London Ambulance Service Software Failure

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Abstract - Software projects often fail, which could lead to huge amount of losses in terms of financial resources, lives or time, amongst others. The London Ambulance Service (LAS) Computerized Dispatch System (CAD) Project which spanned for 5 years (1987 - 1992) serves as a good example of a software failure. The Project involved changing from the slower, cumbersome and sometimes unreliable LAS manual dispatch system to a more efficient and fully computerized system. The first attempt (1987 - 1990) failed, after sinking £7.5 million into the project. The second attempt (1992) also collapsed barely 9 days after the system was launched, leading to loss of lives and financial resources.

This paper gives an account of the LAS CAD project; identified the problems it encountered and brought out the reasons behind its failure. Our opinions were highlighted and suggestions made. It is believed that this research work will serve as a reference point for avoidance of future software projects failures, considering the complexity of the CAD Project and the catastrophe it caused.

I. INTRODUCTION

Computerised systems are becoming a key component to the efficient working of organizations. Due to the world becoming a more competitive environment, computerised or automated systems are used to aid organizations become more efficient. As a result of this, series of software projects have evolved over the years, some of which have been successful, where others have failed. The three potential aspects of failure can be due to a number of factors; complete system collapse, going over time and budget as well as failure to provide the correct functionality. Consequences of software failure can result in severe financial loss, time or resources or in extreme cases, all of them. In this report, we will discuss the London Ambulance Service (LAS) Computerised Dispatch System (CAD) which failed in the three aspects, resulting in human and financial losses.

The LAS deals with over 2000 calls on an average day with a fleet of 750 vehicles, so their systems are an integral part of their efficiency to deal with emergencies. This system was originally manually operated until in 1987 when an automatic service was introduced. The purpose of this paper is to investigate the implementation of the LAS CAD system as well as its shortcomings. The objectives are to identify the causes of its failure, while recognising what could have been prevented and lessons to be learned in order to prevent the future occurrence of such failure.

II. BACKGROUND: THE LAS IN 1992

Founded in 1930, the LAS is the largest ambulance service worldwide responding to between 2000 and 2500 calls per day with a fleet of 750 vehicles under its disposal. The service covers the greater London area (600 square miles) with the cooperation of the London Fire and Civil Defence Authority and the Metropolitan Police. It compromises of the Accident and Emergency Service (A&E) and Patient Transport Service (PTS). Ever since 1974 it has become part of the National Health Service (NHS) and is funded by the government. According to the report of the inquiry into the London Ambulance Service (published in February 1993) its budget income for the years 1992/3 was £69.7 million with 2700 staff employed at the time. The LAS carries out the responsibility of answering emergency calls, screening them and then dispatching an ambulance to the incident scene in less than three minutes.

Manual Dispatch System and the Need for CAD

The LAS had been contemplating replacing their manual system since the early 1980's, in line with other ambulance, fire and police services. The paper-based, manual system they wanted to replace involved three distinct phases [1]:

Call taking – At Central Ambulance Control (CAC) a Control Assistant (CA) writes down the call details on a pre-printed form, including the reference coordinates of the incident location, which has to be identified from a map book. The form is placed onto a conveyer belt, together with details of calls from other CA's, for transport to a central collection point.

Resource Identification – At the central collection point, the details are reviewed by another staff member who gives the form to one of the three resource allocators, depending on whether the incident occurred within the North East, North West or South division. The resource allocator is responsible for maintaining a form for each ambulance with information about the location and status of the vehicle; such information is reported by the ambulance's radio operator. The resource allocator uses this information to decide which ambulance to send to the call. The choice is noted on the form and the form passed to a dispatcher.

Resource Mobilisation – The dispatcher would telephone the relevant ambulance station or, if the ambulance is already in the field, would pass mobilisation instructions directly to the ambulance's radio operator.

Appendix A shows the diagrammatical expression of LAS manual operation.

This manual system had some clear shortcomings, which a CAD system might address, including:

- Finding incident co-ordinates from a map book was time consuming and error prone, particularly given the often distressed calls.
- The movement of paper around the control centre was inefficient.
- The requirements for maintaining location and status information for ambulances by the resource allocator was labour intensive and time consuming.
- Sometimes more than one person would call an ambulance to the same incident. Identification of such duplicated calls relied on human judgement and memory and was error prone.
- Conformity with prevailing performance standards required that this manual process was to be completed within three minutes, but that is not mostly the case.

