Emergency Services Research in Great Britain

Edward H. Blum

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I. INTRODUCTION

On a trip to Great Britain during July 1975, I talked with a number of people engaged in research on municipal emergency services. This working paper summarizes these conversations. It is being circulated as a WP because its technical content may be of interest to a number of people within IIASA.

II. FIRE PROTECTION

In Great Britain, systems analytic work on fire protection is centered largely in a small group in the Scientific Adviser's Branch of the Home Office. This group conducts a considerable amount of analysis itself, coordinates a relatively small amount of analytical work performed at the Fire Research Station in Boreham Wood (a northern London suburb), and supervises contracts let to consultant groups. The principal consultant group working in this area is the Local Government Operational Research Unit (LoGORU), set up in 1965 by the Royal Institute of Public Administration.

On this trip, I visited both the group in the Home Office, directed by Mrs. Jane Hogg (a professional acquaintance since 1968), and the group at the Local Government Operational Research Unit working with her.

FP 1: Scientific Adviser's Branch, The Home Office

Met with:

- Mr. J.K.S. Clayton, Director, Scientific Adviser's Branch

o Mrs. Jane Hogg, M. Sc., Head, Fire Protection Group
o Dr. Ronald Rutstein, Fire Protection Group
o Mr. Michael G. Mytton, Fire Protection Group

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Home Office
Horseferry House
Dean Ryle Street
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Jane Hogg established her group, against much opposition from administrators in the line Fire Department part of the Home Office, in 1968. It quickly received the blessings of the several top-level commissions that examined British Fire Services between 1968 and 1972, and is always noted favorably in the Annual Report of the Chief Fire Inspector, yet a third part of the Home Office concerned with fire protection. But her work has been part of a continual uphill battle against the old-line administrators, who are fighting against "encroachment" by scientific civil servants throughout the British government.

As a result, though her group has produced much technically first-rate work, among the leading work in its field internationally, it has yet to gain a secure footing in the civil service or to make much headway against the national fire administrators, whom it seems to make insecure.

One dramatic example of the battle is particularly painful to the group and strikingly absurd to outsiders: the Fire Department has prohibited Jane or her group from having direct contact with the local fire brigades. The group cannot talk to the fire brigades or visit them, or invite them formally to review the analytical work, without the express permission of the line administrators, which is almost never granted. This prohibition stands in spite of repeated interest in Jane's work on the part of several major fire brigades; her contact with them continues to be

at professional meetings, through the formal publications, and through the medium of her few consultants. Since the Fire Department administrators outrank (and out-clout) the Scientific Adviser's Branch, the group feels it would be destroyed (in classic civil service fashion) if it subverted the prohibition, either openly or semi-covertly.

These dispiriting restrictions notwithstanding, the group continues to conduct and publish good work. And, through its contract with LoGORU, it is having the models and methods tested, refined, and evaluated in selected localities. The results from the tests thus far appear to be quite good. The group is hopeful, therefore, that it may be on the way toward getting distillations of the models' results accepted at the top as the basis for new fire cover and deployment standards. Even if only partly successful in doing so, they could thus change the rules by which the administrators play (and the inspectors enforce), and influence--hopefully, improve--fire protection, despite their nominal lack of clout.

The group's work has focussed on the following questions:

a) What are the effects on fire damage, in different classes of buildings, of changing the response times of needed fire-fighting appliances? (An "appliance" is a single unit or piece of motorized fire-fighting equipment, with the crew of men assigned to it.)

b) Given a loss-versus-response times function, how should one site fire stations to achieve most effective coverage?

c) If one wants to minimize for the community the total cost of fire losses and fire brigade expenses, how many units should be stationed at each site? (This question also entails considering

possible unavailability of appliances, the number of appliances required for large incidents, and the requirement imposed for initial response to incoming alarms. One also has the option, restricted in places, of staffing with full-time personnel, using part-time, retained personnel, or relying on volunteers--with very different costs and potentially different performances.)

Of these, given the work done elsewhere (especially by Rand's group in New York), the most difficult question is the first. There is not enough theory to describe well the underlying processes, and data for losses and response times are generally poor. Jane has been most fortunate, however, to have available through the Home Office the best data of this kind in the world. Using it, she and her colleagues have developed some relatively simple but respectable models and estimated consistent coefficients. (I reserve, however, a number of theoretical and practical objections to aspects of the models and the estimation.)

