MATHEMATICAL PIE

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A MAN BEFORE HIS TIME

For the first time since its original printing in 1950 Mathematical Pie has a new editor. Roland Collins has handed on the goodwill of 37 years of continuous leadership to the Mathematical Association and a new editor, Geoff Fowler.

During the war, Roland was in the RAF teaching aircrew the mathematics they needed for their survival. His first post as a civilian mathematics teacher was at the Gateway School in Leicester. While there, he was asked to look into the uses that could be made of visual aids and through the use and construction of these, he realised the value of novelty, realism and pupil involvement.

Having developed a "Maths Problem Board" for his school and found it successful, he was asked to talk about it at a conference in Sheffield in 1950. Members of the audience immediately wanted copies of his problems and he was asked to circulate them. He printed them on a single sheet of paper folded in the middle to form four pages. Originally 1500 copies were circulated, but the demand exceeded supply and after seven reprints 20000 copies were eventually sold. Mathematical Pie had started.

Gradually through its pages and the contacts made through it, Roland was instrumental in forming the first branch of ATAM (now the Association of Mathematics Teachers) and by 1958 he was heavily involved in the beginning of MME (Midlands Mathematics Experiment). This was a scheme in which pupils were expected to investigate some aspects of mathematics for themselves, thus gaining a deeper understanding of the underlying concepts. Is nothing new?

Now, 111 editions later, Roland and his wife, Grace, who has looked after the finance and distribution of Mathematical Pie all this time, think it is time to hand on the baton and the responsibility for innovation to the Mathematical Association.

On behalf of the readers young, and not so young, I wish them both a long and happy retirement.

J.B.

TEACHING AND LEARNING AIDS

As we have seen, the paradigmatic shift of emphasis from the teacher to the learner in the emerging ideology of primary mathematics brought with it a renewed and growing interest in material aids as part of the learning environment. Gattegno was a prime mover in this field from the 1950s, but his and other contributions in mathematics were only part of a developing general interest in material aids – audio, visual and tactile – for educational purposes. The pressing need to equip military personnel for the technical demands of war certainly helped forward the movement towards greater variety in teaching methods, including the development of material aids. As Bill Brookes has pointed out, 'the war had resulted in people realizing that far more people could cope than the theories beforehand had supposed'. In the cases of the RAF and the Air Training Corps, Wilf Flemming has drawn attention to the strong stimulus of practical need in reforming the teaching of established parts of the mathematics curriculum, such as trigonometry for aspiring airmen, and the renewed interest in correlation between mathematics and other subjects. (167) Roland Collins, who became a founder member of the ATAM, has emphasized the importance of his RAF experience for his educational work, both in school and with other teachers, after the war:

> I had to teach these people, and their lives depended, in part, upon how they were taught. I had to work out the best way of making sure they understood it in case they had to modify it; and it was no good just giving them a rule, they had to work it out for themselves . . . (168)

Evidence of a general movement associated with visual aids in education is provided by the formation, in 1946, of the National Committee for Visual Aids in Education and the Educational Foundation for Visual Aids, and the appearance of a new monthly periodical, *Visual Education*. National activity was accompanied by local activity, involving working groups of teachers, and the movement was not confined to this country. In mathematics, the American National Council of Teachers of Mathematics devoted a complete yearbook, in 1945, to the subject of 'multi-sensory' aids in the teaching of mathematics. The introduction to this yearbook began:

> TEACHING AIDS in mathematics are not new. The last hundred years have brought us the telephone, the phonograph, the radio, television, the silent and sound motion picture, the stereoscope . . . and motion pictures in color. These inventions and developments are being used in many forms in our schools at the present time. It

> is only natural that mathematics teachers, too, consider the possible adaptation of these materials to the improvement of instruction in their field. (169)

In England, the early interest in mathematics was focused on the uses of models, filmstrips and films, and the MA was not slow to take notice of these new developments.

Brief references to mathematical films started to appear in the *Gazette* from 1936, and in that year a subcommittee led by Miss Punnett was appointed to investigate the new developments and report back, which it did, briefly, in the following year. (170) After the war, the Teaching Committee chose visual aids as one new area for subcommittee work, and an early effort was now made by the MA to raise the profile of this aspect of mathematics teaching. The focus on visual aids lent itself to a new initiative from the MA, in 1947: the mounting of a major exhibition at the annual meeting, in addition to the normal publishers' exhibition. A discussion on the place of visual aids in mathematics teaching was opened by I.R. Vesselo, chairman of the visual aids subcommittee and the leading spirit in bringing the idea of an exhibition, with some fifty to sixty main exhibits, to fruition. Pioneering films by R.A. Fairthorne – on unforced and forced vibrations and on hypocyclic motion – were included, along with some filmstrips produced for the British and American navies.