Components and Functions of CAD

A CAD system typically consists of the following components running at the command centre [2]:

- CAD hardware and software
- Gazetteer and Mapping software
- A communications interface
- A radio system

Additionally, the following components would be attached to ambulances:

- Mobile data terminals
- Automatic vehicle location system

Its functions typically consist of:

- Taking calls about incidents
- Automatic resource allocation
- Communication of incident details to the chosen ambulance
- Management and location of suitably equipped and staffed vehicles in order to minimise response times
- Production of MIS reports to support longer term resource planning

First Attempt

A previous attempt had been made to automate the LAS' dispatch system at a cost of £7.5 million. This project was started in the 1980's when company called IAL was selected to supply a system without mobile data but with a new radio interface. The specifications were changed in 1989 to include mobile data. The project was abandoned in the autumn of 1990 after it was found that the system would not cope under the expected load. [1].

Second Attempt

The second attempt by LAS to design and implement a CAD system began shortly after the abandonment of the first. Key dates [2] were:

- Autumn 1990 – to February 1991 – writing of system requirements specification (SRS)
- 7 February 1991 – invitation to tender published in the Journal of European Communities
- May 1991 – contract to supply the CAD software signed with System Options Ltd.
- June and July 1991 – system design specification
- September 1991 - contract to supply mobile data equipment with Solo Electronic Systems Ltd.
- 8 January 1992 – planned date of original implementation

III. THE INCIDENT

On the morning of Monday 26th October 1992 the LAS CAD system went live for the first time. Unfortunately there were 81 known bugs in the system at that time and it had been 10 months since the control room staff were first trained to use the software. The system had 4 primary flaws when it went live; it did not function well when it was given incomplete data regarding the status of the ambulances and the system did not accept errors made that occurred in normal day-to-day use of a computer system. Furthermore, the user interface had black spots which meant that the user could not see all the information on screen and finally, the most important failure, the system stored incident information even after it was not needed, which caused the system to fill up memory and fail. [3]

The first of these problems began to show during the morning rush of calls when it became apparent to all involved in the use of the system that things were about to go wrong. There were a number of duplicate calls being made as the system was losing accepted emergency calls, which lead to a number of distraught callers being kept waiting in the call-queuing system for up to 30 minutes.

The system created further delays when dispatching ambulances. It failed to recognise certain roads and routes, which meant the drivers had to revert back to using maps to navigate their way or call the ambulance dispatch. These system errors led to the late arrival of ambulances, or two ambulances turning up at the same time, or worse not at all. [4]

By Monday evening, the number of system failures had increased due to the number of new emergency calls which began to overwrite old ones that were not dealt with. There were further delays in the system created by exception messages. An exception message was designed to be generated for the operators when a call had not been acknowledged by ambulance crews and demanded priority action. However, the system created exception messages for all unanswered calls in the system and this swamped the operators due to high volume of exception messages. There was a move to rectify this problem by clearing the exception message queue, which would in theory speed up the system; but in reality just increased the number of lost incidents. This ultimately just increased the number of people calling back, and the vicious cycle began again.

By Tuesday afternoon the situation escalated to the point that the system had to be shut down and dispatchers went back to using a combination of computerised call taking methods and locating ambulances manually. This solution, with the additional call taking staff added to each shift, seemed to improve call waiting time. This method of dealing with emergency calls carried on for 7 days until the 4th November 1992 when at 2am the system slowed and locked up all together. Rebooting the system failed to correct the problem, the backup system failed to cut in leaving the control room staff no alternative but to revert back to the fully manual paper based system. The effects of the incident are:

Individuals - Claims were made in the press that up to 20-30 people may have died as a result of ambulances arriving to late on the scene. One 14 year old boy died of an asthma attack after waiting for 45 minutes, whilst an 83 year old man died before the service reverted back to the old system. [5]

Social - Under pressure from the media and the public, the British Health Secretary, Virginia Bottomley, announced a Public Inquiry into the system headed by South Yorkshire ambulance chief Don Page. The findings of the inquiry were eventually published in an 80 page report [6] in February 1993, which immediately became the top news item in the United Kingdom and gained international attention.

