Evaluating the impacts of time-reduction legislation on junior doctor training and service

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Abstract

If junior doctors are to work significantly fewer hours in the future, how can they still receive full training and continue to provide necessary levels of medical service to patients? Historically, excessive hours have been a way of the life for junior doctors worldwide, but *New Deal* regulations, a revised junior doctor contract, and the *EU Working Time Directive* are changing this. A project at Derriford Hospital in Plymouth is researching the nature of 'quality and effective training', and constructing SD models to yield insights and eventually support operational decision-making. This has already yielded significant insights for those at Derriford wrestling with this seemingly impossible task, including, the circularity between junior doctor training, consultants' service and their training-supervision role, and the quality of training provided, and the likely importance of recruiting outside the progression process in addressing service imbalances. It also highlights some of the special challenges in projects where there are many stakeholders, political agendas, and a continuously changing environment.

KEYWORDS

Healthcare, junior doctor training, working time, quality.

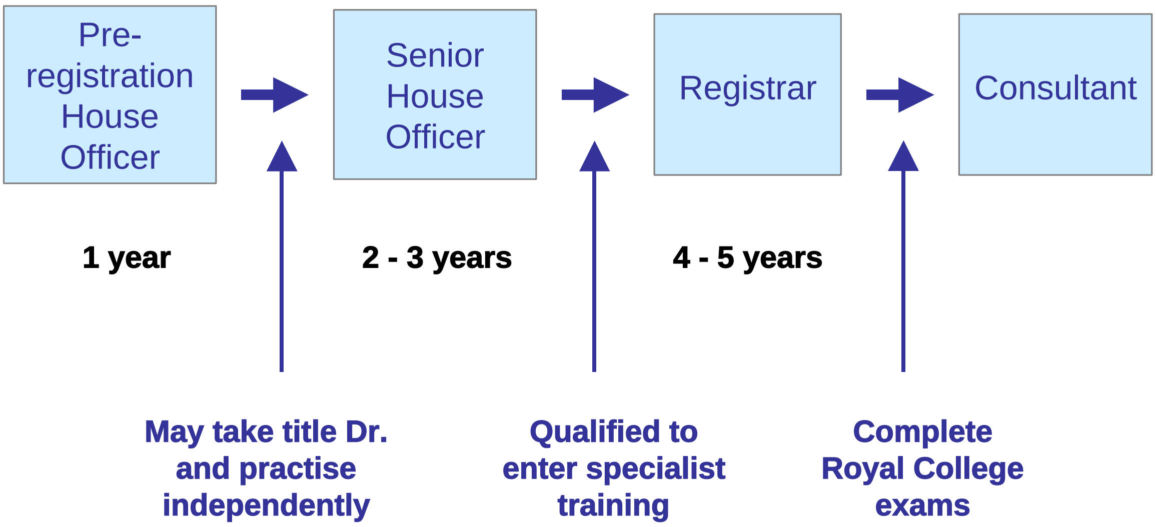
Working time reductions - getting a quart into a pint-pot

The basic question being addressed in this research is: if junior doctors in the UK health system are to work fewer hours in the future, how can they still receive full training and also continue to provide necessary levels of medical service to patients?

Historically, excessive hours have been an integral part of the life of junior doctors worldwide, long hours on-call, soaking up knowledge and training alongside other grades in their specialty. Increased recognition of the lack of safety for patients in this practice, and its adverse effects on learning and the health of junior doctors, has lead to the introduction of the New Deal working hours regulations in the UK and a revised junior doctor contract. This has limited junior doctor hours to 56 hours a week (from legendary figures of 80+ hours) with additional restrictions on duty lengths and rest breaks. Additionally, the European Union Working Time Directive (EUWTD) came into force for junior doctors in the UK in August 2004, also requiring a reduction in working hours to less than 58 hours a week, with further reductions to 48 hours a week by 2009, with a possible extension to 2012 (Department of Health, National Assembly for Wales, *et al.* 2002).