As refined through successive evolutions, these models form the objective function for the siting models, which largely evaluate large numbers of possible site combinations, using basic ordering techniques to trim the trees and enumerative search techniques to focus on the most promising combinations. The approach is mainly heuristic, though portions of it incorporate known optimization techniques. In all the examples published thus far, the total cost curve is very flat near its minimum. In one example, the maximum difference in total cost in the range between 9 appliances overall and 14 was barely 5% of the total--well within the uncertainty in the loss estimates.

We spent several hours profitably discussing the models in detail, mulling over the unresolved problems, disputing the various approaches to analyzing and using loss functions,

and comparing the results of her work with Rand's. She has begun basing her more recent analyses on the much more extensive Rand research, and had some useful comments and critiques on it. Jane supplied several reports, and sent a package with others that arrived at IIASA before I returned.

In addition, she supplied some general references (including The Fire Protection Directory, which contains information about fire protection on the continent that the IIASA library has been unable to obtain in ten months of searching), and offered to help prepare sections on her group's work, or critique appropriate sections of the emergency services book.

The group's publications include:

(1) J.M. Hogg, "The Siting of Fire Stations," Operational Research Quarterly, 19, 275-287 (1968).
(2) "Planning for Fire Stations in Glasgow in 1980," Report #1/68.
(3) "Station Siting in Peterborough and Market Deeping," Report #7/70.
(4) "A Distribution Model for an Emergency Service," Report #8/70.
(5) "A Model of Fire Spread," Report #2/71.
(6) "Operational Research on Fire at the Home Office," paper read May 31, 1972, to the Manchester and District Group of the Institute of Fire Engineers.
(7) "The Siting of Fire Stations in Northampton and Northamptonshire," Report #4/73.
(8) "Losses in Relation to the Fire Brigade's Attendance Time," Report #5/73.
(9) "The Number of Pumps Required in Northampton and Northamptonshire," Report #2/75.
(10) "Methods of Planning Fire Cover Using Cost Effectiveness Criteria," Report #7/75.

(11) "The Number of Appliances Required in Manchester for 1985," Report #8/75.

In addition, they have made available a LoGORU report,

(12) "The Siting of Fire Stations in Manchester," LoGORU Report #C-184, October 1974, by B. Pilgrim and T. Green.

Thermal Imaging

After we had thoroughly covered our mutual analyses, we went up the hall to see some advanced technological work the Scientific Adviser's Branch has undertaken--a thermal imaging camera to detect hot spots and otherwise help the fire service to see in smoke-filled environments. The young man who had developed the camera showed it off very proudly; it could easily discriminate the 0.2° C. difference between white and black panels exposed to the same floodlight.

As we talked, however, it became clear that (a) he was unaware of the advanced state-of-the-art in thermal imaging, developed for both military and medical applications, and thus did not know that more compact, more stable, and less expensive equipment was already available essentially off-the-shelf and (b) he had taken the technically naive formulations of need offered by fire chiefs at face value, without exploring the technical performance characteristics such a device would really need to prove valuable in the smoky fire environment.

To gain high sensitivity to small temperature differences, for example, the device was designed to cover its full range of shades (black-grey-white) over 1° C.; all temperatures 1° C. or more than the baseline thus registered identically. I suggested changing the electronics to permit modifying the sensitivity to make full scale 10° C. or 100° C., as well, so that one could choose the range most appropriate to the problem at hand. Otherwise, it might

prove difficult even to find a hot flame in the midst of a room full of swirling heated air (!), much less detect a fire behind a wall or locate a body in a smoke-filled room. He also needed alternative and better means of filtering out unwanted signals (such as reflected sunlight) and of enhancing the signal-to-noise ratio to eliminate effects such as thermal radiation scattering by smoke.

Before embarking on further technological work, I suggested he arrange some tests to ascertain what signatures (in a signal-detection sense) were displayed by typical important situations: horizontal bodies obscured by smoke; fires, embers, or heated air plumes behind partitions; smoldering fires behind dense smoke, etc. I also suggested he talk with the various manufacturers of thermal-imaging devices, to compare notes and see what combinations of the most advanced technology he could put together, at least as the next stage in development work. Their comments indicated that the free consulting had been valuable, and that they planned to try to follow some of the advice.

FP 2: Local Government Operational Research Unit

Met with:

- Mr. Brian Whitworth, Executive Director
- Dr. Barry Pilgrim, Head of Fire Protection Studies

Address: Local Government Operational Research Unit
201 Kings Road
Reading RG1 4LH

Telephone: 0734-580462

For mutual convenience, the meeting was held at LoGORU's parent body in London: The Royal Institute of Public Administration, Hamilton House, Mabledon Place, London WC1H 9BO.