Organizations - Ever since the accident, a lot of organizations showed interest in the case to understand and explore the sequence of events leading up to the incident in an attempt to

determine responsibility and how the project might have benefited from a more formal specification of the software system. The case is taught in universities as a typical example of "what went wrong" in Software Engineering. Most computing professions in the UK were aware of the failure of the CAD system deployed by the LAS and took steps to prevent similar experience. [7]

Political - John Wilby, chief executive of LAS then resigned within a couple of days and other managers were either dismissed or reassigned. Soon afterwards, a number of MP's called for a crack squad of IT experts to be set up to investigate IT in the NHS. The BCS president and vice president claimed that the breakdown in the LAS CAD system could have been avoided if "computer people" were trained to professional standards. President Roger Johnson stated that:

"*The public are entitled to expect that the same professional disciplines apply in IT as in other professions such as medicine and law*" [8]

Economy - The financial consequences of this incident were not particularly significant in comparison to other reported software failures as it was estimated to have cost between £1.1 and £1.5 million. In contrast, problems with the UK Taurus stock exchange program cost £75-£300 million. The US CONFIRM system incurred losses in the region of $125 million. [9]

IV. WHAT WENT WRONG

Many factors were responsible for the unfortunate failure of the LAS CAD System as discussed below:

Management Problems

The CAD System commenced when there was unhealthy working relationship and lack of trust between the staff and management of LAS. Majority of the staff felt that the working conditions were deteriorating and the management style was seen to be bureaucratic and uncaring [10]. Changes in the NHS and appointment of a tough new Chief Executive of LAS led to a massive reorganization and reduction of about 20% in the number of managers. This in turn resulted to exodus of highly experienced staff and increased stress on the remaining managers. LAS management underestimated the enormous task associated with changing from the manual operation of the LAS to a fully computerized system. The program was complex and the speed and extent of change were considered to be aggressive owing to the circumstances LAS found itself at that time [11]. Furthermore, LAS board members were appointed without knowing their responsibilities, hence, some of their decisions were just rubber stamping [12]. The absence of effective control at the top and inability to manage lower down led to a series of flaws in the project and its eventual collapse.

Preconditions of the CAD contract

In the contract preconditions, LAS top management set a non-negotiable date of 8 January 1992 for full implementation by the LAS CAD system [13] , meaning that the contractors had barely 6 months to fully accomplish their task, in which many LAS staff considered the time to be inadequate and inflexible [14]. A member of Systems Option, the leading contractor once said '*in our contract signed in July 1991, it was stipulated that the system would be introduced in its entirely in January 1992. I don't believe that was realistic'* [15]. 15nother string which the LAS top management attached to the contract was cost restriction, which was pegged at maximum of £1.5 million. This was just one fifth of the money spent on the failed first attempt of the LAS CAD project. The selection team of the contract had no option than to recommend the lowest bidders out of 35 others. System Option, a small software house was therefore awarded the contract for the supply of the CAD software without any prior experience with similar emergency service system [16].

System Specifications and Design

A project committee which comprised of the Systems Manager, Systems Analyst, Control Room Manager and chaired by the Director of Support Services was tasked to develop the SRS for the project [17]. The ambulance crews being key players in the LAS Dispatch System had little involvement in the entire process. It was found that most of the work was done by the Contract Analyst and Systems Manager without official sign-off of the completed SRS [18]. Moreover, LAS top management failed to follow the guidelines of the UK Government project management methodology; the PRINCE (Project in Controlled Environment) in the design and implementation of the project [19]. As a matter of fact, neither the LAS staff nor the system suppliers had prior experience of using the methodology [20].

The CAD system was designed to rely on accurate information on the locations and status of ambulances at all times. However, the effect of imperfect information/communication on the system was not envisaged by the project team. The core software of the CAD system which determines the available resource to attend to a particular incident was designed such that the time taken to allocate a resource will depend on relative distance of an incident scene and availability of potential resources. Hence, the system was bound to be slow in allocating resources at peak times, especially when there are few uncommitted resources. There was no independent software quality assurance team. The project team allowed Systems Option to handle the QA aspect itself, in order to avoid additional cost [21].