In the UK, local healthcare is provided through non-profit entities called NHS Trusts. Hospitals fall under a Trust's management and the Trust must deliver medical care to patients while providing the training opportunity for junior doctors in their initial practical placements (i.e. immediately after initial medical school training). In an effort to reduce junior doctors' hours, there have been significant changes in working patterns over the last few years. These changes include moving to shift working, an increase in the number of contract doctors, reduced tiers and increased cross-cover, as well as some of the new ways of working and extended roles piloted by the Department of Health (2004a). Further changes to junior doctor working will be forced by the implementation of *Modernising Medical Careers*, which aims to restructure and formalise Senior House Officer (SHO) training (Department of Health 2002, 2003, 2004b). The typical training/practice career path for hospital doctors in the UK is given in Figure 1. There have been claims that the reduction in working hours is impacting junior doctor training, as fewer hours spent at work are seen to equate with fewer hours spent training (Kapur & House 1998; Carr 2003). Inherently, this assumes that all hours spent at the hospital are "training" hours. Yet at the same time, it has been widely recognised that junior doctors, and SHOs in particular, provide the bulk of the service – medical attention and treatments - and that a reduction in their hours will also impact on service provision.

Figure 1 – Post Medical School Career Progression



Further, it is also feared that as training becomes more intense and more doctors will have to be trained to fill the service gap, then pressures on consultants' time will also increase. Alongside which, it is not only junior doctors that have to comply with hours regulations, but also senior members. In principle, consultants have always fallen under the 48-hour working week imposed by the EUWTD. However, this has become more acutely apparent in the recent negotiations of the new consultant contract, and demands continue to increase as hospital admissions rise and growth of service provision flourishes. Non-compliance is not an option, and failure to train junior medical staff or provide services to patients results in a withdrawal in funding or other financial penalties.

This is a "messy problem" beyond simple optimisation. Reducing junior doctors' hours involves changes to working patterns, which have very real causally linked impacts, of both a qualitative and quantitative nature. Further, failure to consider the system as a whole is likely to have short and long-term impacts on: training and experience for junior doctors, finance and service provision for the Trust, patient care, and the development of the current and future workforce. Proposed new ways of working need to be evaluated in light of all the potential consequences, beyond simple compliance and costs.

The host organisation and the immediate problem

Plymouth Hospitals NHS Trust, whose main site is at Derriford Hospital in Plymouth, provides acute and specialist care services to approximately 450,000 people in Southeast Cornwall and Southwest Devon, and covering a population of almost 2 million people for some specialist services. With a budget of approximately £250 million, 1300 beds and the busiest A&E department in the South West of England, it employs approximately 6000 people, including approximately 450 junior doctors and 230 consultants. It is a major employer and provider of health services in the southwest peninsula.

The Plymouth Hospitals NHS Trust has established a knowledge transfer partnership project with the University of Plymouth to analyse this situation. From the outset, it was proposed that systems dynamics modelling be a key approach in the analysis, to be the basis for an evaluation tool for senior Trust management to understand this complex system, and aid in their strategic planning and decision making. This will allow not only a thorough comprehension of the situation, but also support decision-making by modelling possible future outcomes of proposed scenarios. In particular, it will show the feedback effects, both long-term and short-term impacts of changes, aiding strategic decision-making in an industry that is often features short-termism in its decision-making, imposed by year-to-year budgets, meeting constantly changing government targets and constant crisis management.