Static and dynamic geometrical models were featured prominently at the exhibition, and the list of contributors included Martyn Cundy, whose 'home-made harmonograph attracted much attention'. (171) The names of Cundy and Rollett became closely linked through their joint authorship of *Mathematical Models*, a very successful reference book first published in 1952. (172) Another major contribution to the exhibition came from a Leicester group, led by W.W. Sawyer, from the local college of technology, and including Collins, who had started to develop the use of working models and demonstrations in his teaching at the Gateway School, a technical high school for boys where facilities for construction in wood, metal, plastic and plaster of Paris were readily available. The potential of material aids helped to further the mission of those teachers seeking to make more of the substance of mathematics more accessible to more people. Lancelot Hogben's *Mathematics for the Million* (1936) and his companion volume, *Science for the Citizen* (1938), symbolized the general thrust, and the works of popularization by Sawyer, beginning with his *Mathematician's Delight* (1943), shared the same spirit. (173)

By the late 1940s, visual aids had become a fashionable topic in education, and, following the report of the NCTM, the MA clearly saw a need for some kind of report focused on English mathematics teaching. But this was a relatively new field, in which both tradition and consensus were lacking. As late as 1957, a report of the IAAM judged:

> The material available for the teacher of mathematics is very limited and is likely to remain so for some time. Commercial manufacturers and producers are reluctant to enter such a hazardous field. It rests largely with the enthusiastic amateur not only to produce his own material, but also to bring it to the notice of other teachers. (174)

The MA's attitude to the commercial dimension was clear: there would be no endorsement of any commercial products, this refusal to endorse being 'in keeping with the policy of the Teaching Committee of the Mathematical Association'. (175) But efforts to produce a major report proceeded, and by 1950 drafts of several chapters had been prepared under the general guidance of Vesselo, the bulk of the detailed writing being undertaken by co-opted members with relevant experience. (176)

There was an unfortunate lack of continuity in the Teaching Committee representation on the visual aids subcommittee, pre- and post-1950, and the draft of the report ran into difficulties when it was put to the full Teaching Committee in 1952. The major bone of contention was that the report ranged too widely beyond specifically mathematical concerns and, in parts, was not well matched to the parallel work of the primary and secondary modern subcommittees. (177) Given that much of the work had been done by co-opted members, who were out of direct touch with the Teaching Committee, this is not surprising. The upshot was a very modest pamphlet, put together by an *ad hoc* subcommittee under Vesselo and finally published in 1954. (178) All consideration of the wider and more general application of visual aids was left to the 'appropriate bodies'.

The MA's pamphlet included annotated lists of filmstrips and films, in which the work of Fairthorne and Nicolet of Lausanne featured strongly. (179) Photographs from the 1947 exhibition were included and also plates from two English films – plucked strings and the Simson line – produced by Trevor Fletcher at the Sir John Cass College. Fletcher had attended the 1947 annual meeting and he joined the MA in that year. But, from 1953, he became very actively involved in the national work of a new association, the ATAM. There is a passing reference in the MA's pamphlet to the formation, in 1952, of an Association for Multi-Sensory Aids for the Teaching of Mathematics, with Collins named as secretary. (180) Gattegno has been referred to as the 'principal founder of the ATAM and the mainspring of its early work'. (181) The circumstances leading up to the formation of a new mathematics teaching association in England, and its connections with the related work of the MA and its members at this time, warrant a closer investigation.

A new branch of the MA was established at Leicester in 1947 and this gave Collins an early opportunity to disseminate his work on demonstration models, displays, including historical material, and filmstrips. He contributed to the MA's 1947 exhibition and gave talks and demonstrations at MA branch meetings, including one at Sheffield in 1950. Here it was suggested that the Gateway School's and other ideas for what was essentially the popularization of school mathematics might be disseminated in the form of a regular, 'cottage-industry' publication. (182) As a result, a new, cheap – it started at 1d for 4 pages – and user-friendly periodical was launched under Collins's editorship, with the title *Mathematical Pie*. The links with the MA branches helped Collins rapidly to build up an impressive mailing list of contacts, principally in grammar schools, through the very successful marketing of *Pie*, and he also started a newsletter. (183) Through the *Pie* network, Collins came into contact with other innovative teachers, such as Ronald Fielding and Miss Giuseppi,

both of whom had established links with Gattegno through his work at the London Institute. (184)

