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ABSTRACT

The Open University from its inception in 1969 has been a technologically based university. It uses technology to deliver high quality, specially designed teaching materials to large numbers of adult students throughout Britain, and increasingly abroad, who study at home. The Open University's teaching system has remained basically unchanged since 1969; however, practical experience with three more recent technologies (interactive videodiscs, audio-graphic teleconferencing, and computer conferencing) has demonstrated the increased instructional power and the increased flexibility of some of the newer technologies. The instructional power comes from improved feedback and interaction for learners, and the increased flexibility comes from the ability of some of the new technologies to exploit fully the range and power of the teacher at a distance, while providing individually adapted courses for individual learners. However, while such technologies are already available, it is likely to be a number of years before they are used on a large scale in higher education, not so much because of resistance from teachers and students, but because of the inability of large organizations to make the structural changes necessary for the successful implementation of such technologies on a large scale. (DJR)

NEW MEDIA IN HIGHER EDUCATION

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INTRODUCTION

The Open University from its inception in 1969 has been a technologically based university. It uses technology to deliver high quality, specially designed teaching materials to large numbers of adult students throughout Britain, and increasingly abroad, who study primarily at home. While the Open University has experimented with a number of new technologies, it is clear that some of these technologies are in fact likely to be just as useful in conventional education as in distance education.

The Open University's teaching system has remained basically unchanged since 1969. However, in the last few years, it has obtained practical experience in using a number of new technologies for teaching purposes. I shall select just three, to illustrate two major features of the new technologies: the increased instructional power and the increased flexibility of some of the newer technologies.

The instructional power comes from improved feedback and interaction for learners, and the increased flexibility comes from the ability of some of the new technologies to exploit fully the range and power of the teacher at a distance, while providing individually adapted courses for individual learners.

However, while such technologies are already available, it is likely to be a number of years before they are used on a large scale in higher education, not so much because of resistance from teachers and students, but because of the inability of large organisations to make the structural changes necessary for the successful implementation of such technologies on a large scale.

THE BASIC TEACHING SYSTEM AT THE OPEN UNIVERSITY

The basic teaching system at the Open University since 1969 has been as follows:

- print: this is the MAIN instructional medium at the Open University, the bulk of the teaching being provided through the specially designed correspondence texts mailed to students;

- broadcast television: most courses receive at least eight broadcast television programmes, and on foundation courses 32, one for each week of study;

- radio: although the use of radio has declined, many courses still use radio; where radio is not used, audio-cassettes are mailed to students instead;

- tutorials: face-to-face tutorials are provided in local study centres on foundation and other courses with large numbers of students; on medium-sized courses, two or three Saturday day schools may be provided instead; in all cases, face-to-face tutorials are optional, and a support service to the main instruction, the correspondence texts;

summer schools: students attend a one-week residential course at a conventional university in the summer, to develop skills that are not otherwise possible, such as laboratory work, at foundation level and primarily science and technology courses beyond foundation level;

home experiment kits: these are provided (free of charge) for students on certain science and technology courses.

Open University courses are characterised by high initial costs, and relatively low presentation costs. It may take two to three years to prepare an Open University course, then it will run for at least eight years with relatively large numbers of students each year. In other words, OU courses tend to have high "front-end" costs, requiring a lot of academic manpower, planning and preparation before the course is ready, but relatively low "on-line" costs once the course is running - the reverse of conventional university courses. It is these high "front-end" costs which often deter conventional institutions from expanding into distance education.

NEW TECHNOLOGY AT THE OPEN UNIVERSITY

While the basic teaching system has changed surprisingly little since 1969, the Open University has experimented with a relatively wide range of new technologies. Altogether the Open University has about 130 undergraduate courses and about 50 continuing education courses. It also has about 30 courses in preparation at any one time, most of which will replace existing courses. In the information given below, I have made rough estimates of the number of undergraduate courses either in presentation or in preparation using each technology. The newer the technology, the more likely it is to be found in courses in preparation.

