Helsinki Learning System

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On-line education

"The next big killer application for the Internet is going to be education. Education over the Internet is going to make e-mail usage look like a rounding error."
- John Chambers, President and CEO, Cisco Systems, Inc. (Source: The Conference Board of Canada)

Expectations

- Virtual educational material will replace current text books
- On-line distance learning will be a low cost alternative to traditional class-room education

Reality

- Text books will stay for many years
- On-line distance learning will attract only a small fraction of students during the next several years

Why so pessimistic?

- Development of educational materials that use the potential of the new media in a right way will take a long time – a new paradigm has to be born
- Broadband access to internet is not yet available for those who otherwise would choose distance learning as their preferred mode of studying

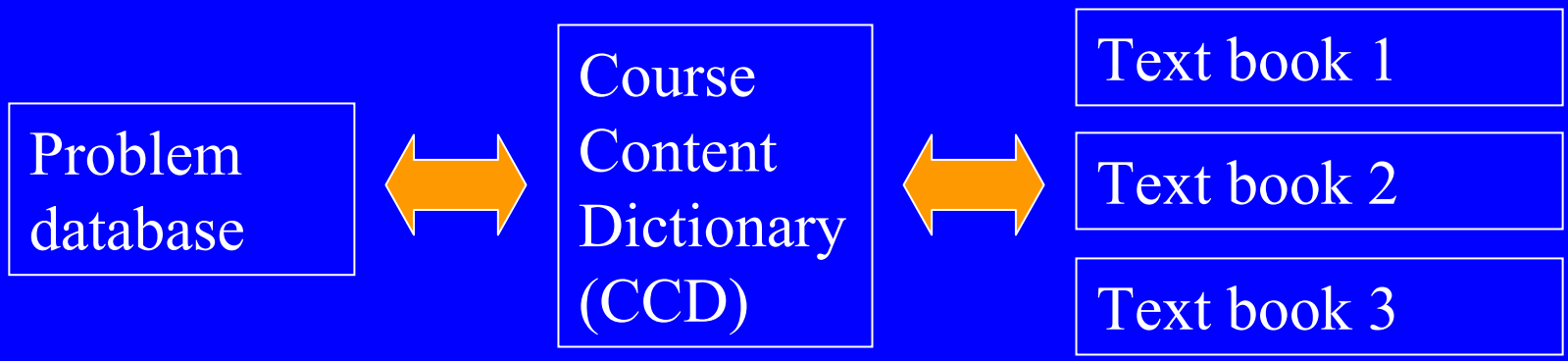
Keys to success

- Find methods to enhance traditional teaching by new tools
- Aim for distance learning but design for class—room use first
- Offer new services
- **Our solution: Helsinki Learning System (HLS)**

Elementary Problem databases

- Have been used extensively in low level math courses at FSU
- Allow students to perform self-assesments prior to taking examinations
- Have reduced the failure rate by about 50%