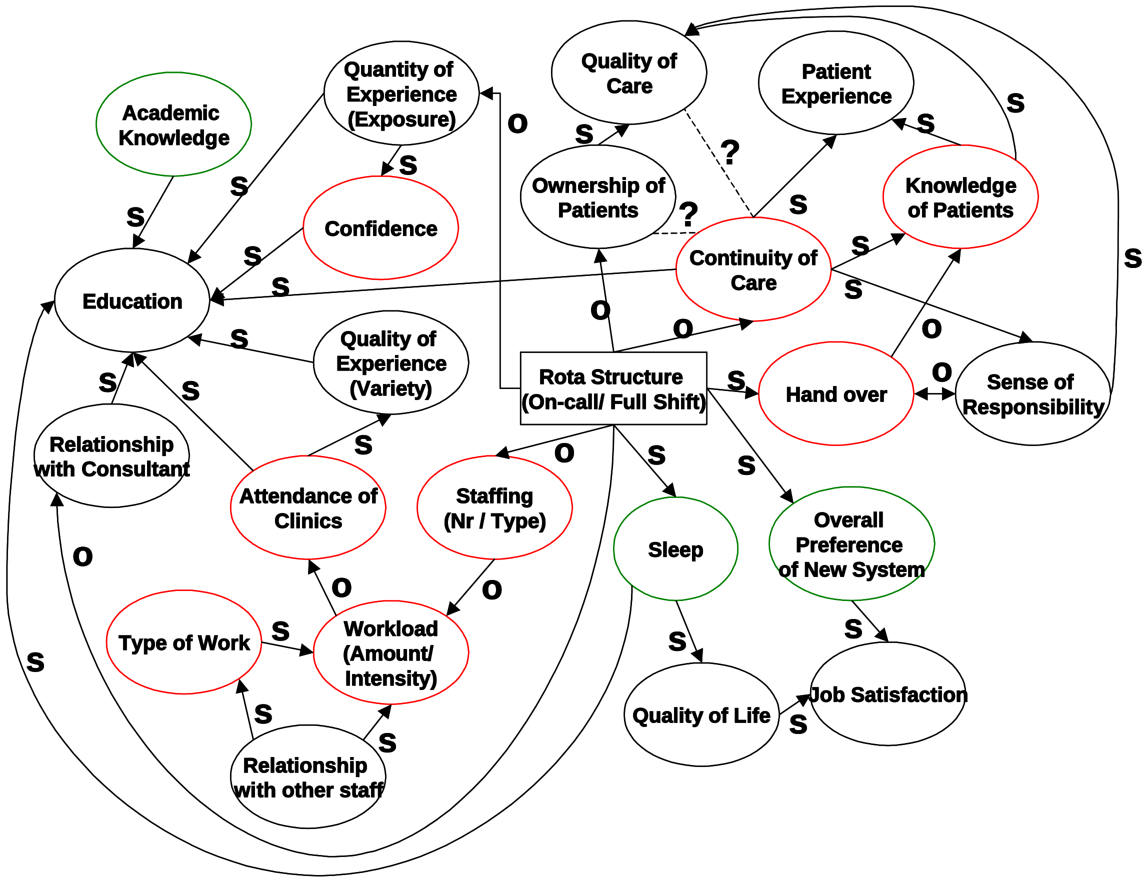
This paper focuses on the developments of this project, highlighting progress and obstacles to date in applying system dynamics to this current challenge in the healthcare sector. It also reports initial results that have come form the related background investigations and early work with the SD tools.

The reasons for adopting System Dynamics as the central tool for analysis

There are two features about problems that typically make them amenable to SD modelling.

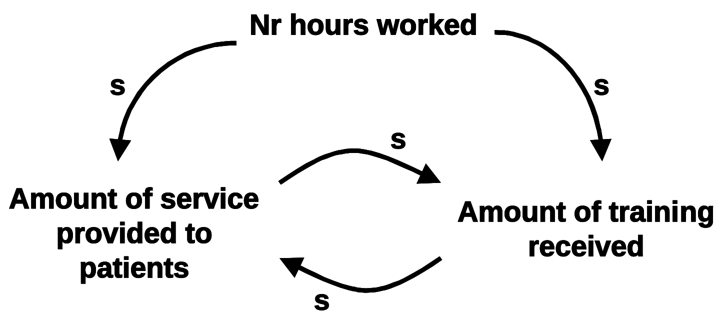
Firstly, a system dynamics approach assumes that structure and behaviour of a system are linked, especially that changes in a system's structure would have impacts on the way it behaves. This was already accepted by both senior medical staff and Trust management at all levels. Changes to the junior doctors hours, especially the movement from on-call to full-shift patterns has had a knock on effect on a wide variety of areas in the lives of the junior doctors, their senior colleagues and the operation of the hospital. An early scoping exercise with junior doctors, employing cognitive mapping techniques, to identify their perceived impacts of moving from on-call to shift working, resulted in a wide variety of issues in their lives as junior doctors, that had seemingly been caused by a change in structure of the system. Upon presentation of this cognitive map to a wider audience within the Trust, including consultants and management, many stakeholders recognised and empathised with these behaviours and knock-on effects of changes in junior doctor working patterns. This confirmed the assumptions that this "problem" indeed was viewed as a system in which behaviour is influenced by structure.