The following technologies have been introduced since 1969:

audio-cassettes	70 courses
video-cassettes	15 courses
video-discs	2 courses
main-frame computer-assisted learning*	30 courses
home micro-computers	10 courses
audio-graphics conferencing*	22 courses
computer-conferencing	3 considering

* at study centres only

It is important to note that the main technological development since 1969 has been the humble audio-cassette. I could say a great deal about this highly cost-effective medium. It is cheap, easy for both course designers and students to use, and when combined with print extremely effective instructionally (see Durbridge, 1983, for a full account of the use of this medium in the Open University). It is a timely reminder that "low" technology can be just as cost-effective, if not more so, than high technology.

However, I will limit myself in this presentation to just three of the more recent technologies, which between them illustrate the power and flexibility of the newer media: interactive video-discs; audio-graphic teleconferencing; and computer conferencing.

VIDEO-DISCS

It is important to distinguish between "stand alone" and computer-controlled video-discs. In the following extract from an Open University Open Forum programme, you will see Professor Robert Fuller, of the University of Nebraska, demonstrating the BBC Enterprises "British Garden Birds" disc. Professor Fuller, who designed the first commercially available educational video disc, on the physics behind the Tacoma Narrows Bridge disaster, worked with me as a consultant at the Open University. "British Garden Birds" was designed as a stand alone disc, but in the following demonstration, Professor Fuller has written a computer programme to control the disc.

(EXTRACT FROM BBC/OU OPEN FORUM PROGRAMME)

This demonstrates a number of features of the video disc:

- its huge storage capacity (57,000 still frames)
- superb still-frame quality, and ability to hold still-frame without any wear to the disc or laser
- ability to step through frames singly or in controlled slow or fast motion
- ability to access any single frame within two and a half seconds
- ability to add computer assisted control and computer assisted learning to still or fully moving pictures

<u>Interactive videodiscs</u>
It is this last quality that lead the Open University, in conjunction with BBC/Open University Productions, to design an interactive video-disc for a second level Technology course on Materials Science. Although the disc is about the structural properties of polymers, it has become known as "The Teddy Bear Disc", because the disc is constructed around a court case, where the manufacturer of teddy bears sued the supplier of the washers which held the teddy bears' eyes in place, because the eyes became glazed and eventually fell out.

The disc was designed to be used with the following equipment configuration:

Philips VP705 (or VP835) Laservision Player, with teletext encoding facility

Apple IIe micro and twin disc-drive

interface board for Apple, connected to VP705

Teletext TV monitor

The disc was designed for use at the course's compulsory summer school. Students completing laboratory work would then go to an interactive video work-station, and work through the disc. Since it takes at least three hours for most students to work through the disc, they were able to return to the disc in their own time, in evenings or coffee breaks.

The disc was in effect a revision disc, being based on a broadcast television programme which most students will already have seen. However, the broadcast programme was substantially re-edited, and a large number of additional stills were added, as well as the computer programme, which was written by staff of the Open University's Academic Computing Service (ACS). In fact, the disc was very much a team effort, involving academic staff from the Faculty of Technology, ACS, BBC/OUP, and the Institute of Educational Technology.
ACS used their mainframe DEC-20 to create the software, incorporating the STAF II authoring language, which allows students to key in words or sentences in response to questions, using keyword search and spelling correction functions. The software was then converted and transferred to a diskette,for use on an Apple, using UCSD Pascal. Although an existing broadcast programme was used as a basis for the video, production costs were nevertheless high, mainly because of the large number of video still graphics required, but also because of the amount of time required to design and produce the disc.

The disc was evaluated at summer school (Laurillard, 1984), and appeared to be very favourably received by the students. The Open University is now in the process of designing another inter-active video-disc for a second level Physics course, on the physics of water, for first presentation in 1987.

As a result of our experience at the Open University, and experience from a number of other video-disc projects in Britain and the U.S.A., it is now possible to identify some of the advantages and disadvantages of inter-active video:

Advantages

well-designed discs permit students to work through the material in a variety of ways, allowing for individual differences

computer control enables students to receive excellent feedback and interaction, and can be highly motivating interactive video is rich symbolically, incorporating still or full moving pictures, a wide variety of graphics and animation, clear text combined with pictures, and two independent sound tracks

it provides an intensive learning experience; one interactive video-disc can involve each student in at least three hours of intensive study