From 1950, Gattegno had been instrumental in the development of an international network in mathematics teaching under a somewhat inflated title: the International Commission for the Study and Improvement of the Teaching of Mathematics (ICSITM). He acted as general secretary and clearly saw the potential for a group of like-minded British activists to be linked with the work of the ICSITM. Through his existing contacts and *Pie* network, Collins was well placed to take an organizational lead and he was brought in as an 'import' for an informal meeting with Gattegno at the Institute. As a result, a first circular was sent out by Collins in February 1952, inviting co-operation in the establishment of a new association. (185) A testimonial from Gattegno was attached:

> I welcome the initiative taken by Mr. R.H. Collins, a member of our Commission, to form in this Country, a Committee of all those who wish to contribute to the visual side of Mathematics Teaching. I am confident that this Committee will find the adequate response among teachers and will contribute a great deal to clarify the ways in which our pupils improve in their learning processes. (186)

Collins's early work with visual aids had, not surprisingly, also attracted the attention of the MA's visual aids subcommittee. However, his overtures were not well received. Independently, Collins was making an early impression through the dissemination of visual aids at prices teachers could afford. Mathematical Pie, as a 'cottage industry', became a limited company and registered charity. The success of *Pie* helped to subsidize these efforts. Collins's initiative in helping to start a new association was driven by a strong sense of pedagogical mission and was clearly intended to bypass the MA. (187)

Twenty-four respondents to Collins's circular indicated their willingness to become involved at committee level in what was named the Association for Teaching Aids in Mathematics, at the meeting held at the London Institute in June 1952. (188) There was an attendance of twelve at this meeting, and Gattegno was elected as chairman as well as 'director of studies', with Collins as secretary and Miss Giuseppi as assistant secretary. (189) About half of those involved at this stage were also members of the MA. A first full list of contacts was sent out as part of a second circular in July 1952, and it included 164 names grouped in regions, including Scotland, Ireland and an overseas group. Thus a solid basis upon which to build a new national association was readily established, and the ATAM progressed from strength to strength through the 1950s and 1960s.

Early members of the ATAM shared a general sense of mission: to further the development of mathematics for the multitude. As Brookes has remarked, 'if human beings couldn't do it, it was something else which was turning them off not the mathematics', and the development of ways forward 'was part of what the Association was about'. (190) Obviously, individual members' perceptions and priorities differed. In particular, as Fletcher has succinctly put it, Gattegno was 'very much the founding father' and 'the idealist', and Collins 'very much the pragmatist'. (191) Oral

accounts suggest that Gattegno was a guru-like figure and a challenge to work with, in more ways than one. He was junior to Daltry, at the London Institute, and personal hostilities existed between the two lecturers. (192) Daltry was an MA stalwart, in the London branch and nationally, and Gattegno was viewed with some suspicion not only by Daltry but also by other MA stalwarts such as Rollett and Combridge. (193) Collins and Gattegno would have been united in the belief that the MA was not the appropriate organization within which to pursue their respective missions. Furthermore, Gattegno's championship of the use of Cuisenaire rods was clearly out of step with the MA's policy to isolate commercial from professional interests, both in textbook and visual aids production.

From the outset, the ATAM was a very different kind of organization from the MA. The latter had a long-standing and well-established link with the independent schools and the universities which they fed. The ATAM was not strongly associated with one particular sector of education, and its leading members in the 1950s came from various occupational locations: grammar, technical, secondary modern and comprehensive schools, and teacher training institutions. (194) The ATAM enjoyed the benefits of youth and enthusiasm in its membership, and, within a relatively small organization, innovators and activists soon made a significant impact. Fletcher has recalled that in 1953, after an initial letter to Collins, he was swiftly drawn into the central committee's work; in the following year he also took over the editorship of the *Bulletin*. (195)

Communion was central to the ATAM's work and influence on a growing membership, which had reached a thousand by 1958. On a small scale, residential meetings, initially held at Brazier's Park, a retreat in the Chilterns, provided an opportunity for in-depth reflection and personal development under the guidance of Gattegno himself, as 'director of studies'. His behaviour was, by all accounts, most guru-like in such a setting. On a larger scale, exhibitions, including lectures and demonstration lessons, were mounted in various parts of the country and they made a considerable early impact. (196) The pattern was established at a first meeting in London, early in 1954, and, later in the same year, meetings in Manchester and Exeter attracted around 300 and 250 people respectively. Typically, Gattegno demonstrated the use of Cuisenaire 'briquettes' (coloured rods) or the geoboard, which comprised a five-by-five square grid of pins on a wooden board designed for use with thread or elastic bands. Collins specialized in filmstrips and Fletcher led the early work involving films. Lists of models, films and filmstrips were distributed through the growing ATAM network.

