where the b_i are known functions. We note that equation (9) is of order $(n-m)$ in v_1'. Since the above steps are reversible, the problem of determining y_p has been 'parametrically reduced' to that of solving an $(n-m)$th-order linear equation.

'Reduction of order' corresponds to the case $m=1$. Condition (1) becomes $y_1(t) \neq 0$ and there is no condition (2). The substitution (4) is $y_p = v_1 y_1$, whence (9) is of the form $\sum_{i=1}^{n} b_i v_1^{(i)} = b$, an equation of order $(n-1)$ in v_1'.

'Variation of parameter' corresponds to the case $m=n$. Condition (1) is not needed; condition (2) holds on I iff $\{y_1,\ldots,y_n\}$ is a fundamental set. Equation (6) becomes

$$a_n \sum_{k=1}^{n} v_k' y_k^{(n-1)} = b. \tag{10}$$

Equations (8) become

$$\sum_{k=1}^{n} v_k' y_k^{(j)} = 0, \quad j = 0,\ldots,n-2. \tag{11}$$

Equations (11), together with equation (10), allow us to determine $v_1',\ldots,v_n'$, whence we can find $v_1, \ldots, v_n$ by anti-differentiation.

In discussing variation of parameter, many texts state that conditions (11) are 'arbitrarily imposed' in order to obtain enough conditions on the unknowns $v_1', \ldots, v_n'$. In the development given here, conditions (11) are seen to be a (nonarbitrary) consequence of equations (4).

A related (but nonequivalent) treatment for linear systems may be found in [1], pp. 49–50.

Reference

1. P. Hartman, *Ordinary differential equations*. Wiley (1964).

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Obituary

Kenneth Scotchburn Snell

It is difficult to write dispassionately about Kenneth Snell so soon after his death when one knew him intimately and worked closely with him for so many years. He had all the likeable qualities of a great man, with the kindness and generosity of the ideal colleague; ambition and self-interest were utterly alien to him. He leaves behind him a fine reputation as a most gifted and conscientious teacher, an able administrator and an example of all that a schoolmaster should be.

Although he was interested in games of all kinds he was, primarily, a dedicated learner and teacher. At school and university he was distinguished on the academic side—a Grecian at Christ's Hospital and a Wrangler at Trinity College, Cambridge. His first teaching post was at Shrewsbury School (1922–29), and then he joined the famous Arthur Siddons at Harrow. Shortly before the War he took over from A.W.S. as Head of Mathematics, and not long afterwards (1941) became a House Master. His extra duties within the School were more than enough for one ordinary mortal—taking games, his House, ration-books, firewatching and many committees—but he had the ability to work quickly and, it seemed, simultaneously, on a multitude of tasks.

Retiring from Harrow in 1961, at the age of 60, he fulfilled one of his lifetime ambitions, to serve as a teacher amongst some of the less fortunate peoples. (This was, perhaps, a second choice, since, for many years, he intended to take holy orders and work as a missionary.) He taught for three years at Mfantsipim School in Ghana, where he quickly established a great reputation. Before Kenneth Snell arrived, clever schoolboys in Mfantsipim thought little of school-teaching as a career, but, after they had been taught by him and had learned something of his worth, several of them decided to try to follow his example. One still hears reports of the impact which his comparatively short tour made upon them.

At this time he became seriously disabled with arthritis, but he fought against the crippling effects of the disease with all the courage and strength with which we had become familiar. Unfortunately his wife had to return home, as the Ghana climate was too much for her, so he was unable to extend his contract. Instead he became a lecturer at St. Luke's College, Exeter, a post which he greatly enjoyed until his final retirement in 1967.

His work for the Mathematical Association began before the War, when he joined the Teaching Committee and, soon afterwards, became Honorary Treasurer. The survival of the Association, and its ability to restart full activity very shortly after the War, were due to the devoted work of a very small group of men, of whom he was not the least. When he resigned from this office in 1948 there was a sound basis on which the Association could build. His services were recognised in 1952, when he was elected President, but he continued to take the greatest possible interest in the Association right up to the time of his death.

Perhaps a personal recollection will not be entirely out of place. Shortly after I had joined the Harrow staff I was playing bridge with Kenneth Snell. I had shown him a problem which interested me; he had just begun to consider how he should play a hand; the telephone rang. He took his hand and the problem to the telephone, where he answered some very detailed questions without hesitation, worked out how to play the hand and solved my problem, all at the same time, as far as I could see. What a wonderful man he was to work with. In over twenty-five years of friendship and duties shared I never once heard him say one single unkind word about

anyone, and he never showed the slightest impatience with my less purposeful meanderings—and yet he would not tolerate unfairness or injustice where it lay in his power to prevent or oppose them. Certainly he was a great man on whom we all could utterly rely, and we shall miss him very, very sincerely.

J. B. MORGAN

Thomas Arthur Alan Broadbent

When Mr. Quadling invited me to write this Obituary, my spontaneous remark was "But I feel so inadequate", to which he replied "So are we all". This scrap of conversation would not of itself be worth recording, except that it condenses, in instinctive form, the feelings of two Editor-successors who knew Alan Broadbent and loved him well.

Perhaps only those who had the privilege of personal acquaintance will see what I mean when I say that outstanding characteristics were absolute kindliness and utter modesty, combined with complete authority and, when necessary, righteous wrath—a combination fully possible only when sympathy and integrity go hand in hand. Few men can have been more honest both in their thinking and in their speaking. We often talk about hating the sin while loving the sinner; it is certain that Alan Broadbent hated the sham while loving the shammer.

I begin at that end, since that is where much of his value to the Association seems to rest. As an *ex-officio* member of Council and committees, he helped to guide us by advice that was always cogent, definite and kindly. Gifted by a voice that was both incisive and warm, he could express himself with the clarity and brevity of a real master of the English language. I remember, for example, impassioned pleas for the fuller incorporation of the young into the affairs of the Association.

His knowledge of the membership of the Association was extensive. For some years I acted as Chairman of our Programme Committee, of which he was a member. He always had names to suggest, and could immediately give a thumb-nail sketch (positive or negative) of anyone proposed for lecture or discussion. It was typical, too, that we usually met under his hospitality at the Royal Naval College at Greenwich.

'T.A.A.B.' edited *The Mathematical Gazette* from 1931 to 1955, making an outstanding contribution to mathematical journalism for the teaching profession, and to the whole reputation of the Mathematical Association in particular. It is inevitable, but sad, that many of our present members did not see him in action and, indeed, that they may now have few chances of being able even to turn up his own major contributions. But all who can should read (or re-read, or even re-re-read) at least his article "*The Mathematical Gazette*, Our History and Aims" in No. 291 (1946) and his Presidential Address "Printer's Ink and the Teacher" in No. 324 (1954). Quite apart from the content, the pure pleasure of reading lucid, nervous English will be an experience in itself.