Figure 2 – Cognitive Map of the Knock-on effects of moving from on-call to shift working, as perceived by a sample of junior doctors (includes s/o notation to bring it in line with CLD notation)



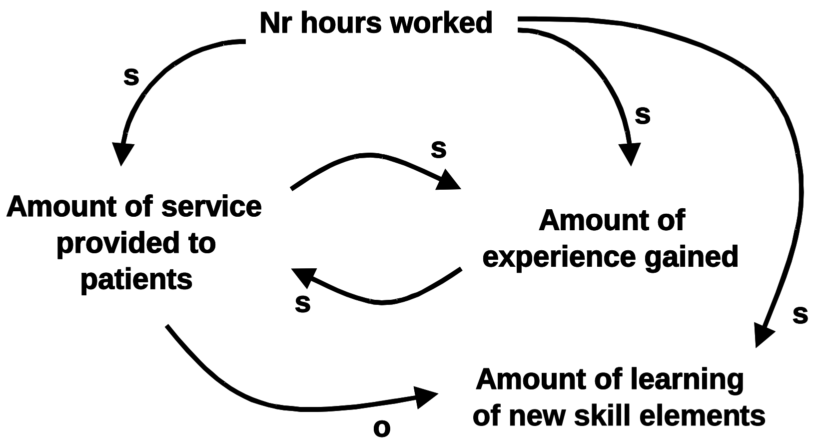
Secondly, circular causality in the problem structure clearly has a major influence of system behaviour. What became immediately apparent is that while there was an obvious tension between junior doctors acquiring the skills and knowledge in their postgraduate training while at the same type being required to deliver their medical services to the patients, all within a reduced number of hours.

Figure 3 – Diagram of initially assumed relationship between hours, service and training



At first glance, this problem appears to have a reinforcing feedback loop, which is being negatively influenced by the reduction in hours. This is due to the assumed simultaneous relationship between “training” and “service” that prevailed in the medical profession: all hours spent at the hospital were considered both training and service. However, the relationship between the concepts of “service” and “training” do not allow for the feedback loop to be simplified quite like this. This is because while a single term “training” is used in the sector, there are really two major and different kinds of training: the gathering of “experience” which is acquired by providing services to patients, and the learning of something new, either on the “shop floor” or through formal teaching sessions. The latter type of “training” is the type that is often at odds with “service” activities, whereas the former one is the one that can comfortably occur simultaneously.

Figure 4 – Diagram of revised assumed relationship between hours, service and training



However as the project evolved, separating out the two elements of “training” still did not allow the problem to be completely captured. While it now showed the reinforcing feedback which was felt to be negatively influenced by the reduction in hours, regarding the conflict between “service” work and new experiences or “taught” sessions, it was difficult to understand the relationship between the “experience” element and the “learning something new” element. Also, this did not capture exactly how the reduction in hours was directly influencing the training and service elements, i.e. tying what junior doctors do at a task level to the other elements in the system.

There is clearly a trade-off going on in the training/ service relationship, but it was difficult to specify or pinpoint at the outset because of the elusive nature of the concepts of “training” and “service” in this problem. There was a lack of understanding of these issues, not only for the model builders and project team, but also in the problem stakeholders. While, inherently everyone seemed to know and witness that the reduction of hours was impacting training and service for junior doctors, it was difficult for any particular person to specify the exact relationship. Views of this problem were wrapped up in existing practices and prejudices - or “the way things were”- and it was difficult for people to see beyond this. Additionally, early research revealed that there was further feedback in the system in relation to consultant time and availability, beyond the junior doctor training, service and hours issues, which impacted on the problem. This meant that more work was needed in questioning the status quo with reference to the relationship between “service” and “training”, and how these were present in junior doctor activities.

Such structural and dynamic complexity points naturally to SD as the study approach, and Mark Ratnarajah and John Morecroft (2004) similarly chose it in their study of similar issues. However, their study focused on issues relating to morale and the attrition rate of junior doctors due to the EU Working Time Directive within the sector as a whole. While this is an aggregate model dealing with workforce planning issues, as opposed to the operational and strategic decision making aid, balancing training and service requirements within its workforce that this projects is seeking to build, it is confirmation of the successful application of the technique in this area.

Thus, although the scope of the problem had seemed reasonably clear at the outset, it rapidly became clear that definitions, meanings and metrics were not uniformly understood. Secondly, what complicates this situation further, is that there is no fixed individual or set of "problem owners". Different sets of people in the Trust are responsible for the creation of rotas (hours), the provision of clinical education (consultants, clinical and college tutors) and the management of service (clinical directors, management, consultants). With responsibilities spread across such a wide variety and number of people in the trust, it is inevitably difficult to get them all together in one place, working together on "one model". Their views would have to be incorporated, but this cannot be achieved through a usual set up of the client-consultant relationship through one or two key players. This means that more effort is probably needed than usual needed to negotiate access to people's time, especially in such a pressurised environment, where strategic and long-term decision-making can take a back seat.