HLS Adaptive problem databases

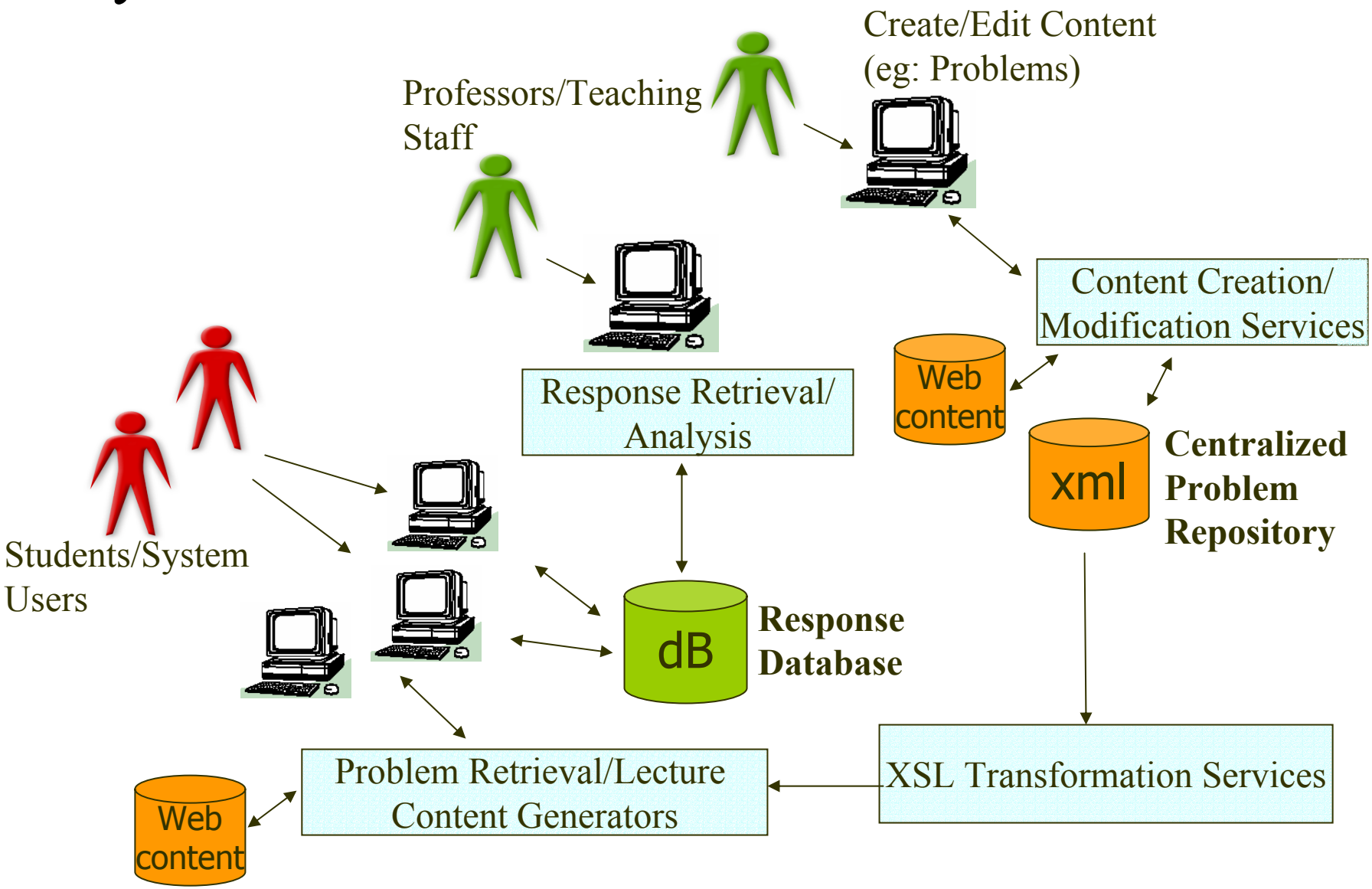


The MAMMA project headed by J. Väänänen and M. Seppälä has developed an adaptive intelligent learning system that will enhance traditional books. Via the on-line CCD, the problem database can be used with any text relevant to the course in question.

Main features of HLS

- The system is multilingual
- Exercises are problem trees with different feed-backs to correct, wrong and ’I do not know’ answers
- When used in exams, the problem tree structure allows automatic partial credit

System Architecture - I



Main technical features of HLS

- Developed in Java – Using the latest Java Servlet and JSP technologies.
- Java and XML – Cross-platform deployment
- Not a static system, unlike many standard class websites.
- Can be integrated with existing courseware like eGrade, Blackboard etc.

HLS Exercises are problem trees

Root problem

$$\int \frac{x^5 - x^4 + 2x^3 - x^2 + 2x - 1}{x^3 + x - x^2 - 1} dx$$

1

Divide the polynomials

2

$$\int (x^2 + 1)\,dx$$

3

Find partial fraction decomposition for

$$\frac{x^2 + x}{x^3 - x^2 + x - 1}$$

4

$$\int \frac{dx}{x - 1}$$

5

$$\int \frac{dx}{x^2 + 1}$$

HLS Problems are XML files confirming to the Problem DTD

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    \webapps\mathapp\xmlrepository\mpb.xml">
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      <TimeStamp>2001-11-01</TimeStamp>
      <Author xlink:href="http://www.helsinki.fi/~ahalko/">Aapo Halko</Author>
      <CopyrightOwner>University of Helsinki</CopyrightOwner>
      <Level>10</Level>
      <RelevantText>Hughes-Hallet et al. edition 4, Stewart edition
        5,http://calculus.math.helsinki.fi/</RelevantText>
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      <SubTopic xlink:href="">Chain rule and its applications</SubTopic>
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      <CopyrightOwner>University of Helsinki</CopyrightOwner>
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HLS Problem Editor