Disadvantages

designing an interactive video disc from scratch involves very high production costs; an average figure (at total costs, including overheads) is around DM300,000 (£90,000)

a single study workstation for an interactive Laservision disc can cost up to DM10,000 (£3,000)

the investment in a study workstation is harder to justify given the current lack of teaching discs; each interactive video disc requires the correct combination of hardware (disc player, brand micro, interface and monitor) to work; there is as yet no standardised system

given the intensive use of each interactive disc, the lack of a range of courseware to work on the same workstation, and the cost of workstations, the equipment costs per student can work out on the high side

producing fully interactive video-discs which exploit to the full the potential of the medium requires a very complex production procedure, requiring advanced and detailed planning and team work from a number of different professions; not all institutions are capable of providing the framework which such a production process requires

from the Open University's point of view, the main disadvantage of interactive video-discs is that they are not home-based, nor will they be in the foreseeable future; conversely, they are more suitable for use in conventional teaching establishments, but only when the alternative to video-disc would be very expensive or impossible to do by other means.

to date, the range and level of interaction via a micro-computer has been rather restricted to the "show, test and help" model following the old programmed learning approach, but with better visuals; it is proving more difficult to programme in such a way that students can explore in a more creative and open-ended way (but with guidance) the large data-base that such a system can offer; there is also a lack of good indexing and "help" routines, which should be standard components of any interactive video computer programme.

It is now clear that interactive videodiscs have great potential where there is a major training need, or where alternatives (such as building expensive simulators) would be very costly. It is less clear that the benefits will automatically justify the high costs in higher education, although at this stage the full potential of interactive videodiscs has still to be explored.

Stand-alone videodiscs

I fear that there is a danger of trying to run before we can walk. I have outlined a formidable list of reservations about interactive videodisc in higher education, but these reservations do not in most cases apply to stand-alone videodiscs.

A good example of stand-alone videodiscs are those on cell biology being produced by the Institut für den Wissenschaftlichen Film in Göttingen. They have taken a series of film from their extensive archive and transferred them to videodisc. The first disc on functional organisation shows a whole range of different examples, with a specially written sound commentary (in German and English). The disc is accompanied by a detailed printed handbook, which provides a full index of each example.

The provision of a resource disc such as this has a number of advantages. Firstly, a teacher or student with the remote control handset can explore the disc as he or she wishes. They are not locked into a routine laid down by a computer programme. A teacher or student can choose their own route through the materials. The teacher can use the disc in a group situation, selecting exactly what is required from the disc, thus cutting down on the need for expensive work stations. On the other hand, the teacher can provide guidance for students, either by providing written support material, indicating ways to use the disc, or by writing their own computer programme to control the disc.

The main advantage though of designing stand-alone rather than computer-controlled interactive videodiscs is that it becomes much cheaper to produce, by merely transferring or editing existing film and video material to disc, thus rapidly increasing the supply of courseware at a low cost to users.

It will be interesting to see in the next few years in which direction higher education will move regarding videodiscs.

AUDIO-GRAPHIC TELECONFERENCING

This is the use of microprocessor technology to allow the incorporation of locally produced graphics with standard audio teleconferencing. The best way to explain this is to demonstrate how the system works:

(EXTRACT FROM BBC/OUP OPEN FORUM PROGRAMME)

It will be seen that the system allows either student or tutor to draw on the screen by means of an electronic light pen or graphics pad, and the picture will be seen at all the other sites connected via a telephone conference system. At any site, the picture can be altered or amended. By using two telephone lines from each site, sound and picture can be integrated. Because the system codes the picture signal digitally and converts the codes into a sound signal, the picture can either be sent in "real time" via the telephone system, or preprepared and stored on audio-cassette, so that the tutor can add in "frames" in just the same way as adding slides or overhead transparencies. Neither students nor tutors need any computer programming skills to create graphics with this system, although tutors do need to prepare their tutorials carefully in advance, so they know what graphics they are likely to use.

The Open University has been using straight audio telephone conferencing quite extensively, but it has suffered from two major limitations: the quality of the sound is often poor, due to the poor quality of some of the lines into individual homes, particularly in rural areas; and the lack of visuals to accompany the tutorial.

Consequently, the Open University experimented for three years with an audio-graphics system developed in-house by staff from the Maths and Technology faculties, called CYCLOPS.
Appropriate equipment was installed in 15 local study centres in one region (the East Midlands, centred around Nottingham). CYCLOPS was used on a total of 22 courses in the region, mainly courses where there were too few students to organise face-to-face tutorials in local study-centres, but where one or two students could easily get to study centres. Altogether, over 600 students used the system over the three year experimental period.