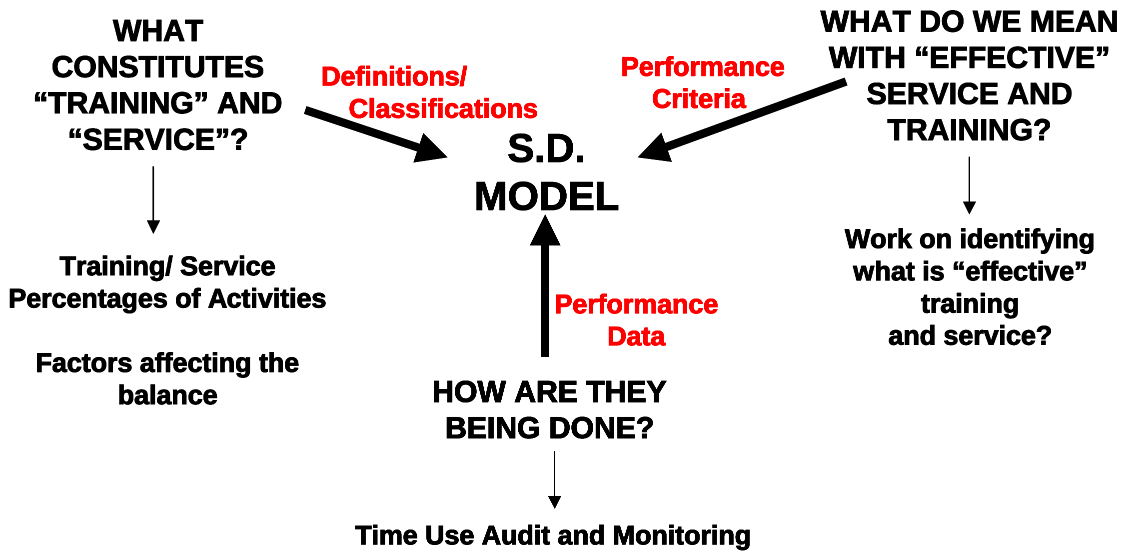
To overcome these problem-specific issues, the lack of clarity, and gain a better understanding of the issue, so that it could be built into an accurate and representative system dynamics model, a "three pronged attack" was devised (This is more fully described in Derrick 2004):

1. **Defining/ Classifying the concepts**: defining what is meant with "training" and "service", in particular by classifying junior doctor activities along the training/ service continuum, and identifying the factors that affect the balance.

2. **Collecting data to allow estimation of relationships**: data on how much time is being spent in each of these "training" and "service" modes?

3. **Identifying targets or ideal situations**: defining what is meant by "effective" service and "effective" training for junior doctors, and how this is achieved and/ or witnessed. This allows the identification of drivers and performance measures in the areas of "training" and "service" that can be incorporated in the model.

Figure 5 – Illustration of the three-pronged approach to informing the development of the SD model



Laying the stepping stones

The results on this project to date have resulted from research activities along the three "prongs" outlined above, as well as developments to date in the system dynamics model that is being constructed from the knowledge gained.

