Should people be Paid to Do Research in Mathematics?

Most mathematicians will admit that there is a sense of achievement in having made a mathematical discovery, no matter how small. This emotion along with the desire to gain the respect of other mathematicians are the inner motivating factors for doing mathematical research. A more materialistic motive for doing research is the fact having a number of papers published lessens the likelihood that one will be unemployed for long. Thus research mathematics shares this motivation with many other occupations: if you're good at it, you'll feel good about it and you'll get a good job out of it. It does not follow from this personal motivation that working as a research mathematician is necessarily a good thing.

Mathematics is an important tool in most of natural science and engineering. Clearly one would expect mathematicians to be paid for their services in the same way as laboratory technicians and bricklayers are. But there is a difference between applying the results we know and trying to find out new results. The questions begs itself: do we need to know any more mathematics — can't we make do with what we have?

There is no reason to suppose that mankind will perish without further mathematical research. This does not mean that some future mathematical discovery might not be useful; nor does it deny that a mathematician who has done some "pure" research will usually be a better applied and teaching mathematician.

However, given that technology has outstripped man's needs, if not her desires, research mathematics is becoming a luxury good. Its benefits to mankind in general are increasingly marginal and we face the question: are we justified in paying mathematicians to do research and attend conferences when over half the world's adults are illiterate?

Brendan McCann,
Department of Mathematics,
University College Galway.

Dr. Martin J. Newell (1910–1985)

Seán Tobin

The signature Máirtín O Tnúthail appears prominently on the very fine silver salver which was presented to President Éamon deValera, to mark his Golden Jubilee as Chancellor of the National University of Ireland, in December 1971. The salver is now on display in the Presidential Room of the National Museum—and it must have been very agreeable to Éamon de Valera, who maintained a lifelong interest in mathematics, to have on his memorial salver the signatures of two mathematicians (the other being that of Dr. Donal McCarthy, President of U.C.C.) as pro-vice-chancellors of the University. Dr. Newell's signature is firm and very clear, and this fits well with salient characteristics of the man himself: clarity of expression and firmness of decision, two qualities which became especially significant during his tenure of the Presidency of University College Galway, from 1960 to 1975, when the course of university development was charted for many years to come.

Martin J. Newell was born and bred in the heart of Galway, where his family lived in Shop Street, one of the old central streets which still preserve the outlines of the mediaeval City. He was educated there in St. Joseph's College and in 1926 he entered University College Galway, taking first places in the County Council and University Entrance Scholarships. A brilliant career as a student was crowned with the award in 1930 of the M.Sc. Degree in Mathematical Science (with first-class honours), and the N.U.I. Travelling Studentship. This brought him to Cambridge for three years in St. John's College, where he studied for the Mathematical Tripos.

In 1933 he was appointed to the staff of St. Michael's College in Listowel, and in 1935 he returned to Galway as Lecturer in Mathematics (through Irish), in succession to Eoghan McKenna who had become Professor of Mathematical Physics. Incidentally his own successor in Listowel was James Callagy B.A., they had been fellow-students at U.C.G., where they shared an enthusiasm for geometry.

In 1950 Martin J. Newell was appointed a member of the Governing Board of the School of Theoretical Physics at D.I.A.S., and he continued in that capacity until 1965. In 1952 he was awarded the degree D.Sc. by the N.U.I.

for his published work, and in that year also was elected a member of the Royal Irish Academy.

In 1955 he succeeded Michael Power as Professor of Mathematics in U.C.G.; he himself had no direct successor since — on his recommendation — the College extinguished the monolingual Lectureship in mathematics and established a regular Lectureship instead. About this time also a successful operation restored his hearing (he had been troubled for some years by an increasing deafness) and so in 1955 he entered on a new phase of life. This was a time when the Irish university system, dormant during World War II and its aftermath, was itself quickening to a new life. New courses were planned, young research workers were recruited, and in general the staff in universities began to exert more influence on policy. Symptomatic of this was the formation of staff associations, U.C.G. being well to the fore. In all of the new initiatives Martin Newell played some part, and he was chairman of Cumann Lucht Teagaisce an Choláiste when that body arranged the presentation of a bronze bust to Monsignor Pádraig de Brún, to mark his retirement as President of the College. (This fine portrait bust, the work of Cork sculptor Séamus Murphy, is now in the U.C.G. Staff Club.)

An even greater change was to occur in 1960 when Martin Newell, a surprise candidate, succeeded Pádraig de Brún as President. He was the first native of Galway to hold that office, and he brought to it a high sense of purpose and integrity — in private he said that his guiding principle was "Only the best is good enough for U.C.G.!" His lively sense of humour and ready wit combined with unfailing courtesy, which made him welcome company in any social gathering, helped also to lighten the burden of the many committees which he was called on to chair.