Staff Training

Staff training was critical to success of the project considering the strained relationship between LAS management and its staff who were the key players in the LAS Dispatch System. Even if the system would have been properly developed, its success would still rely heavily on its smooth operation by the LAS staff. Though there was evidence of training, it was not enough, as the staff complained on inadequate training when the Central Ambulance Control Staff received 2 days training to familiarize themselves with the system prior to the initial implementation date [22]. There were several changes to the system design and long delay before its live operation. These reasons made it difficult to achieve a comprehensive and consistent training which was evident, considering the performance of the LAS staff during the live operation, especially the ambulance crew pressing wrong buttons and sending inaccurate status report to the control room.

Testing
Although there was functional testing of various components, integration testing to ensure that the system can operate together was not carried out. Thus, there was no attempt to test how the system would react to different circumstances such as high call rate, multiple incident reporting, vehicle location problems, falling back to backup servers, etc. The Assistant Director of Operations was quoted in a memo he sent to the Accident and Emergency Team that ' *following the initial operating period of the CAD system, a full review of the radio network capability will be carried out'* [23]. By implication, live operation of system was to form part of testing procedure. As a result of lack of thorough testing, several avoidable errors occurred when the system was implemented, which would have been detected and corrected during testing.

Implementation
The failure of the CAD system which came to live operation from 26 October 1992 was as a result of cumulative consequences of associated problems (identified above) that joined together to produce a chain of decline in its performance. The absence of near-perfect information upon which the system relied to allocate the required resource to an incident was a key factor to this decline [24]. The problems experienced during the implementation/live operation are summarized below: [23] [24]

- Incomplete software.
- Inability of the CAD software to identify and allocate the nearest available resource.
- The AVLS not being able to identify all the ambulances in the fleet.
- Communication problems among the CAD system, AVLS and Mobile data system.
- Slow operation of the system.
- Locking up of workstations.
- Inaccurate status reporting by ambulance crew when wrong buttons were pressed.
- Use of different vehicle by the crew from the one assigned by the system.

The diagram of the causes/effects of CAD Systems failure is contained in Appendix B.

V. CONCLUSION

The LAS being the largest ambulance service in the world was founded in 1930 and covered a resident population of 6.8 million and receives between 2,000 and 2,500 calls daily. Prior to its computerization project, it operated manually, where details of an incident call taken by a control assistant is used to ascertain the location of an incident scene through the use of a map book. This information is then passed to a dispatch team who direct the appropriate ambulance to the incident scene through a radio call. Due to the short comings of this manual system, the LAS thought it wise to computerize its dispatch system. The first attempt failed in 1990 after spending £7.5 million. The second attempt embarked upon in 1991 also faced serious challenges which eventually led to its collapse on 4 November 1992, barely 9 days after its launch. The project was designed to have Gazetteer and mapping software for location finding. CAD hardware and software for automatic resources allocation and effective communication system between ambulances and central control room for quick passage of instructions and obtaining accurate status of all resources.

CAD contract was signed in May 1991 with a consortium of three companies (System Options, Apricot Datatrak and SOLO) systems option (small software house) being the main contractor. Time and financial constraints linked to the contract which affected the outcome and final product. During the development, the system was not properly tested as an entity and the staff were not efficiently trained on the system. These issues were clear when the system was launched on 26th October 1992. The implications of these problems during the launch and use of the system caused incident calls to be lost in the system while a number of calls did not ever reach the ambulances. The CAD system itself was very inefficient in identifying incident locations and reporting the accurate status of ambulances. Hence there was a slow response in dealing with incoming calls which resulted in higher call waiting times, multiple calls, and greater exception message queues.

The incident was so frustrating that some ambulances could not locate incident scenes due to incorrect or inaccurate information, which led to loss of life. Growing frustration between patients and ambulance staff due to worsened situation caused loss of confidence in the system. The process was temporarily reverted back to the manual paper based system due to its inefficiency. The CAD system finally crashed on 4 November 1992 as a result of a leftover program code by a programmer, which was the foundation for insufficient memory to the server.

In our opinion the CAD system suffered from the strict time and financial constraints. There should have been greater negotiation and communication among the stakeholders regarding the time and financial requirements of the system. There was a breakdown in communication between the management and staff of LAS meaning that not all the stakeholders interests were included in the system.
From all indications the staff who are the main actors in the system were insufficiently trained to deal with the complications of the CAD system. The LAS management should have taken upon itself to set training sessions and standards. The system was never tested as an entity meaning LAS had no prior knowledge of how the system would appear and how problems would be dealt with. The tight time schedule coupled with continuous modifications of the system did not allow the system developers to carry out sufficient testing. The system would have benefited from an independent quality assurance team working on the system as they would have identified a number of key flaws.