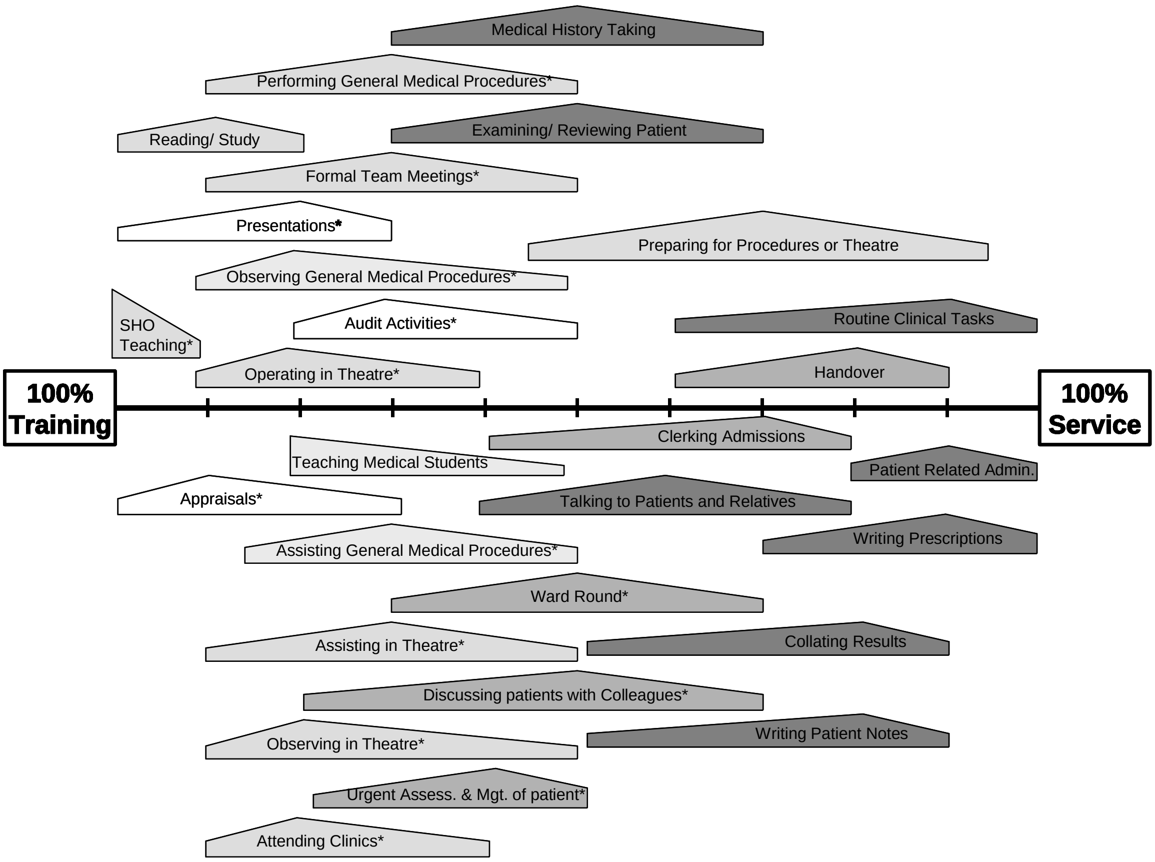
The training/ service continuum and factors affecting the training/ service balance in junior doctor activities

As previously described, it was necessary to scope and clarify the concepts of "training" and "service" and question the status quo of the simultaneous nature of the two, that was currently assumed in the profession. In particular, with reference to junior doctors it was important to understand: what constitutes training and service? How are they related? Is this a continuum or really a binary (either training or service)? How do junior doctor activities fall along the training/ service continuum? What factors affect this balance?

In addressing these questions, data was collected through questionnaires and focus groups. The entire population of SHOs at Plymouth Hospitals NHS Trust (PHNT) were targeted with a questionnaire, yielding quantitative data about training/ service balance perceptions and possible independent variables influencing these. Subsequently a sample of SHOs, Consultants and Tutors participated in focus groups, providing qualitative data on the same matter, gauging balance of training/ service activities and identifying factors that affect these. The focus group data helped validate and added depth to the data collected through the questionnaires.

The outcome of this was creation of the training/ service continuum diagram, as seen below. This shows how junior doctor activities are placed along the continuum, depicting the inter-quartile range (the peak displays the median, the higher and lower ends of the shapes show the 75% and 25% quartiles). This provides an indication of the level of consensus amongst respondents in their perceptions of the training/ service balance in the activities.

Figure 6 – The training/ service continuum of junior doctor activities



A number of observations can be noted from these results. Firstly, the more frequently undertaken activities (pictured in the darker shades) are generally towards the service end. Secondly, the activities that are generally supervised by a more senior colleague (the starred activities) are generally placed towards the training end. This indicates that frequency and supervision have a high impact on the perceived training/ service balance of an activity. This was confirmed by analysis of the questionnaires responses. Regressions and correlations showed that just under 70% of variation in training percentage perception could be explained by variations in frequency and supervision across the 28 activities. Unsurprisingly, frequency and training percentage perception are significantly negatively correlated (at the 0.01 level), i.e. the more frequent the activity, the lower the perceived training focus. As expected, the existence of supervision and the training percentage perception were significantly positively correlated, i.e. the existence of supervision in an activity increases the perceived training focus.

Finally, in confirming the experience that there are a wide variety of views on the issues dealt in the training/ service/ hours conundrum, it is apparent that for some activities, there is a much higher level of consensus than others. For example, there is a high level of consensus about the training/ service balance in a SHO teaching session, but a more variable activity in its execution, such as ward round, or discussing patients with colleagues has a high interquartile range of responses, indicating a far lower level of consensus in views.

