment.

The project will design a novel generation of pharmaceutical products, as well as a system of consumer service personalised to fit each individual customer's needs. The development of personalised skin therapy protocols requires achieving an accurate diagnosis of skin condition and an extensive analysis of biological markers. Non-invasive methods as well as minimally invasive skin sampling will support the establishment of a range of biological profiles corresponding to skin diseases and skin sub-pathogenic conditions. Statistical processing of these data will allow biomarker patterns specifically associated with given clinical conditions to be defined.

A bio-informatics data mining protocol will be elaborated, together with multifunctional biomarker analysis software, to build a refined, personalised diagnosis method. Finally, the computer data analysis will yield a decision support system (DSS) to assist dermatologists, pharmacists and clients in the prescription of personalised treatment. This concept will be evaluated by a pilot study for a few selected skin diseases like psoriasis, contact dermatitis, and UV skin photo-aging. The pilot will also address customers' expectations regarding the marketing of the final product in terms of time of delivery, quantity, odour, package design and decoration. This stage will be accompanied by the development of personalised services and marketing strategies. The entire concept will be validated on volunteers with skin diseases and compared with conventional treatments and services.

The project consortium consists of 15 organisations and is based on a partnership between SMEs and research institutions.

Identification of relevant gender issues

Equal opportunities for women and men in research

It is important to ensure an acceptable gender balance in the project consortium and team, both overall and within each partner organisation. As women tend to be under-represented in biomedicine, it is likely they are under-represented in the consortium partners' organisations too. The project can offer an opportunity to question and address the reasons and mechanisms underpinning this under-representation.

Gender in research content

Both the concepts of sex and of gender are relevant to the planned work and the conceptual distinction between both is necessary, especially for disciplines like biomedicine and health sciences.[3]

[3] Klinge and Bosch (2005), Transforming Research Methodologies in EU Life Sciences and Biomedicine. Gender-Sensitive ways of Doing Research. State of the Art. EJWS 12(3): 377-395.

Sex, as a biological variable, should be addressed because the incidence of specific skin diseases among men and women may differ, as might their manifestation (symptoms), evolution and reactions to treatments. Lack of sex recognition during the research may lead to inequalities in the effectiveness of treatment, which would ultimately lead to unequal health outcomes for men and women and a poorer impact for the project. It is thus important that the samples of patients involved in the research have an adequate male-female balance, so that statistically relevant conclusions can be drawn for both sexes. Logically, all analyses will have to take the sex variable into account, so that significant differences can be identified. In the dissemination phase, relevant differences supported by disaggregated data should be reported.

The project outline notes that a pilot study will be run for a few selected skin diseases. To avoid a gender bias, these diseases will have to be selected gender-sensitively (i.e. taking into account possible differences in prevalence between men and women).

Gender is also relevant to the project work in different ways:

- the prevalence of certain skin diseases might differ between the sexes owing to different behavioural patterns of men and women (e.g. total lifetime exposure to harmful solar rays),
- skin diseases might on average be diagnosed at a later stage of their evolution in men than in women owing to higher uptake of medical services by women than by men.

In the literature, a multitude of influences are described to explain the higher uptake of medical services by women, such as the level of knowledge of the disease or awareness of associated services, the perceived risk and associated level of distress, health care seeking behaviour and/or attitude (e.g. acceptance) towards medical examinations of the patient. These factors, which depend to a considerable degree on the specific diseases as well as the population, deserve to be considered as they might have direct implications for the project (for example, in the response male and female patients might have to personalised treatments).

The project will analyse 'customers' expectations' regarding the marketing of the final product. These 'customers' will be men and women, who might have different preferences. It is therefore useful to arrange for an adequate balance also in this sample of respondents, so that the final marketing decisions that will be taken appeal to the highest possible number of future customers.
Gender-neutral marketing takes care of the design of packaging. This may already be important in the evaluation phase.

Finally, it is worth noting that the language used in the outline is not gender-neutral: both the person to be treated and the dermatologist are referred to as if they were male, by using the terms 'he' and 'his'. Also the phrasing "one-man syndrome" suggests that the possibility of women suffering from skin diseases may be ignored. The use of a gender-neutral formulation (s/he, his/her, etc.) will show the project's sensitivity to gender issues, thereby indicating its willingness to involve the population of stakeholders in its entirety.

Case 2
Medical imaging

Project outline

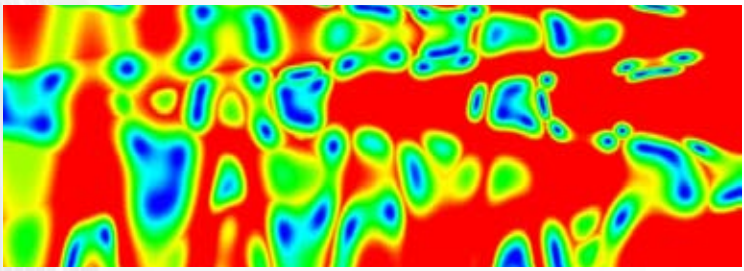
The project will develop an innovative medical imaging technology, based on magnetic nanoparticles combined with submicronic bubbles and dye.

The objective of the project consists in developing tailored biocompatible magneto-optical nanosystems based on magnetic iron oxide nanoparticles. The project will comprise the elaboration of the nanosystems and the characterisation of their structural, optical and magnetic properties. In vitro and in vivo tests will be carried out to test their biocompatibility.