Overall, this research could serve a reference point for any future software development project considering the complexity of the project and the way it was implemented; transforming a large emergency system from operating manually to a completely computerized one.

The LAS has since been able to computerize its dispatch system and is currently working on improving its efficiency by signing a new contract in 2008 for a newer system to be implemented in 2010. For more details see Appendix C.

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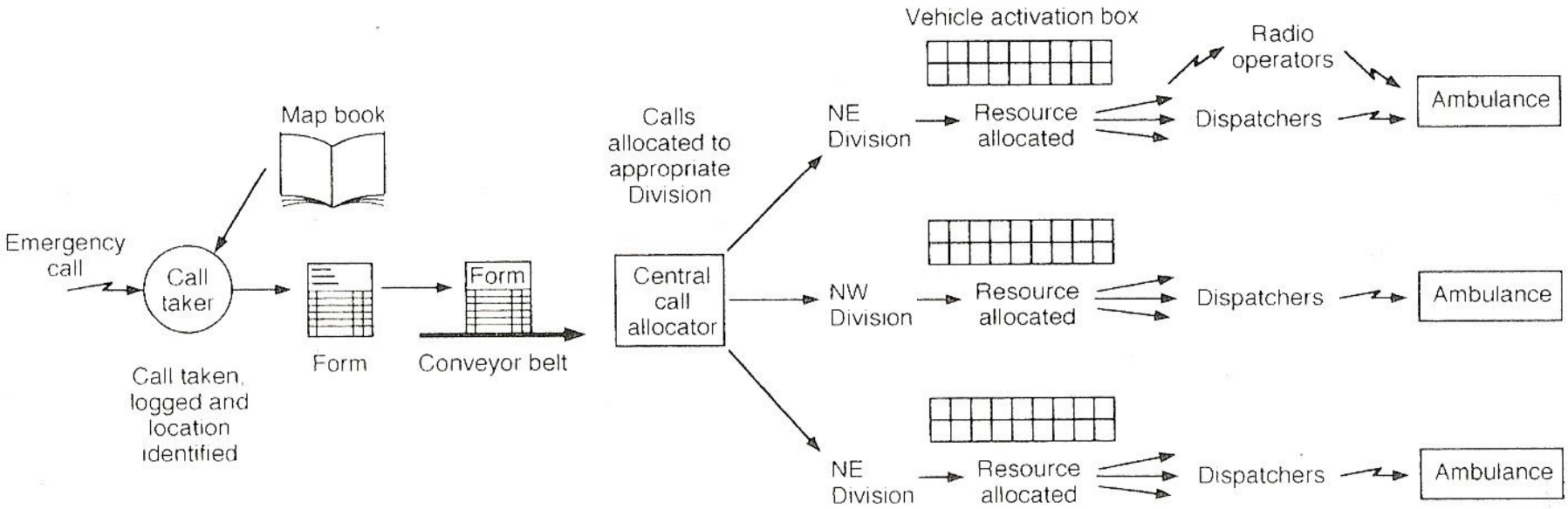

Figure 4.1 Central Ambulance Control

Appendix A.
The diagrammatical expression of LAS manual operation.

