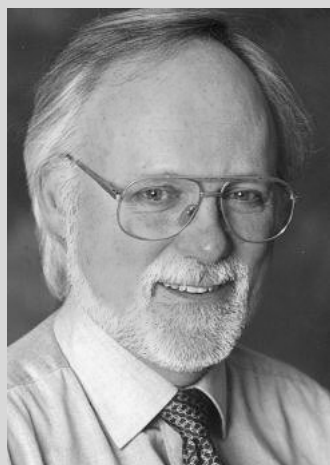

OpenCourseWare – a Free Lunch from MIT?

**Peter Edwards,
Bournemouth
University**

pedwards@bournemouth.ac.uk



MIT OpenCourseWare is at:

<http://ocw.mit.edu/index.html>

How many amongst us are old enough to remember the days when the only source of material to help in the production of lecture notes was from our own library's finite resources?

Nowadays, an appropriate phrase entered into a web browser reveals a plethora of academic material that can be used by students directly from the Internet, or can be edited to produce one's own set of course handouts.

But in editing material from the web, doesn't there seem to be something covert, furtive - criminal even? After all, who owns the copyright? Even so, many have sought such support from the Internet.

Now, for those with, or even without, a conscience, this is about to change. A project from Massachusetts Institute of Technology, at the pilot stage in 2002, has resulted in MIT's educational material being laid before the world as a *totally free* Internet resource for anyone to use. This is the OpenCourseWare (OCW) project [1].

One OCW web page announces, "*materials contained on the MIT OCW Web site may be used, copied, distributed, translated, and modified, but only for non-commercial educational purposes that are made freely available to other users under the same terms defined by the MIT OCW legal notice*".

So this gives users (almost) *carte blanche* [2] to utilise the material in a non-covert, non-furtive and non-criminal way. And from MIT, the quality has to be top rate, necessarily making it a top rate resource. Doesn't it?

Self-aggrandisement, World domination or Ultimate altruism?

At an American conference in the summer of 2002, the author of this review happened to join a group of American engineering educators who were talking about OCW. Most expressed incredulity at MIT's arrogance in promoting themselves in this way, indicating ironically that MIT "obviously knows what's best for the rest of us"! Certainly, some of the quotes from the OCW site seem to bear this out. "This material is out there for the good of mankind", was one quote from an MIT spokesman. "The project ...[will] serve as a model for university dissemination of knowledge in the Internet age" was another.

So is this pure philanthropy on MIT's part, or is it just a further advancement of the Americanisation of education that, in turn, promotes MIT as a leading global player? How exactly *does* MIT benefit?

First and foremost, MIT is being funded \$11 million initially to institute this resource, enhancing, amongst other things, their research and development capabilities in Internet delivery. Second, it is not possible to obtain an MIT degree from home study with this material, so MIT is not likely to fall short on its own student targets. And third, MIT would like the content to be reviewed by users, so underpinning an iterative process of improving its own educational material.

What is available?

By 2007, MIT hopes to have material for all 2000+ of their courses on the Internet, but the pilot project, first appearing on the web in September 2002, hosts material from just a sample of 32 courses covering 17 disciplines

including Aeronautics, Economics, Philosophy and Mathematics.

Don't become too excited yet. These are early days. While the emphasis of *this* review is primarily the Mathematics content, an investigation of Aeronautics, for example, reveals that the only content is "Logistical and Transportation Planning Methods". This same content is also one of only two courses listed under "Electrical Engineering & Computer Science". Together with lecture notes looking like a PowerPoint presentation wrapped up as a .pdf file, this is disappointing – and incapable of being edited.

Some of the material is presented as straight HTML, as static web pages. However, also provided are documents in .pdf format, Java applets embedded in web pages, colourful, but static, output from mathematics software and video lectures. Not only will you find course notes (as HTML or .pdf) for some of the courses, but also syllabuses, course timetables, assignments and past examination papers and solutions. *However, you will not find all of these resources for all of the courses.*

International users unfamiliar with the US education system will probably be a little perplexed by some of the content covering course administration. The prerequisites for one course are, "... *high school calculus ... with a score of 4 or 5 on the AB, or the AB portion of the BC, calculus test ... or a passing grade on the first half of the 18.01 Advanced Standing exam!*"

Mathematics Content

At the time of writing, the Mathematics courses available are:

18.013a	Calculus with Applications
18.04	Complex Variables with Applications
18.06	Linear Algebra
18.996	Topics in Theoretical Computer Science: Internet Research Problems

OCW mathematics is directed primarily towards four groups of MIT's own B.Sc. Mathematics undergraduates, namely those studying:

- General Mathematics
- Applied Mathematics
- Theoretical Mathematics and
- Mathematics with Computer Science

Consequently, what is currently available is not necessarily comprehensive for *all* mathematicians. For those lecturing engineering mathematics, for example,

using the site's Search facility for "Z Transforms" returns "no result". But these *are* early days...

