THE LIVE BOOKS PROJECT

is an attempt by a group of faculty members of several Mathematics Departments to create a coordinated set of textbooks covering most subjects taught in undergraduate math courses, both upper and lower division. These textbooks will not be geared to any particular type of course (brick-and-mortar, Web,...) We believe that *textbooks* (not courses) *are the primary subject of mathematical education;* their structure determines the optimal way their contents are delivered to students. Our requirements on these textbooks are:

(a) Each textbook incorporates all technologies pertinent to education.

(b) Each textbook is self-contained; references are to other textbooks in the set or to material available on the web (such as Strang's calculus book, or one of the numerous sites on nonlinear dynamics). The book must be suitable for self-study and include rigorous proofs (when appropriate to the level).

(c) The material must be available for free on the Web.

Requirement (a) obviously implies "interactive e-book." The reader (with hands on a computer keyboard) must be able to modify graphs, change parameters in examples and experiment on her own with any aspect of the subject.

The software we use is *MATHEMATICA,* available in a reasonably priced student edition (this project is not associated in any way with Wolfram Research). Although we use some aspects of Wolfram's .cdf (computable document format), our approach is different. In a .cdf document graphs can be turned around with the mouse or animated, parameters in examples can be changed, etc. However, the possible modifications (achieved with cursor, sliders or typing) are predetermined and limited by the author. In our approach, each time a nontrivial formula or graph is encountered, the reader is linked to a *MATHEMATICA* notebook where the coding for the formula or graph is laid bare, so that changes of parameters or animations can be achieved transparently. Not only the parameters in a model but the entire model can be modified. The reader can experiment not only as suggested by the author, but in her own way. The role of numerical or symbolic experimentation in suggesting (or disproving) results is emphasized, as is the use of critical thinking in interpreting numerics.

The primary object of these textbooks is *mathematics;* the software is learned example-by-example and there are no extensive tutorials. The object of this approach is to create a new kind of math major, one that is able to harness the power of the computer for any calculation of simulation related to her studies (e. g. bifurcations in nonlinear dynamics). Note that we are not advocating an "applied major" or a "major in applied mathematics"; calculations and/or simulations are contemplated in all subjects, including number theory and abstract algebra. Of course, our approach is *not* practice-over-theory as old fashioned teachers may suspect; for instance, the implicit function theorem is rigorously proved, but the student also learns how to compute an implicit function numerically. Likewise, the algebra of integration of polynomial quotients by expansion in partial fractions is completely covered and the expansion is shown to exist for polynomials of any degree, but the student also learns to compute the expansion numerically or, when possible, symbolically.

Requirement (b) is designed to save students' time, although references to material not on the Web will also be included for further study.

We believe (c) is essential; the profit motive has clouded teaching objectives for a long time and must be put aside.

The output of the Live Books project will be organized not as a set of textbooks per se but in "blocks" from which textbooks can be assembled. At the lower division level there is a block on differential calculus and another on one-variable integration; out of these two blocks the first two courses of a calculus sequence (each including differentiation and integration) can be assembled. There is a block on infinite series and analytic functions (with emphasis on complex power series) that can be used in the last course of a calculus sequence. There are two blocks on multivariable calculus, one including differentiation, line integrals and some elements of partial differential equations, another on multivariable integrals and the integral theorems of vector analysis. Applications to physics, economics, biology and other disciplines are brought in whenever possible; we believe that teaching application-free mathematics goes against the grain and results in students losing interest.

At the upper division level there is a block in linear algebra including applications such as discrete population models, Von Neumann - Leontieff economic models and oscillation of structures, two blocks on nonlinear dynamics (one discrete, the other continuous), another on number theory, another on abstract algebra, another on complex analysis with emphasis on the geometric aspects (as opposed to the power series approach in the lower division block), etc. Blocks (or parts of them) can be combined to produce quarter or semester courses.

Status of the project. As of 2013 some blocks are essentially complete, but in view of (b) we believe that all related blocks should appear at the same time. Other blocks exist only in outline. There may be a trial period, during which some faculty in the group will test the material in their own classes. Should the project show some success we contemplate versions using other computer algebra systems such as Maple or Matlab. The whole project is interactive: input from users will be used to improve the e-books whenever possible.