

Two page exercise on the University of the 21st Century (by Marie Farge)

1

University is a place where students experiment:

- *self-development*,
- *independence* (they learn to live far from their family),
- *freedom and responsibility* (they are there by their own choice and for their own sake),
- *friendship and social life* (they learn to live with others and develop a network nurturing their personal and their professional life),
- *knowledge* and methods to acquire and assess it.

2

In the present pattern the period of life spent at University corresponds to the transition from childhood and to adult life (maturity). It plays a similar role as the initiation traditional societies offer to perform this transition. It is also the period where one can freely experiment sexuality and even found a family.

In my view, the access to *University should be open to anyone*, whatever his/her age (on the model of College de France in Paris). University should be a place where you can take a break when you need to reflect on your life and acquire knowledge (for instance when you have lost or drop your job, or as a transition when you retire).

3

I did a Master of Science at Stanford in the seventies. Being a woman I could not apply to Ecole Normale Supérieure-Ulm, nor to Ecole Polytechnique. I therefore chose Stanford and got a grant from the French Ministry of Foreign Affairs to pay my tuition, together with two teaching and research assistant grants from the university. The main qualities of Stanford University for me are:

- *very wide choice of courses* which always evolves (see the 858 pages of the Stanford Bulletin for 2009-2010 on [//www.stanford.edu/dept/registrar/bulletin](http://www.stanford.edu/dept/registrar/bulletin)),
- *flexibility to choose* the courses you want 'a la carte' under the guidance of your advisor who is there to support (not to judge),
- *be treated as an adult* (student-professor are based on mutual confidence) and given academic responsibilities,
- *international team work* (my friends and colleagues were mostly from Asia, Latin America and Canada),
- *students are at the core* of the University mission (they are precious to both professors and administrators).

I consider that these five qualities should be shared by any university since they do not depend on finance but on the attitude towards students.

Tutors and advisors acting as mentors are the secret of few top American and two British universities. It is a luxury which should be preserved, developed and reproduced, but the cost there is too high. A way to go around that constraint could be to hire graduate students to mentor undergrads.

4

University should realize that *the world has drastically changed since the seventies*. I just list few changes:

- *children brain is wired differently* from ours, thanks to computers, cell phones, video games and internet,
- exchanges of information, goods and humans are made at *global scale* (on Earth and in space),
- *productivity* has boosted and wasting time is no more allowed.

5

Since we have the Web and Google, the problem we face is no more to access to knowledge, but *to sort information and assess its quality*. This requires to reinforce the critical posture necessary to develop knowledge. We should give intellectual tools for this to our students, as early as possible in the course of their studies.

The *development of databases* has become an important part of research activity and students should be trained to use them, but also to enrich them, criticize them and create new ones. *Data processing* and *statistical methods* are skills they should master to retrieve, analyze and represent the information content of databases.

6

The way we do research in physics, mathematics and computer sciences, which are my fields of expertise, has drastically changed from individualist towards *team activity* (note that a team could be made of scientists spread all over the planet, as it is the case of mine). Having team work in mind, I consider counter productive the way students are presently ranked on a competitive basis. Ranking develops suspicion towards others seen as competitors, together with frustration and a need of revenge which may be transmitted to the next generation. *Collaborative work* should encouraged and *self or mutual grading* should be tried.

7

Knowledge is a 'common wealth' made to be freely shared, not to be sold. When you invite someone for diner at home, you do not ask him/her to pay a bill. When you speak, you do not pay fees for using a language. Knowledge as friendship or language should remain freely accessible. Today there are drastic problems to address concerning the present trend towards the private control of publications and patents. We should develop new legislation requiring that research which has been produced using taxpayer money, or produced in the past, should have *free open access*. Solving that issue condition the way knowledge could be taught and curricula chosen at University.

One last advice: as for cooking (*'choose good ingredients and don't spoil them'*), University should choose good students (capable and motivated) and do its best for not spoiling them.

**Two page exercise on an example of curriculum
for the University of the 21st Century
by Marie Farge, Berlin, January 12th 2010**

I propose a series of 12 lectures (2 hours each) presenting physics from a cultural point of view. My argument is that physics is an integral part of modern culture and should be taught to humanity students in a non-technical way. I will focus on what a 21st Century 'honnête homme éclairé' should know about physics to understand its present evolution.

1 Representations and tools

Continuous representation, differentiability and integrability.
Discrete representation, approximations and sampling theorem.
Harmonic representation, Fourier and wavelet analysis.
Statistical representation, averages and ergodic theorem.
Probabilities, random processes and central limit theorem.

2 Basic notions and principles

Space-time referential and relativity principle.
Velocity, acceleration, mass, force and inertia principle.
Energy conservation and least action principle.
Temperature, internal energy and maximum entropy principle.

3 Classical mechanics of a particle

Dynamical system, linear and nonlinear motions, stability, predictability, chaos.

4 Classical mechanics of a field

Continuous field, gravitation, fluid mechanics, waves, electromagnetism.

5 Statistical mechanics of an ensemble of particles

Statistical equilibrium, Brownian motion and diffusion.
Scaling and phase transition.
System out of equilibrium and irreversibility.

6 Quantum mechanics of a wave-particle

Radiation, atoms, wave-particle dualism, quantum states, elementary particles.

7 Methods

Observation and laboratory experiment.
Theory and modeling.
Numerical simulation, data processing and data assimilation.

- 8 Turbulence and aerodynamics**
- 9 Meteorology and climate**
- 10 Plasma physics and thermonuclear fusion**
- 11 Geophysics and Solar physics**
- 12 High-energy physics and astrophysics**

These last five courses will present different applications of physics, explaining the problems under study, the state of the art of present research and the remaining open questions. The content of those five courses will be given later.

In complement to the course, students will be asked to choose a topic related to physics, for which they have a particular interest. They will gather information about it, read papers, discuss them with me, or with specialists I will advise them. From there, they will prepare a Web site presenting the topics, its historical evolution and its present status. To advertise for their Web site they will also prepare a poster and give an oral presentation followed by an open discussion with the audience. They will be graded for the quality of their Web site, poster and oral presentation, together with their assiduity and active participation to the course.