Navigation around the OCW web site.

Most pages have a vertical coloured bar down the left side containing a Navigation menu. Some pages use hyperlinks embedded in the main text for navigation. Other pages also contain a menu bar across the top to access the OCW Home Page, the Course List, About OCW and Feedback. Navigation is easy.

Calculus with Applications

Space here does not allow an in-depth investigation of the mathematical strands, but following the Calculus with Applications link, for example, reveals some worthwhile content.

The following provides navigation from the Calculus with Applications main page.

- Course Home
- Syllabus
- Required Readings
- Tools
- Study Materials

Syllabus directs the user to a web page listing 48 sections - no hyperlinks - of the MIT Calculus course ranging from Basic Functions and Vectors, through Differentiation and Taylor Series, Integration including Line Integrals, Stokes and divergence theorems, Numerical Integration and Numerical solution of differential equations and some basic Linear Algebra.

Required Readings takes the user to a page with hyperlinks to the 35 chapters of Calculus course material. Chapters (or, more specifically, the sub-chapters) open as flat HTML web pages – as a 'textbook on the web' – although some enhance the text with embedded interactive Java applets.

Tools is a hypertext list to all 23 of the available 'Calculus' applets that, from here, can be run as standalone applets. The 3D applets, with their ability to rotate the view in 3D space, are particularly useful in deepening understanding through visualisation.

Study Materials is a Glossary of Notations, 78 in all, such as, " $\tan x$ – works out to be $\sin x / \cos x$ ".

Newton's Method

As an example, it is useful to follow the Chapter 13, Solving Equations, link and hence to Section 13.1,

Newton's Method.

The Newton's Method page loads HTML and an embedded Java Applet. The text above the applet gives a short discussion on the theory, which could be read on a slow PC with a V90 modem while the applet took its approximate 3 minutes to load.

The text below the applet window gives examples and exercises on how to program Newton's Method into a spreadsheet (how to use a spreadsheet being the contents of Chapter 0).

How accessible is this to those who would like to bend the material to their own students' requirements? Obviously the text can be saved as the whole web page itself – and so can be manipulated easily with a standard word processor. But wait. Where you might have thought MathML would have been used to generate the mathematical equations, each is stored as a .gif file, making the equations impossible to edit.

The applet itself can only be run from the OCW web site, so cannot be downloaded for off-line classroom use.

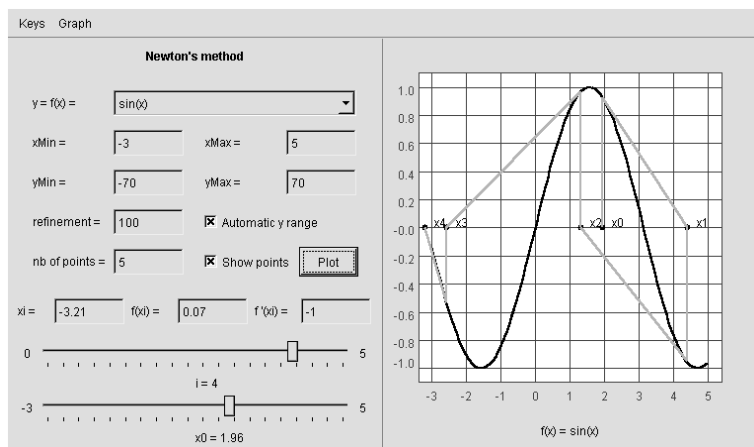
So, can MIT's, "... OCW Website... be... modified"? Yes, but not as easily or as comprehensively as you might at first have thought.

The Newton's Method applet

This applet shows well the workings of Newton's Method (see Fig 1) – to anyone who knows what they are looking at! Accompanying information indicating what to look out for is available for each applet from a pull-down menu, but is sometimes a little frugal with its content. To a student meeting the material for the first time, it may not be immediately apparent what the applet is supposed to do, or show.