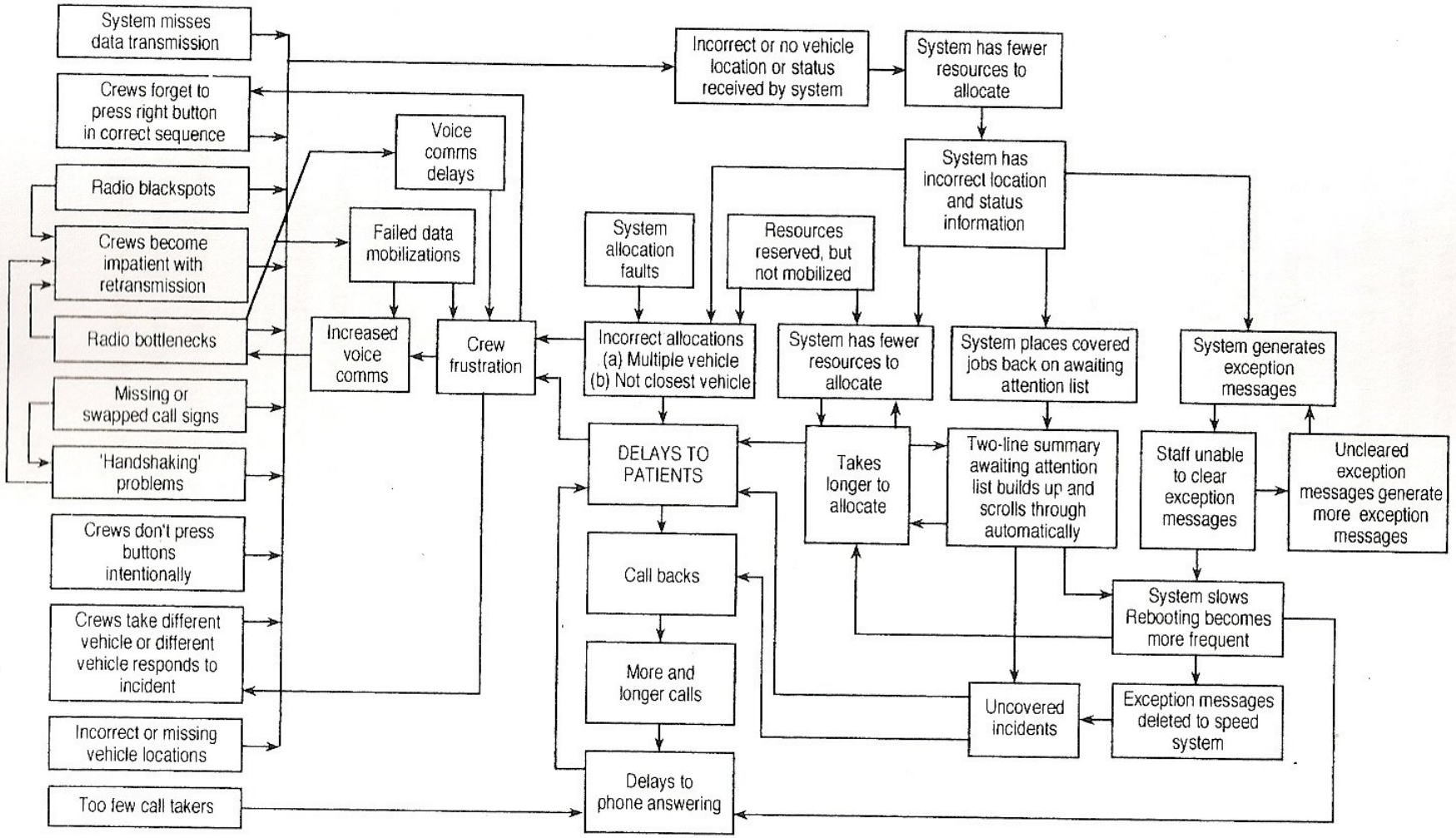

Figure 4.5 26/27 October cause/effect diagram. (Source: Page *et al.*, 1993)

Appendix B.
The diagram of the causes/effects of CAD Systems failure.

Appendix C.

Service to introduce new system to handle 999 calls15 December 2008

The London Ambulance Service has signed a contract for a new system to handle 999 emergency calls and send ambulance staff and vehicles to patients.

Northrop Grumman has been appointed to design, develop and implement the new computer aided dispatch system, which will be introduced in 2010.

Director of Information Management and Technology, Peter Suter, said: "Ever-increasing demand on our ambulance service and a growing population in the capital means that we need an enhanced system to meet future needs and help us improve patient care.

"We're moving away from a one-size fits all service to one where all our patients should get care tailored to their needs, and the new system will play a vital role in helping us to achieve this goal.

"It will enable 999 calls to be handled more efficiently and will make it easier to send the right response to patients as quickly as possible."

The system will be designed to deliver a number of other benefits. It will have an improved capability for managing large-scale events or major incidents, will be more resilient, and will have greater flexibility to be developed as new requirements are identified.

Peter added: "Northrop Grumman has a proven track record in providing computer aided dispatch systems and we look forward to working with them during the next two years to introduce a system that will enable us to continue providing Londoners with high quality care for years to come."

-Ends-