His Presidency coincided with a period of great expansion in the Irish economy, and so he was able to bring to fruition plans already begun under Monsignor de Brún for major new developments. His period of office, from 1960 to 1975, might well be termed the Golden Age of U.C.G. Student numbers more than tripled, extensive new lands were purchased for the campus, a long-range physical development plan was established, a new Library and academic complex was built, staff numbers increased greatly and many new disciplines were introduced.

Dr. Newell was well-regarded also in the larger academic community, and in 1971 was awarded the honorary degree of Ll.D. by Dublin University in recognition of his achievements. He maintained his interest in mathematics, and took a partial Sabbatical from his administrative duties in order to prepare

publications [7], [8] and [9].

After his early retirement in 1975, for health reasons, his tall spare figure with its shock of wavy hair was only occasionally seen in U.C.G., in summer-time - winters were spent in Spain, summers in his lakeside house on Upper Lough Corrib, which was appropriate for a lifelong angling enthusiast. It was with a deep sense of loss and sadness that friends and colleagues learned of his sudden death, soon after his return to Spain in the Autumn of 1985. His body was brought home to rest in his native city; the large and distinguished attendance at funeral ceremonies in Dublin and in Galway was eloquent testimony to the affection and respect which he had earned over his many years of service to his country.

No appreciation of Brod Newell, as he was known to his friends, could be complete without a tribute to his wife Noreen who is happily still hale and hearty, and whose friendship is treasured by those of us who have had the privilege of knowing her for many years. She too is blessed with a keen sense of humour, and was always the soul of hospitality to students and staff alike. Her constant support and her careful concern for his health contributed greatly to her husband's success as teacher, researcher and administrator; and she created a happy family life for their five children (Sinéad, Michael, Martin L., Éamonn and John).

Since the present healthy state of algebra studies in Ireland has arisen largely because of the impetus given by M.J. Newell and his students in Galway it is pleasant to record that his son, Martin L., has followed his example, being himself a professor in the U.C.G. department of mathematics and well-known internationally for his research work in group theory.

A Personal Note

As a student majoring in Mathematical Science in U.C.G., I helped Brod Newell to proofread some of his papers—actually, as it happens, in the same room where I am writing these lines. It was due to his influence that I went to Manchester to study algebra (in fact group theory with Graham Higman); and at his request I returned to Galway from the U.S.A. to become the first Lecturer in Mathematics at U.C.G. I owe more than I can say to him and to Noreen for continuing friendship, advice, encouragement and hospitality over the years since then. One of his old colleagues, whom I asked for his considered opinion of Brod, said "He was always a gentleman". I think that this is as good a summing-up as one could wish for. Ar dheis Dé go raibh a anam dílis.

Mathematical Work

Martin J. Newell won the Peel Prize in Geometry at U.C.G. in 1926, and in later years kept a hopeful eye on subsequent winners as potential future mathematicians. It seems fitting that his first venture into print was as one of the contributors to Mathematical Note No. 1031, on *A difficult converse*, in the 1932 Mathematical Gazette [1]. This note commences as follows: "The difficulty of proving that if the [internal] bisectors of two angles of a triangle are equal [in length] then the triangle is isosceles is well known; three fairly simple proofs are given in this note." The first proof is Newell's: quite a simple argument based on an ingenious construction—possibly a carryover from his student days in U.C.G. Incidentally, the other two proofs were derived from articles in the *Lady's and Gentleman's Diary*, 1859 and 1860, showing that the comment "well known" was well founded.

Curiously enough, despite his inclination towards classical geometry Martin Newell's own forte was in combinatorial algebra. He was a master of matrix theory, a virtuoso performer of polynomial calculations. These qualities are evident in—and indeed are the basis for—his published research papers [2] to [9]. Some of these interests show through also in his book *Algébar Iolscoile* ("A University Algebra") [10] where Laplace and Cauchy expansions jostle for space with theorems of Jordan and Binet-Cauchy on compound matrices, in a beautifully concise exposition.

Papers [2] to [7] inclusive are in the classical tradition of group representation theory deriving from Frobenius and Schur; they consist in the main of original and often elegant proofs of known results, most of which are due to Littlewood or Murnaghan. In some cases these results are extended or generalized, and methods are given for simplifying tedious calculations which arise in their development.

References [A] and [B], as well as the later [C], give the background to Newell's papers; as texts they make difficult and at times frustrating reading but, for those who are interested in sampling the original flavour of the Frobenius - Schur results, a beautiful introduction is given in Walter Ledermann's book [E]. Boerner [D] covers roughly the same ground as [A] and [B], but this material is no longer the sole concern of texts on group representation theory;

for instance Walter Feit's recent book [F] ignores it, being concerned entirely with modular theory.