The project was funded largely by British Telecom, and was extensively evaluated (see Sharples and McConnell, 1982, for a full description and evaluation). As a result of the evaluation, the following advantages and disadvantages were identified:

Advantages

the system permitted the design of high quality graphics by tutors, using colour, text and good quality pictures

it was easy for both tutors and students to use

tutors learned quickly how to design the graphics to encourage student interaction

the system was popular with students, being ranked higher than any of the alternatives available to them (e.g. day schools, straight telephone tutoring) the system required very little "front-end" preparation by tutors - but more than for a conventional face-to-face tutorial; the evaluation found that in general, CYCLOPS tutorials were better prepared than face-to-face tutorials, being more structured and interactive

Disadvantages

the main disadvantage from the Open University's point of view was that students had to go to study centres to use the equipment; at the time of the pilot, it was not home-based

the system was an add-on cost; it provided a service which otherwise would not have existed; it also required two telephone lines; it was therefore an added cost to the Open University system at a time when it was looking to save money because of cuts to its budget

there were commercial problems with the hardware: the University in the pilot used prototype machines; a commercial company was approached to fund further developments and produce a commercial system; the commercial company, Aregon International Limited, improved the technical specifications and turned it into a most successful office-of-the-future system, but which unfortunately for the Open University retails at around DM10,000 (£3,500) a unit, pricing it out of the education market; this was all the more frustrating to the designers, since it is technically feasible to design the system to fit on to an EPROM which would fit the BBC Micro, at a cost of around DM200 a unit, but it has been impossible to raise the money necessary to do this

lastly, the system lacked institutional and governmental support; the University was looking to reduce rather than increase expenditure and services, and it was seen, correctly, as an add-on to what is already a complex and sophisticated teaching system; there was not a commercially available low-cost version which the University could install; and the government agencies seemed more interested in supporting large-scale, high-tech developments for commercial markets.

Consequently, at the end of the trial period, the system was discontinued. I myself am greatly disappointed by this. Here was a system ideally suited for distance education, which required very little further investment and development. It was easy to use, and had great potential for home use, as a peripheral or EPROM to a standard micro. The only consolation is that such a system is almost certainly to emerge as a standard feature of the next generation of micros, but not necessarily so nicely designed for educational use.

COMPUTER CONFERENCING

While the previous two technologies have been actually used in course presentation at the Open University, the next technology I want to describe, computer conferencing, is one which we are hoping to introduce in the near future. In fact, we are at this moment in the process of seeking course teams who might be interested in using computer conferencing.

The Open University has just decided on a policy for home-computing. At the moment, Open University students are expected to use computers for two main purposes: for learning about computers and developing programming skills; and for computer-assisted learning. Up to now, students have had to use terminals in study centres linked into a network of DEC-20 computers. With the growth in home ownership (approximately one third of Open University students have a micro at home) and easy access at work, the University has now decided to allow a limited number of courses to design their materials on the assumption that students will have access to a micro, which can be linked via the public telephone system to the OU's mainframe DEC-20 system.

This opens up a whole range of possibilities, including self-registration, fee-payment, and other administrative functions, as well as the more traditional computer education and computer-assisted learning. One of the most exciting possibilities is the use of computer conferencing.

Students with a home micro will be linked via a modem and a communications chip or EPROM to the DEC-20 mainframe system; so too would the course tutors, either from home or from a workstation at work.

We plan to use computer conferencing for advanced level courses with relatively small numbers of students (no more than 100 a year) spread throughout the country, particularly on courses where students are expected to do a good deal of project work or individual research.

Each tutor would be responsible for about 10 students maximum. The tutors may be full-time academic members of the Open University staff, supplemented with a few external tutors covering specialist areas. The tutors will work within an agreed broad content outline, but will negotiate individually with each student, via computer conferencing, each student's work programme and projects. Students will key in project outlines, and draft project reports, for comment and marking by the tutors. Corrected or finalised versions of selected project reports or studies will also be made available to other students for comment.