The first *Bulletin* of the ATAM was edited by Collins and distributed in duplicated form in January 1953. (197) Fletcher took over from the third issue: the size of the journal increased and the quality of production was improved. From 1955 the journal was printed and distributed under the title *Mathematics Teaching*. It served to disseminate news about developments in teaching and learning mathematics, both in England and abroad, at a time when the *Mathematical Gazette* was hardly fulfilling this function. It also served to publicize the work of the ATAM and to enhance the new association's reputation.

In 1956 Gattegno resigned as chairman of the ATAM, but he was then elected to the special position of President. He left the Institute in the following year and took up a post abroad. But he continued to act 'at a distance', and to maintain links with individual members of the ATAM, particularly through the ICSITM, as the movement for modernizing the content of school mathematics gained momentum from the late 1950s. Collins took over from Gattegno as chairman for a short time, but complications developed over the links between the ATAM and Collins's limited company. From 1959, a new secretary, David Wheeler, and a new chairman, Ian Harris, helped to secure the ATAM's independent constitutional and financial position in good time for the expansion of its activities in the 1960s. Collins's influence on the ATAM faded – he moved to a new headship in the Midlands, which brought new curriculum development opportunities in the 1960s – but the influence of Gattegno was a deep and lasting one. The spirit of his inspiration was well summarized in a message to the ATAM in 1958:

> When in the committee we learnt to work together as a team, the obvious thing was to know that we had to learn a great deal and that the best way for us to grow was to go to the teachers and the students where they are. Our humility and our enthusiasm gave us the chance of appearing what we were: keen students of the science of teaching mathematics. Because we learnt by observation, by studying pupils' mistakes and tracing them to the mental structures and the techniques we used, we struck the right direction and all over the country first, in several countries afterwards, our Association became known as formed of a group of earnest workers; practical people who had ideas and a great love of truth . . . Our membership is international because our problems are simply human . . . There is so much for us to discover in our activity and so much improvement to bring to our work in order that the joys that we receive from our success shall be the everyday feature of our function, that *Hope* is the sign under which we can now work. Indeed, when we think of the smiles and the bright eyes of so many who formerly were condemned to remain untouched (or even disgusted) by mathematics and now enjoy and even love it, we can see our work as providing spring-boards for the young generation, and no longer straight-jackets. (198)

here, across the Channel or across the Atlantic.' (122) Through publications and international contacts, American and continental influences were in fact helping to shape such experimentation in Britain, but on the question of intuition versus rigour the British approach was typically a moderate one. Cockcroft and Land summarized their impressions from the 1962 Stockholm ICM:

> both French and American mathematicians were in a majority amongst those who mistrusted intuitive ideas and vigorously attacked associating concrete experiences with mathematical arguments and . . . amongst those who thought in terms of mathematical ideas being abstracted from practical examples and concrete situations, a majority were from Britain, Germany and the Netherlands, there being some important exceptions on both sides. (123)

The shortage of mathematics graduates and the problem of teacher supply, the growing involvement of industrialists and professional mathematicians in the educational arena, the organization of major conferences focused on school mathematics, innovations by individual teachers, and influences from science education and abroad, all contributed to a more organized and better resourced approach to British reform through curriculum development projects of various kinds, focused principally on mathematics up to O-level standard in the GCE examinations.

In terms of status and resources, the early involvement of independent schools was significant, as was their independence. The SMP initially involved four public schools, and the Contemporary School Mathematics (CSM) Project had its roots in St Dunstan's College, Catford, under the guidance of Matthews, before he became director of the Nuffield Mathematics Project. However, independence was not a necessary condition for involvement in these new developments. The Midlands Mathematical Experiment (MME), with which Roland Collins of the ATAM became centrally involved, started with a group of eight lower-status secondary schools: two grammar, four technical and two modern. (124)

No central government funding was forthcoming for the early projects in England and Wales, by contrast with Scotland, where a single national project, the Scottish Mathematics Group (SMG), was supported by the Scottish Education Department. But some funding was forthcoming from industry for the SMP and the Mathematics in Education and Industry (MEI) Project, and LEAs also provided some support for local projects. Typically, projects devised their own materials, including teachers' guides, and established links with publishers. Ideas and materials were also disseminated through single meetings, conferences or short courses. In addition, a major factor in the success of the three principal O-level projects – the SMP, CSM, and MME – was the use of the examining boards' special syllabus provision to gain the acceptance of alternative project syllabuses and papers, alongside the existing alternatives A and B (the Jeffery syllabus). (125)

The SMP rapidly became the most successful of the modern mathematics projects in England and Wales, and by 1968 the SMP examinations were available through all the examining boards. By this time it has been