LoGORU's fire protection work stemmed from two sources: First, of course, was its application, evaluation, and refinement of Jane Hogg's fire cover models. Second, was

some work stimulated by the major realignment of local authorities that took place in 1974 (and which will be completed in Scotland only this year), helping new jurisdictions to rationalize their service.

Under the contract with Jane Hogg, LoGORU is applying her group's models to ten selected localities, ranging from dense urban areas (e.g., Merseyside) to sparse rural areas, to see how readily they can be applied and how well the results are or can be accepted by the fire service. The intent of the work is to test whether (and then to build confidence that) the models can be used as a basis for national standards, eventually to be applied to all fire brigades in the country--except Greater London, which everyone views as the outstanding exception that must be treated separately. (There are currently about 130 fire brigades in Great Britain; though the number is changing through consolidations and reorganizations, it has remained roughly constant since the end of World War II, when the nationalized fire service--pulled together from over 1400 pre-war brigades--was returned to local authority.)

Barry Pilgrim noted that, for most of the areas examined thus far, the fire incidence was so localized and the number of fires relatively so small that the analysis itself was relatively simple, almost trivial. Occasionally the models did reveal things the fire brigades did not already know; in one instance, the "revelation" arose from incorrect data, though in the others the insights were readily accepted by the fire officers once they had had time to think about them. Even where the siting recommendations closely matched those already developed by the fire brigade, however, the models did provide quantitative arguments and estimates where the fire brigade generally had only qualitative feelings.

It may be interesting to note here that Jane Hogg was critical of LoGORU for relying so heavily on acceptance by the fire brigade as a criterion of success, arguing that if the models could do no more than tell the fire brigades things they would accept immediately, and generally already knew, they would not represent much of an advance, and probably would not be worth the effort to develop, test, and implement. Barry Pilgrim, on the other hand, argued that if the models were to be more than abstract exercises or interesting theory, they had to yield results that would agree with experienced fire officers' judgments or at least make enough sense to them to be accepted as realistic. Barry's feeling, very close to mine, is that good models should yield non-intuitive results in non-intuitive situations (i.e., where analytical assistance is needed), but must yield intuitively acceptable results in situations where intuition should work well. Nonetheless, there seems to be a basic tension between Jane and Barry, reflecting both the tension between analyst-as-modeller and analyst-as-pragmatist and the tension inherent in Jane's having to rely on LoGORU to do her hands-on work with the fire service.

Barry noted that though the analysis, per se, was usually fairly simple, the follow-through phase was usually not. The fire brigades tended to become quite rigid once they had decided upon station sites, tending to fight on forever against other components of local or national government that might want the land for other purposes; in turn, some of the other parts of local authorities could be quite rigid, too, and oppose the fire brigade for reasons that made little real sense. There were also problems in getting the fire officers to understand and be willing to participate in the analysis, especially when the models yielded early suggestions that were not immediately obvious.

As we discussed our various experiences in implementation, it became clear that Britain has two important structural influences making implementation relatively more difficult than in the U.S. (and some continental European countries). First is, of course, the rift between administrators and analysts, and the extreme defensive steps taken by the national administrators to "protect" their positions. Second is the relatively low level of education among top fire officers. In Britain, few top officers seem to have any college education at all, whereas in the U.S. many top officers of major fire departments have at least taken formal education in fire science or public administration and a fair number have quite good technical education (e.g., New York has several high-ranking officers with engineering degrees; the Chief in Los Angeles has a master's in mathematics). On the continent, following the tradition of separating top from middle management (e.g., führung from leitung), officers and firemen form distinct and separate hierarchies, with only rare promotions to officer (usually near retirement) for those who have not entered as part of the top group. In these countries, entry as an officer requires a college degree, usually in engineering.

As one might have expected, given the nature of the administrative bureaucracy, it seems unlikely that reports on the implementation phase of LoGORU's work will ever see the light of day. Indeed, there is every reason to believe that the reports finally approved for release will omit all but the barest technical details. That is, naturally, disappointing, but perhaps inevitable.

III. EMERGENCY MEDICAL SERVICES

The Local Government Reorganization of 1974 shifted responsibility for emergency medical services from local authorities to the National Health Services, part of the

huge national Department of Health and Social Security (DHSS). The aims of this shift were largely to ensure closer coordination between ambulances and the doctors and hospitals they serve, and to improve the quality of local services through central planning and research and the development of national performance standards.