Topic: Applications of integration

Applications of integration

Topic url: index.htm

SubTopic: Volumes of solids

Volumes of solids

SubTopic url: Applications2/1.tex

SubSubTopic:

SubSubTopic url:

Root: ☑

Include I do not know button: ☐

Level: 56

Subproblem 1: ah00031

Subproblem 2:

Subproblem 3:

Copy English version to other versions

English version

Problem text

```
A circle $x^2+(y-2)^2=1$ rotates around the $x$-axis. What is the volume of
this resulting torus?
```

HLS Exercise Editor

id	1
Author	Juha Nurmonen
Copyright owner	University of Helsinki
Relevant text	Hughes-Hallet et al. edition 4, Stewart edition 5,http://calculus.math.helsinki.fi/
Exercise type	MC
Topic	Integration techniques
	Integration techniques
Topic url	index.htm
SubTopic	Integration by substitution
	Integration by substitution
SubTopic url	IntegrationTechniques\Substitution\1.tex
SubSubTopic	Computing integrals by substitution
SubSubTopic url	

Problem sequence

Problem ref	mpbch.xml#jn00068
Order	1
On correct	
Display solution:	☐
Go to	
	Congratulations! That was correct.

Single Variable Calculus

Mika Seppälä

System Requirements

Powered by

and

Mathematics displayed by

Meaning of the word "calculus"

Oxford English Dictionary definition for "calculus"

Computing integrals by substitution

By the definition, we compute antiderivatives or indefinite integrals by finding somehow a function whose derivative is the given function. For this purpose we may use a table of derivatives of known functions.

More powerful methods are offered by the chain rule and by other rules for computing derivatives.

Recall that by the **chain rule**,

$$\frac{df(g(x))}{dx} = f'(g(x))g'(x).$$

Example Consider the function $h(x) = \sin(x^2 + 1)$. Then we may write h as the composed function $h = f \circ g$, where $g(x) = x^2 + 1$ and $f(u) = \sin(u)$. Then by the chain rule

$$\frac{d\sin(x^2+1)}{dx} = \cos(x^2 + 1)(2x).$$

In view of the definition of the integral, this means that

$$\int 2x\cos(x^2 + 1)dx = \sin(x^2 + 1) + C.$$

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Address http://mark.math.helsinki.fi:8080/mathapp/LectureNotes/IntegrationTechniques/S

Lecture Aids

Computing integrals

By the definition, we compute integrals by finding somehow the given function. For this pu derivatives of known functions

More powerful methods are of other rules for computing deri

Recall that by the **chain rule**,

$$\frac{d f(g(x))}{dx} = f'($$

Example Consider the func

Then we may write h as the c where $g(x) = x^2 + 1$ and $f($ chain rule

$$\frac{d\sin(x^2+1)}{dx} = \cos$$

In view of the definition of th

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Problem ID : jn00068

Determine $\int_0^{\pi/2} \frac{\sin x}{1+\sin x+\cos x} dx$.

- $\frac{\pi}{4} - \ln 2$
- $\frac{\pi}{4} + \ln 2$
- $\frac{\pi}{4} + \ln \sqrt{2}$
- $\frac{\pi}{4} - \ln \sqrt{2}$

HLS Report Card: dialogue to help students to solve problems

Calculate $\int_0^1 \left(\frac{1+t}{1+t^2} - \frac{1}{1+t} \right) dt$.

- $\frac{\pi}{8} - \frac{1}{2}\ln\sqrt{2}$
- $\frac{\pi}{8} - \frac{1}{2}\ln 2$
- $\frac{\pi}{4} - \ln\sqrt{2}$
- $\frac{\pi}{4} - \ln 2$
- $\frac{\pi}{4\sqrt{2}}$