In the years 1948-50 Martin J. Newell wrote up and published, in five papers [2] to [6], results which he had obtained over the previous decade. The first of these is in some ways the most elegant of the series; he commenced by remarking that while the quotient of two alternant determinants had been much used, the quotient of two alternant *matrices* had not been exploited – an omission which he proceeded to rectify, by showing "that consideration of the quotient matrix furnishes simple proofs for most known theorems".

Some definitions will be useful, to explain the thrust of his work. Let $\alpha_1, \alpha_2, \ldots, \alpha_n$ be a sequence of n indeterminates and let $(t) = (t_1, t_2, \ldots, t_n)$ be a strictly decreasing sequence of non-negative integers $t_1 > t_2 > \cdots > t_n \geq 0$. Let $A(t_1, \ldots, t_n)$ be the alternant matrix whose (i,j) entry is $\alpha_i^{t_j}$. The determinant $|A(t)|$ is an alternating polynomial in $\alpha_1, \ldots, \alpha_n$; in particular when $t_1 = n-1$ it is Vandermonde's determinant. Let σ_r and h_r respectively be the elementary and the complete homogeneous (Wronski) symmetric polynomials of weight r in the indeterminates $\alpha_1, \ldots, \alpha_n$ where $r \geq 0$; define $h_i = \sigma_i = 0$ if $i < 0$. The key result in [2] is the following:

For any positive integer s, and for $1 \leq k \leq n$,

$$\alpha_k^s = [h_{s-n+1}, h_{s-n+2}, \ldots h_s] Q [\alpha_k^{n-1}, \alpha_k^{n-2}, \ldots, \alpha_k, 1]'$$

where the dash denotes transposition and Q is the matrix

$$q_{ij} = (-1)^{j-i} \sigma_{j-i} \,. \qquad (\text{Thus } |Q| = 1).$$

From this it follows immediately that

$$A(t_1, t_2, \ldots, t_n) \equiv BQA(n-1, n-2, \ldots, 1, 0)$$

where B is the matrix $b_{ij} = h_{t_i - n + j}$.

Taking determinants we see that

$$\frac{|A(t_1, t_2, \ldots, t_n)|}{|A(n-1, \ldots, 1, 0)|} = |B| \,.$$

This is the classical Jacobi-Trudi equation, and that is Newell's proof of it.

Now clearly $|B|$ is a symmetric homogeneous polynomial, with integer coefficients, in $\alpha_1, \alpha_2, \ldots, \alpha_n$. If $\lambda_i = t_i + n - i, 1 \leq i \leq n$, then $|B|$ has degree

$\lambda_1 + \lambda_2 + \cdots + \lambda_n = m$ say, where $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_n \geq 0$. The sequence $(\lambda) = (\lambda_1, \lambda_2, \ldots, \lambda_n)$ gives a non-increasing partition of m; reversing the procedure we might now, given such a partition (λ) define $t_i = \lambda_i - (n-i)$ thus getting a strictly decreasing sequence (t). The corresponding polynomial $|B|$ is known as the *Schur function*, or S-function, associated with (λ) and is denoted here by the symbol $\{\lambda\}$. These functions $\{\lambda\}$ play a central role in studies of the characters of the symmetric groups S_m, as also in the character theory of the real orthogonal and sympletic groups.

The study of identities which link S-functions and other basic symmetric functions such as σ_i, h_i and the power-sums $s_i = \alpha_1^i + \cdots + \alpha_n^i$, the study of rules for expressing given symmetric functions of $\alpha_1, \ldots, \alpha_n$ in terms of S-functions— hence e.g. rules for calculating the coefficients $g_{\lambda\mu\nu}$ where $\{\lambda\}\{\mu\} = \sum_\nu g_{\lambda\mu\nu}\{\nu\}$: these are the subject matter of the papers [2] to [7]. Possibly the strongest influence of this work is to be seen in Murnaghan's book [C] based on a course of lectures which he gave in 1957 at the Dublin Institute for Advanced Studies. In the preface he refers to considerable improvements upon the exposition in [A], and mentions "for instance, the treatment of the modification rules for the rotation, sympletic and orthogonal groups, in which I have been able to use with great profit the ideas of Professor M.J. Newell."

Already two years earlier, in his lectures to the 1955 St. Andrew's Colloquium, Philip Hall had cited Newell's work — I am indebted to Ian Macdonald of Q.M.C. for this reference. Hall was discussing the proof of certain key properties of Schur functions and remarked that "a particularly elegant derivation of the central theorem, and of many other important formulae" had been given a few years previously by Dr. M.J. Newell. (In fact Newell was present at that Colloquium, and must have been pleased with this complimentary reference to [2]. Subsequently however he expressed more interest in the fact that, having gone to speak to Hall after one of the lectures, he had noticed on the margin of Hall's manuscript a pencilled note "Joke here" followed apparently by an outline. He was surprised that the eminent Cambridge group theorist should (a) think a joke necessary during his lecture and (b) need to write one down. This illustrates a fascinating aspect of Newell's own character, namely the way in which he combined apparently contradictory traits. Thus he himself, quick in repartee and a good raconteur, would never have needed to write down a joke — yet on the other hand he never, to my knowledge, made a joke when lecturing.)