Though much systems analytic work had been done on emergency medical services, therefore, most of the specific results have had to be rethought and redone to take into account the new national perspective and the new organizational and operational structures.

Analytic work on emergency medical services is now centered in the Operational Research Service (ORS) of DHSS, which has a sizeable in-house staff and a fair-sized budget for extramural research and consulting. Formally, the ORS is a staff consultant group, with the operating arms of the National Health Service among its main clients. It thus is subject to all the pressures and cross-currents such groups face, though it seems to have established itself better and won more independence than the Scientific Advisory group in the Home Office--perhaps because analysis is, in general, better accepted as legitimate in health than it is in fire.

On this trip, I talked with people in ORS and with several of its consultants, particularly with the National Health Service Operational Research Group (NHSORG--recently spun-off from LoGORU) and independent researchers.

EMS 1: Operational Research Service, Department of Health and Social Security

Met with:

- Dr. D.Y. Coomber, Senior Principal Scientific Officer, head of the Operational Research Service
- Dr. C. Himatsingani, Scientific Officer, ORS

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Department of Health and Social Security
131-151 Great Titchfield Street
London W1P 8AD

Telephone: 01-636-1696

Norman Glass, recently of IIASA, now working at DHSS, had arranged for me to meet with Dr. Himatsingani, an operational research specialist knowledgeable about work on emergency medical services, though not currently engaged in it. He was most cooperative and helpful, and spent several hours reviewing recent work and calling various people to obtain further names and references.

Our discussions identified the following reports and resource people to contact:

a) "Resource Consequences of Different Patterns of Provision of Accident and Emergency Services," DHSS Report, 2 volumes, October 1972.

Done by Peter H. Gentle, M.D., both as an MSE thesis and a DHSS report. The author is now with the

Tunbridge Health District
Sherwood Park
Pembury Road
Tunbridge Wells, Kent

Telephone: Tunbridge Wells 3811

This report has been approved by DHSS for external distribution.

b) "Ambulance Service Performance Standards and Measurement," 12 July 1974. Final Report by Orcon Services to DHSS.

Prepared by Mr. Norman Webster, Senior Lecturer in O.R., Cranfield Institute of Technology, Cranfield, Bedfordshire.

This report is the basis for new DHSS standards specifying that, in all districts, ambulance response

times must be less than 8 minutes at least 50 percent of the time and less than 20 minutes at least 95 percent of the time. A sanitized version has been approved for external distribution. Unfortunately, it lacks the highly detailed data that make the complete version (which sins by identifying the districts in which the performance data were obtained) a unique resource in the field.

c) Professor R.N. Curnow, Department of Operational Research, University of Reading. "Study of the Reading Ambulance Service," 1973.

d) Dr. Canvin, Operational Research Unit, University of Exeter.

e) A private consultant, Mr. Donald Hicks, 26 SE Kingsmark Avenue, Chepstow, Monmouthshire NP6 5LY.

Hicks, said Dr. Himatsingani, had data to show that in certain areas real emergencies made up only 6% of the cases (the preponderance of the rest being simple transport), but constituted 30% of the effective workload for the service force.

Himatsingani then introduced me to Dr. Coomber, who was in the midst of putting together a progress report. He noted work by Dr. Kenneth Groom and his associates at NHSORG, developing ambulance cover models (similar to the fire cover models developed by Jane Hogg), which DHSS hoped might become the basis for putting into effect nationwide the performance standards developed by the Cranfield group (see (b) above). He was pleased to hear of the synthesis being developed at IIASA, and said he would be glad to review or arrange for review of draft chapters on emergency medical services, with particular attention to the material on Great Britain.

Coomber suggested a return trip to London once draft chapters were in hand. He offered to help set things up to visit DHSS formally, beginning at the top of the administrative hierarchy, to get formal approval to use and publish all the material I had already obtained and would obtain and to get the blessing of DHSS for the UK part of the synthesis project. Touching all the bases would make his job easier in cooperating further with me, he explained, and would also minimize any screaming or recriminations about what was said in the final publication. He suggested calling him about six weeks before the visit; then he would suggest what to write to whom.