For the Newton applet, it is disappointing to note that if an iterated value falls outside the range of the displayed graph, it is not possible to scroll the graph left or right (although you can always change the scale and replot). Interesting values, such as an initial or iterated value falling on a turning point, cannot always be achieved. The default situation for one function, for example, has such a point at $x = 0$, but moving the applet's x_0 slider allows -0.04 at one point and then $+0.04$ at the next, so missing the interesting case!

Fig 1 Applet showing Newton's Method



Bearing in mind current accessibility issues, some might find the applet difficult to see or use. Standard 'battleship grey' sliders on a standard 'battleship grey' background, for example, do not necessarily give enough contrast for visually impaired users. The size of applet windows is good, however. On a PC in either 1024 x 768 or 800 x 600 mode, the applet opens in a window that fills the screen.

On a P133 (an old PC, granted), different parts of the applet window tend to disappear, fairly randomly at times. Sometimes a scrollbar will disappear as it is being used – and at iterated values close to $f'(x) = 0$, the graphics area occasionally becomes a solid white rectangle!

But such are the vagaries of Java's "platform independence"!

... and the other mathematical courses on offer?

Linear Algebra has a good, comprehensive set of videoed lectures. These are not presented by a media professional but, even so, the lecturer, with his 'Um's and 'Er's, gives a good discourse which is both engaging and informative. Unfortunately, these videos use Real Player while downloading from the Internet, so a student accessing these from home using a V90 modem may hear the voice continuously but, on slower PCs, the video is likely to consist of single frames showing at about 1 per second, with occasional pauses while the system rebuffers the video stream. It is not possible to download videos for offline (and hence more stable) viewing.

Unlike Calculus with Applications, Linear Algebra's Required Readings list consists simply of chapter headings taken from a textbook – authored by the video presenter, as it happens – so individual users who do not have access to the textbook will be disappointed, as will users searching for editable material. The 'Related Resources'

option here links to several applets, but these are on a non-MIT web site. Linear Algebra does offer, however, five years' worth (1996 to 2000) of assignments and examination papers in .pdf format.

Complex Variables with Applications also directs users to chapters from a recommended book for its Required Readings. Even the assignments, disappointingly, just reference questions from this book although, paradoxically, worked answers are provided (in .pdf format). A link to a "Riemann Surfaces" page displays text and colourful, but non-interactive, graphics output from MATLAB.

Topics in Theoretical Computer Science provides on-line slides and notes; some as .pdf files and some in LaTeX format, but like the two previous courses does not provide a comprehensive list of easily editable material.

Any other Mathematics?

Other OCW courses also contain mathematical content. Mechanical Engineering, for example.

Here, "Modelling Dynamics and Control 1" contains no course notes, again just referring to a book. With a syllabus containing 1st and 2nd order systems, the MIT approach would have been of interest to engineering mathematicians.

In the "Intermediate Mass and Heat Transfer" course, the "Required Readings" also comes from a book (once again written by the course lecturer), but, laudably, *this book is fully available as a 7.3Mb downloadable, hyperlinked .pdf file.*

Conclusions

"MIT are offering all their course material on the Internet!" You can almost hear the gasps from the crowds. But does it live up to the expectations of MIT's claims that the material is setting the standard for Internet delivery and that the content can be *"copied, ... translated and modified"*?

There is no doubt that some of the material is top rate, promising many riches, but, of the four mathematical

areas on offer, only Calculus with Applications comes close to being a useful Internet happening. On the one hand, its 'textbook on the net' is rather flat, but on the other hand, its content availability and its interspersed applets draw the user in, making it more of an enjoyable, sometimes stimulating, student-centred experience. Videoed lectures here would certainly be the 'icing on the cake'.

Web page content that is merely a dead-end, in particular a vehicle to promote the sale of somebody's book, is a waste of Internet space, raising user expectations unnecessarily - unless, of course, the book is also available in a fully hyperlinked electronic form.

Individuals are unlikely to use OCW courses that require a hardcopy textbook (which may not even be readily available) and others will be disappointed that some content, while having the potential to be exciting, isn't.

Anyone hoping for a 'free lunch' will also be disappointed. While all the material has the potential to provide an invaluable resource for others to produce their own material, there is not too much on offer here (yet?) that can be downloaded easily and modified, or even implemented in the classroom without using the material 'as is' over the Internet.

Hopefully, one is not supposed to base judgement on the ultimate quality of an, as yet, incomplete resource from its pilot project. However, eleven million dollars should provide more than adequate funding to produce a truly stimulating student-centred Internet learning experience.