The combination of magnetic and optical properties will be achieved through hybrid nanoparticles made of a magnetic iron oxide core on which an organic layer (dye) will be grafted through a dendrimer molecule and a phosphate entity. This grafting strategy will be extended to bubbles to which magnetic nanoparticles will be attached. The grafting sites will be controlled in order to design new geometries and architectures from rings up to submicronic magnetic spheres. Magnetic nanoparticles with monodisperse size between 2 and 100 nm will be elaborated in order to increase the possibility range of achieved properties.

The opto-magnetic nanoparticles will be tested in a medical application and a dedicated magneto-optical probe will be fabricated. Current methods for labelling the lymph node system use a dye (vital blue) or radionuclide injection detected through optical or gamma probes, respectively, or a combination of both types of markers.

Combining optical and magnetic labelling into a single biocompatible nanosystem will provide higher spatial resolution than presently, and will avoid using ionising radiation, thus improving patient safety and medical effectiveness. Stabilised submicronic bubbles labelled with the optical-magnetic nanoparticles will play the role of a contrast agent currently used in ultrasound imaging and will facilitate the uptake of the iron nanoparticle, therefore improving node imaging.



Identification of relevant gender issues

Equal opportunities for women and men in research

As women tend to be under-represented in the nanosciences and nanotechnologies, it is likely they are under-represented in the consortium partners' organisations too. The project can offer an opportunity to question and address the reasons and mechanisms underpinning this under-representation.

Gender in research content

The sex variable is especially relevant to the planned work, because male and female bodies might react differently to the substance that will be developed. The biocompatibililty of the solution, and thus its effectiveness, might be different for men and women. For instance handling iron oxide nanoparticles may cause health risks whose relevance can be sex-dependent.

It is important that the samples of patients who will be involved in the research have an adequate male-female balance, so that statistically relevant conclusions can be drawn for both sexes. Logically, all analyses will have to take the sex variable into account, so that significant differences can be identified. These differences should be reported in the dissemination phase, with supporting disaggregated data.

The project will undertake in vitro and in vivo tests, which will involve ethical decisions and considerations. Ethical considerations and decisions are underpinned by moral values and norms which might differ for men and women. Furthermore, ethical decisions concern women's and men's lives and due consideration of how the decisions affect these is needed.

Case 3
Customised production

Project outline

This project proposes to develop a system for the design, production and online commercialisation of customisable clothing items. It will develop and test a new production model based on decentralised networked SMEs.

This approach will not only interlink critical Mass-Customisation (MC) enabling services, it will also adapt these services to the specific needs and preferences of the target customer groups. It will enable and encourage end consumers to play an active role in designing customised items.

Garment design options will be provided in the form of 3D simulated dressed humans. Users will be able to choose a style, change texture and size and do some limited editing on the garment design. An application for users to virtually try on simulated garments will also be developed.

The selected product configuration will influence the production scenario. Central to this scenario is the concept of the Virtual Customer Advisor (VCA), which, depending on the profile of the customer, will recommend the optimum product configuration. This recommendation is based either on style preferences, functional requirements (e.g. for protective clothing or sportswear), or issues related to body morphology, physical disability or problem figures.

In the upstream part of the chain, this network will introduce the innovative organisational concept of the networked Micro-Factory (MF), directly linked to the concept of User-Centred Production Configuration. The MF concept promotes the idea of decentralised production close to retailers and consumers (giving a proximity advantage). MFs comprise networked small-sized but high-tech MC production sites, as well as sites equipped with automatic knitting machines, or even semi-automatic 3D assembly centres (single-ply cutter + sewing robots).

The knowledge-based web services will integrate style expertise, human body expertise and data, material and specific manufacturing knowledge.

Identification of relevant gender issues

Equal opportunities for women and men in research

SMEs are a target group that is quite difficult to reach with specific messages. The fact that the project will network a number of SMEs offers an opportunity for awareness-raising in these companies of the positive impact that diverse teams have on the quality of work. The project team leader can point out the need for a sex-balanced project team to the organisations that take part in the project.

Gender in research content

The outline does not specify whether the target customer groups will be both women and men or whether the service will be available to only one of the sexes.

In either case, the question can be asked whether the 3D simulated dressed humans' bodies will reflect the diversity of morphologies of the future clients who are likely to use the system – as this is precisely one of the added values of the system that are claimed. Also, it will be a challenge for the system not to build in (and thus to reproduce) gender stereotypes, notably in the styles, colours, textures, models and even in the types of garments themselves that will be offered to men and women respectively.

In summary, care should be taken that the choices that will be made available to men and to women do not reduce the future clients to the stereotypical man or woman but allow a variety of personalities to co-design the garment of their choice.

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USEFUL READING

Caprile M., Sánchez B., Vallès N., Gómez A., Potrony J., Sixto E., et al. (2008), *Monitoring towards gender equality in the 6th Framework Programme* - Synthesis Report: Aeronautics and Space - Nanotechnologies and nanosciences - Sustainable Energy Systems - Euratom - Sustainable Surface Transport, European Commission.

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Van den Brandt E. (2006), *Ambition without Future? Obstacles and Stimuli in the Careers of Men and Women in Optics*, Centre for Gender and Diversity, Vrije Universiteit Brussel, http://www.equalisnotenough.org/followup/papers/ElkeVandenBrandt.pdf (25.03.2009).

For further information and useful links, please consult the Gender in Research Toolkit and Training website under www.yellowwindow.com/genderinresearch.