Because each communication is stored on the mainframe computer, tutors and students can call up information as and when necessary and convenient. The time between student assignment and receipt of tutor's comments and grades, currently a minimum of 10 days via postal systems, will be as short as the time it takes the tutor to respond, which in most cases should be a maximum of three days, given careful planning, and could be in many cases within 24 hours. Thus the teaching would be asynchronous (since the tutor and student do not have to be in communication at the same time), but on-line.

The system is basically a mixture of two computer technologies: an up-graded version of electronic mail (up-graded because all versions of communications can be stored and automatically indexed) and the use of a mainframe as a large data-base.

We have given a good deal of thought about the kind of data-base we will need to provide. From experience in developing our own in-house viewdata system ("OPTEL") we are aware of the high cost of creating a comprehensive electronic data-base, particularly if a great deal of print material has to be transferred, given the limitations of existing optical document readers. We are therefore investigating the following possibilities:

- a selection from existing data-bases (DIALOG, etc): we are aware of the high cost of direct on-line access, but we may be able to negotiate for the transfer of a limited selection of material on to our own data base; however, we do not see the use of commercial data-bases being practical on a large scale

- each tutor being required to spend 10-20 hours contributing to the creation of a data-base in his or her area of specialism; with 10 tutors on a course, this could cover much of the core material for a course

- tutors would also provide lists of references and abstracts for the data base; students could access copies of any full paper they require by requesting hard copy stored at the centre, which would be mailed to students, thus keeping down the costs of transferring hard copy to an electronic data-base, much of which might never be used

- in addition to content and references, tutors would provide a data-base of local resources, e.g. places where students could go locally to access information of a specialised nature, such as museums, university libraries, or even individual contacts

- an important source for the data base would be the students' own projects, which over the years would accumulate

- lastly, it will be important to provide a powerful index, so students (and tutors) can find material in the data-base easily and quickly

It is unlikely that we will find a course team initially willing to teach solely through a combination of computer conferencing and direct telephone contact. We have found in the past that in the OU system, it is easier to innovate incrementally, rather than go for radical changes. Consequently, the first two or three courses are likely to use computer conferencing as an add-on or replacement for conventional correspondence tutoring.

Nevertheless, at this stage we see the following advantages and disadvantages of this technology:

Advantages

it is basically an extension of "real-time" conventional teaching, allowing tutors to respond quickly and sensitively to students requirements as and when they arise, but at a distance

relatively low "front-end" costs: academic staff will spend less time at the OU in preparing materials, and more actually tutoring the course, bringing the central academic staff in more direct contact with their students

perhaps the most important advantage is that it allows for individualised teaching; up to now, all students have had to study the same material on Open University courses; this system allows students to negotiate their own project work and areas of study, an important requirement for advanced level, mature students who often have specific study or work requirements

lastly, it allows the university to respond more quickly to providing new courses; as well as central OU staff, experts from commerce and industry can also be recruited as tutors, if the expertise does not exist within the University

Disadvantages

this system transfers costs to students: they have to provide the microcomputer hardware and pay line-charges

at this stage, the system seems suitable only for advanced level courses with low student numbers; it is not a system which could realistically be used across a large number of courses

while the software for running computer conferencing can be bought "off-the-shelf", the systems we have seen to date are not user-friendly enough; we need a system which is so transparent that neither tutor nor student has to worry about how to use the system

what do we do about the many students who will not have their own home micro? This is a general problem of course for all home-based computing courses, but it could easily price out many students for whom the Open University was intended

As we get more experience, we will no doubt see more clearly the disadvantages, while not all the advantages we foresee may be achievable. but I do believe that such a system has great promise.

WHICH TECHNOLOGY WILL WIN?

I have chosen only three examples of new technology being used at the Open University. I have said virtually nothing about computer-assisted learning, or of video-cassettes, both of which are used far more extensively in the OU than the three technologies I have described, but I have assumed that CAL and video-cassettes were more familiar technologies. As well as these, there is viewdata, cable and satellite TV, teletext and telesoftware, all of which have educational potential.

Which of these technologies then is likely to win? Which will predominate?
In my view, none. They all have weaknesses as well as strengths. There is no super-medium which will meet all our requirements efficiently and at low cost.

I suspect though that those technologies which are easy for both students and teachers to use, which are low-cost, and require relatively little front-end preparation will predominate over those which are complex to use, expensive, and require a great deal of advanced preparation.