Some of OCW's existing content is, and some has the potential to be, great content. The waiting world can only hope that the content and presentation of MIT's next phase of production builds upon the best of what has already been achieved - and that the rest is discarded.

References

- [1] OpenCourseWare is on <http://ocw.mit.edu/index.html> [Accessed 17/11/02]
- [2] Terms and conditions of use can be found on <http://ocw.mit.edu/global/terms-of-use.html> [Accessed 17/11/02]

Supplier Comments from MIT

As we are sure you recognize, a glass that is being used is partially full and partially empty. And that is so with any project.

Naturally, it would be wonderful, if someone were to put study materials on the web which made learning everything exciting and easy, and which materials were simple to adapt and to modify by any teacher or student.

And we think that would please your reviewer, though he might not like the color scheme of the materials, might be a bit upset at the nerve of people to have the temerity to do such a thing, and might be tempted to question the motivation for such an action.

On the other hand many things must happen in order for this to take place. First, someone has to create the materials, and integrate them into a teaching and learning scheme. In addition others must have the will energy and money to make the materials available to all. This second endeavor involves coaxing the materials from their authors (ultimately, from hundreds of them), worrying about copyrights and other annoying issues, and publicizing the projects so that they become visible amid the incredible noise level of stuff on the web.

We have next to no information on this second stage which is where the money for the OCW project is spent. But we can tell you about some of the problems involved in creation of new material that is aimed at being exciting and stimulating to students in very old fields of knowledge. Unfortunately there are many. We comment only from an ‘ant’s eye’ view of the entire OCR

First, who is to create new materials?

Research oriented mathematicians expend their mental energies on the worlds of their research problems, not on educational questions. Educators rarely have enough insight into subject matter to envision useful new approaches, applets or what have you. Those both capable and willing to think about mathematical education in new ways are rare, and few if any of those people have the computer skills to create applets at all.

The problem is made worse by the fact that there is no reward for taking on such activity, aside from personal satisfaction. A capable mathematician who takes on the task of trying to create such material relegates his or her self to second class status in the pecking order of the mathematics community, since it necessarily takes time away from research. Doing so can ruin the career prospects of a young mathematician, and it is folly to expect new tricks to originate from old dogs. And few if any financial rewards can be expected from giving away your educational ideas to the world without financial remuneration of any kind.

The second problem is the size of the task and the annoying technical issues that complicate things.

It is not enough to create interesting applets and gadgets that illustrate mathematical concepts. These can be useful in getting ideas across, and in stimulating interest, and in empowering students, but you really want to embed them into some kind of text, so that the student can develop the power to

create the results of the applet by his or own self, using a tool like a spreadsheet or pencil and paper. Applets by themselves become mere gee whizes, unless imbedded into an appropriate text.

So you want a text to go with them.

Creating such a thing, even a flat one is a formidable task in itself, and one that is equally unrewarding. Its a bit like creating the text for Rowlandson’s Dr. Syntax pictures.

A problem is that at any time there are a myriad of directions to go that can improve the material: better colors and layout in the applets (though colors come out different on different browsers), more applets, rewritten text, better integration of applets to the text, better exercises, solutions to exercises, more subject material, and so.

The technical task involves balancing the software used to make it accessible to slow modems and old browsers, and yet functioning. Newer Java versions and MathML are much easier for an author to use but failed the accessibility test at the time we created this material. As time goes on MathML will most probably be a better choice at some stage, and perhaps already now.

What we created in this course is full of embarrassing mistakes and awkwardnesses, many of which we have found and corrected since its issuance, some we have not noticed. It would be nice to have all the features your reviewer wants and more.

The present version of this course is really a first draft, created hurriedly in one year, which undoubtedly is only a shadow of what it could be and should be. To be fully useful users should be able to assemble the parts that they want to use and modify the text their way. We would like to make this possible but are not quite sure how to do it.

Here we face another problem: we really need feedback about what people dislike about it, and where it turns students off instead of on, because with effort these can be fixed. But getting constructive critical comments about the material, which is what we need, seems quite difficult. In fact the comments of your reviewer are the first I’ve seen. Most users, and we have heard from a number of them, are so pleased that the glass has something in it, they can’t bring themselves to complain about what is lacking.

So we want to thank your reviewer for his insights and ideas, and hope that they stimulate active criticism from others.

Best Regards,
Jean-Michel Claus / Daniel Kleitman