The last paper in this series, [7], deserves special mention, being Newell's only joint paper (his co-author was a long-time associate, Rev. Professor

James McConnell of D.I.A.S.); it was written and published during his term of office as president of U.C.G., it makes effective use of the concept of "conjugate symmetric functions", and it was written in order to prove fully certain results given by Littlewood [B] where the proofs, "when looked into ... are found to be incomplete". It is a substantial paper, filling a substantial gap, and represents perhaps a final act of pietas.

The papers [8] and [9] also appeared while M.J. Newell was President, and exhibit the working-out of ideas which had interested him previously. In [8] he shows how to express the discriminant (necessarily non-negative) of the characteristic equation of a real symmetric $n \times n$ matrix S as a sum of squares of minors from a rectangular $n \times n^2$ matrix M such that $m_{rs} = \text{trace}(S^{r+s-2})$; for $n = 3$ this reduces to an old theorem due to Kummer (1843). The final paper [9] is an application of algebra to a problem in calculus. If $F(x_1, x_2, \ldots, x_n)$ is a continuously differentiable function of n real variables, then the nature of a stationary point is (h opefully) determined by a quadratic form; the matrix A of this form is $n \times n$ with $a_{ij} = \partial^2 F/\partial x_i \partial x_j$, and whether the form is semi-definite or not may be decided directly by examining the signs (+ or −) of the leading principal minors of A. An analogous (and apparently new) criterion for the case where there are $n-k$ auxiliary conditions $\varphi_i(x_1, \ldots, x_n) = 0$, $1 \leq i \leq n-k$, is derived very neatly in [9], and here again determinantal expansions due to Jacobi and Laplace are used to great effect.

M.J. Newell took his responsibilities as Lecturer through Irish very seriously, and prepared textbooks on algebra, calculus and geometry. These were written for An Gúm, the Government agency for publication of books in Irish; the algebra and calculus texts were published but An Gúm apparently found the geometry too unorthodox and it never appeared in print. The calculus text [11] had Michael Power, then Professor of Mathematics at U.C.G., as co-author and was quite orthodox. The most noteworthy book was Algébar Iolscoile [10], which was used regularly by honours classes in U.C.G. It is a brief introduction to classical algebra with a minimum of jargon and a maximum of information, and is still treasured by those who acquired it as their first university-level text in algebra.

Bibliography

1. *Note No. 1031,* The Mathematical Gazette, 1932, 200-202.

2. *On the Quotients of Alternants and the Symmetric Group,* Proc. London Math. Soc. (1951), 53, 345-355.

3. *On the Multiplication of S-Functions,* Proc. London Math. Soc, 53(1951), 356-362.

4. *A Theorem on the Plethysm of S-Functions,* Quart. J. Math. Oxford (2), 2(1951), 161-166.

5. *On the Representations of the Orthogonal and Symplectic groups,* Proc. R.I.A., 54A (1951), 143-152.

6. *Modification Rules for the Orthogonal and Symplectic Groups,* Proc. R.I.A., 54A (1951), 153-163.

7. (with J.McConnell) *Expansion of Symmetric Products in series of Schur Functions,* Proc. R.I.A., 73A (1973), 255-274.

8. *On Identities associated with a Discriminant,* Proc. Edinburgh Math. Soc. 18 (II), (1973), 287-291.

9. *The extremum problem with auxiliary conditions,* Proc. R.I.A., 74A (1974), 27-32.

10. *Algébar Iolscoile,* An Gúm, Dublin, 1947.

11. (with M. Power) *Nótaí ar Mhion-Áireamh,* An Gúm, Dublin 1960.

References

[A] F.D. Murnaghan, *The Theory of Group Representations,* Johns Hopkins Press, Baltimore 1938.

[B] D.E. Littlewood, *The Theory of Group Characters and Matrix Representations of Groups,* Oxford 1940, (2nd Edition, Oxford 1950.)

[C] F.D. Murnaghan, *The Orthogonal and Symplectic Groups,* Communications of D.I.A.S., Series A, No. 13, Dublin 1958.

[D] H. Boerner, *Representations of Groups,* North-Holland, Amsterdam 1963.

[E] W. Ledermann, *Introduction to Group Characters,* Cambridge 1977.

[F] W. Feit, *The Representation Theory of Finite Groups,* North-Holland, Amsterdam 1982.

Mathematics Department
University College Galway