EMS 2: National Health Service Operational Research Group (NHSORG)

Met with:

o Dr. Kenneth Groom, Director, NHSORG

Address: National Health Service Operational Research Group
310 Kings Road
Reading RG1 4HX

Telephone: 0734-64678 or 65817

Ken Groom met me in London at the Royal Institute of Public Administration, accompanying Brian Whitworth and Barry Pilgrim. He and Brian explained that the group had been split off from LoGORU at the request of the National Health Service, when the NHS had taken over responsibility for ambulance services. At first the staff had overlapped and been shared, but now as the new group acquired enough funding and began establishing its own identity, it was becoming more separate, though still physically adjacent and close professionally.

Ken's group has developed several relatively simple queueing and set-covering models for determining good

ambulance cover and for assessing whether specified numbers and configurations of ambulances will meet the new NHS response-time standards. Under NHS sponsorship, monitored by ORS, they are now testing the models--and validating them with operational data--in six areas, chosen to represent a fair sample of the range of ambulance service conditions encountered in Great Britain.

The results obtained thus far are encouraging, though Ken is encountering many of the same problems in understanding, acceptance, and implementation that Barry Pilgrim has encountered in fire. Ken feels that his main accomplishment thus far, besides validating the models, has been to persuade NHS to take a fresh look at the possible value of merging its two-tier ambulance systems back into one-tier or modified-one-tier systems. In several of the regions examined, such modifications could reduce by over 20% the number of ambulances (and crews) needed to meet the response-time standards for emergency calls.

Perhaps a few words of explanation are in order: In Britain, as in most other countries, ambulances serve two relatively distinct purposes--(1) responding to emergency calls, trying to stabilize the condition of often quite sick or badly injured people, and bringing the people to hospital emergency rooms. In all these operations, time is of the essence. (2) Providing non-emergency taxi service to transport to doctors and hospitals people who otherwise would find it hard to get around or whose doctors feel they ought to travel under semi-medical supervision. In this operation, the constraints are those of scheduling; hospitals and doctors tend to want their patients at particular times, and the ambulance service does its best to oblige.

In some places, the same set of vehicles and personnel handles both functions. This arrangement is termed a "one-tier" system. In others (e.g., Moscow, New York, Vienna,

and most of Britain), the emergency and transport services are separate, though usually managed by the same authority (and often with the transport service a training ground for the emergency service). These are termed "two-tier" systems.

The arguments for separate services are typically that (a) the personnel skills and equipment needed for the transport service are much less than those needed for emergencies. Moreover, transport is a daytime service, while emergencies occur in all 24 hours, so that the services are distinct. (b) Transport demands can be extremely open-ended, so that in a one-tier system they can readily become the tail that wags the dog, possibly tying up ambulances needed for emergency service at critical times.

In the context of suburban and rural British health service, however, Ken Groom and his staff have shown that proper control--coordination, scheduling, and limiting of appointments--can reduce peak demands for transport ambulances and thus leave with very light loads some that can become essentially reserve or back-up emergency ambulances, given appropriate equipment. In queueing terms, a partial merger, having some transport ambulances serve also as emergency ambulances, increases the number of potential servers, and thus reduces the probabilities of long delays or long travel times. (Similar reasoning would appear to apply as well to improving the undersupplied emergency--Rettung--ambulance system in Vienna.)

The coordination on which such a system depended was still a long way off, Ken cautioned, because the doctors still regarded themselves as the centers around which all else should revolve. They thus were not yet willing to surrender any scheduling authority or even try to schedule their patients in ways that would permit the ambulance service to improve its services.

Ken supplied three reports, the only ones thus far approved for distribution:

(a) "A Model to Evaluate Emergency Ambulance Cover," K.N. Groom and N.P. Pearce, Report #75/1.

(b) "Planning Emergency Ambulance Cover in West Glamorgan," K.N. Groom, K.E. Holloway, and W.R. Mann, Report #75/4.

(c) NHSORG Annual Report for 1974-75, Report #75/7.

EMS 3: Independent Researchers

Talked by telephone with:

- Dr. Kenneth Lee, Lecturer in Health Economics
  Nuffield Centre for Health Services Studies
  The University of Leeds
  Clarendon Road
  Leeds, LS2 9PL
  Telephone: 0532-459034

  He has prepared a report on the operation of ambulance services in the UK, and written several papers about emergency medical services.

- Dr. Daniel Davidson
  IBM Scientific Centre
  Meadow Road
  Peterlee, County Durham
  Telephone: 078-323-3322

  He has worked extensively on the scheduling of transport ambulances in Scotland, and has written about the work.