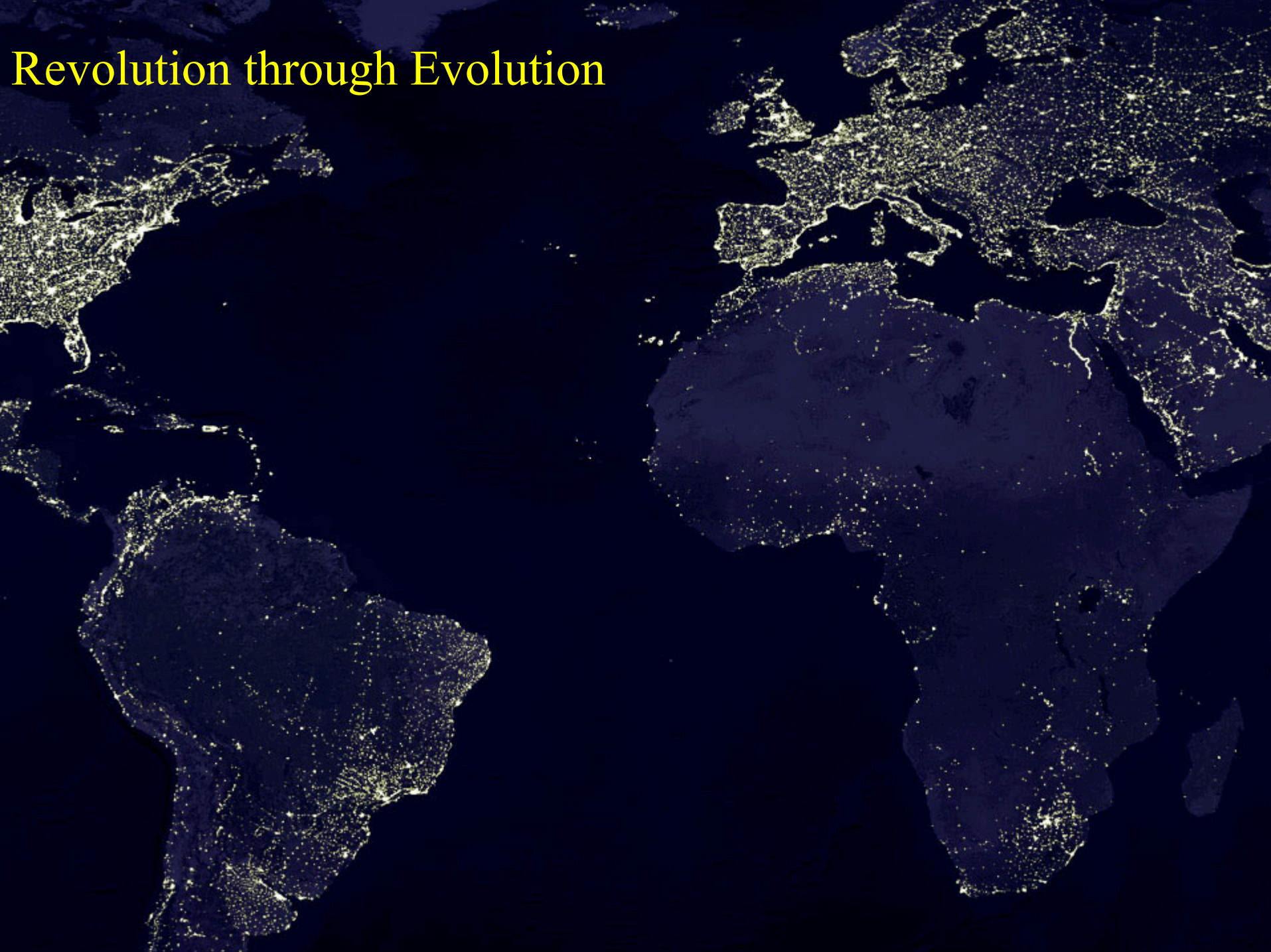
The integral has to be solved by substitution. The next problem will direct you to the correct substitution.

Correct answer is $\int_0^1 \frac{t}{(1+t)(1+t^2)} dt$.
This has to be integrated further. The following problem is a variation of this one.

You have to perform partial fraction decomposition. That leads to an integral of the type of the next problem. Can you integrate this one?

Developing Content for the HLS

- Group in Helsinki (2 senior persons, 5 junior)
- Project at FSU (aim: to hire 5 persons)
- Collaboration with UNED (Madrid, translation to Spanish)
- Collaboration with a group in Mexico (translation to Mexican Spanish)


Revolution through Evolution