Consequently, I see the following technologies as likely to be the most popular for off-campus teaching at a higher education level over the next few years (roughly in order of popularity):

print (still a relatively cheap and easy technology to use, and with new technology such as word processors, camera-ready copy and laser xerography, becoming faster and cheaper to produce)

audio-cassettes (used to supplement other media, rather than for delivering lectures)

video-cassettes

broadcast television

computer conferencing

audio-graphics conferencing (perhaps enhancing computer conferencing as well)

face-to-face teaching (old habits die hard!)

Conversely, I see the following as less likely to be in widespread use in higher education in the next few years, although I am sure there will be many "showpiece" demonstration projects (the least likely to be used listed last):

computer-assisted learning

straight videodiscs

interactive videodiscs

CAL with AI (mainly because of the time-gap; when it is available, it could revolutionise CAL and interactive video)

However, this is dangerous speculation, and could easily be made to look silly by new government policies, economic restraint or yet further technological advances.

THE MAIN BARRIERS TO INNOVATION

However, I will be surprised if there is extensive use of any of these new technologies in higher education, either on-campus or at a distance. This is not because the technology is inappropriate (although in some instances it is), nor even because of bloody-mindedness by teachers.

The main barrier to innovation lies in the nature of existing educational institutions. Their decision-making structures have evolved to protect the existing system, protecting not only existing academic departments, but more importantly existing administrative structures, both of which need to change radically if new technologies are to be successfully integrated. Many of the technologies are suitable not only for teaching but for administrative purposes, but traditionally administration and teaching systems in universities are structurally separate.

Let me give some examples. At the Open University, we have had two computer systems, one for administration and one for teaching and research. However, if a student is at home, he or she wants one system which covers teaching, registration, tutor-marked assignments, change of address, etc. It is however no simple task to remove two existing systems with a third integrated system which will serve the needs of all clients. It is not just the technological and funding difficulties that have to be overcome, but also the need to persuade all parties to agree to a common solution and priorities for use.

To give another example: the introduction of new technology usually needs a fresh injection of capital, and recurrent costs to operate. Sometimes, it will lead to savings in the long-term, but in the short-term, in an increasingly common situation where reources are fixed or even diminishing, innovation can only take place by robbing Peter to pay Paul; in other words by cutting an existing budget to provide funds for the innovation. University decision-making structures though have been finely honed to prevent that kind of thing from happening.

A third and last example is the need to change not just teaching methods but the whole process of curriculum design if new technology is to be used sensibly in higher education. Both closed-circuit television and computer-assisted learning are under-utilised in most universities, because they are seen as appendages to existing teaching methods. In very few places has the whole teaching system been transformed so that these new technologies could be fully exploited. The same lesson still applies to the more costly technologies, such as interactive videodisc.

It has to be faced that most new technologies require high set-up costs, both in terms of equipment and academic time, and there is little evidence yet to suggest that the returns, in terms of increased effectiveness, lower running costs, etc., are worth the investment.

Another major barrier is lack of academic staff development in teaching methods in higher education institutions. To use many of the newer technologies, even the simplest, some form of training is essential. Time and again research has shown that differences within media are greater than differences between media; in other words, it does not matter which medium one uses if the teaching is poor. A well designed television programme will teach better than a poorly designed lecture, and vice versa. But to design a good television programme, the teacher needs to know what television can do well, and what it does badly. The producer cannot do that for the academic, because only the academic [illegible]lly understands his or her subject area, and how they want to t[illegible] it.

Lastly, the range of media of potential use in higher education has expanded so rapidly in recent years that academics need help in deciding which combinations of media to use. It is important for any higher education institution to have instructional designers available who are independent of any particular medium, to advise and help academics in course design, if new technology is to be used. It is too much to expect academics to be specialists in their own subjects and to know all about designing teaching for a wide range of possible media. Some help and guidance is essential, but there is a tendency for instructional designers to be the first to go in times of financial cuts in Universities.

These are all major obstacles to the introduction of new technology in higher education. However, it may be no bad thing that higher education is cautious and conservative regarding new technology. Not all that is new is good, and if the traditional obstacles require the new technologies to be fully justified, this could be a welcome counterbalance to the sometimes "gung-ho" attitude of politicians and media specialists towards the new technologies.

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