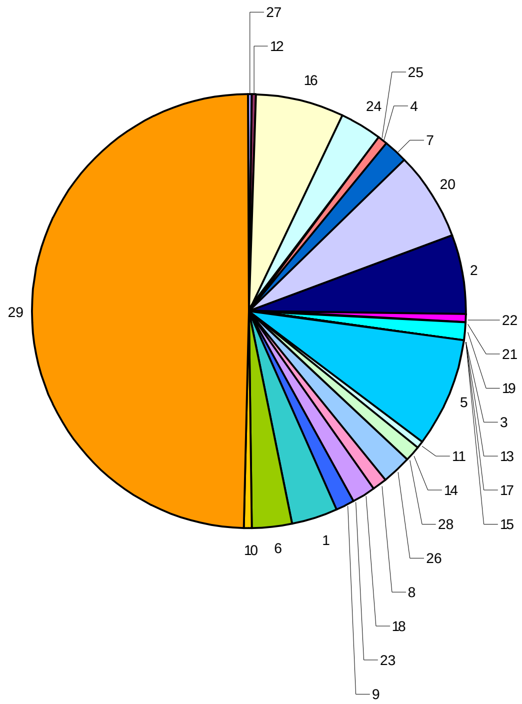
Complementing these results was a list of factors that affect the training/ service balance in the activities, which were arrived at from the focus groups. These included: time available for undertaking the activity, number of patients (workload), type and nature of work in the specialty, the individual trainee and trainers motivation and attitudes, interaction, purpose and focus of the activity, other commitments, experience and competence of the junior doctor. These were all factors regarding the execution of the activities. Some are quantitative features that can be more readily incorporated in the system dynamics model. Others, such as motivation and attitude, are not easily measurable, but this does not make them any less significant. In fact, this problem features a number of "soft issues" that have very definite real and "hard" impacts. This is something system dynamics should be amenable to modelling.

"Time-use" data collection and performance measures for "effective" training and service

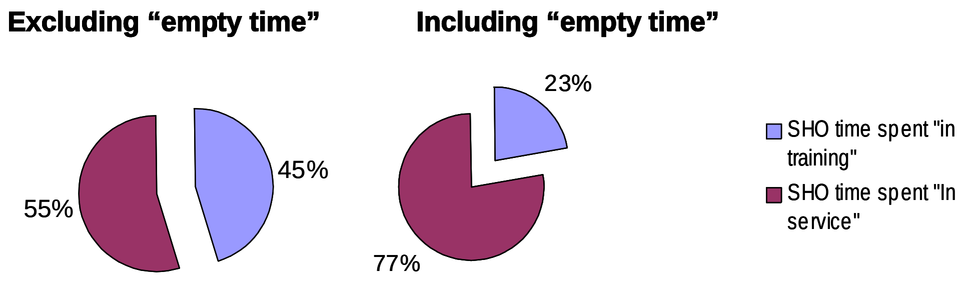
The other two "prongs" of information sought for informing the SD model, included the application of the training/ service percentages arrived at above to time-use data, and employing cognitive mapping to representatives of stakeholder groups to arrive at a collective view of "effectiveness" as it pertains to junior doctor training and service activities.

Analysis of time-use data, collected at PHNT as part of the Medical Workforce Skills Mix Analysis project in 2003, showed that 45% of SHO time is spent "in training" if the "empty" time (i.e. time spent doing other sundry activities such as walking, waiting, time in the doctors' mess (lounge), etc.) is not accounted for. However, if this time is included then the average time spent "in training" falls to 23% (implying conversely that 76% of SHO time is spent providing service).

Figure 7 – Results of junior doctor time-use analysis



1 Ward Round
2 Examining/ Reviewing Patient
3 Medical History Taking
4 Clerking Admissions
5 Patient Related Administration
6 Writing Patient Notes
7 Collating Results
8 Taking Blood/ ECGs/ Cannulation/ Catheterisation
9 Urgent or Emergency Assessment and Management of Patient
10 Writing Prescriptions
11 Performing General Medical Procedures
12 Assisting General Medical Procedures
13 Observing General Medical Procedures
14 Preparing for Procedures or Theatre
15 Operating in Theatre
16 Assisting in Theatre
17 Observing in Theatre
18 Talking to Patients and Relatives
19 Handover to next SHO (or cover)
20 Discussing patients with colleagues (incl. GP)
21 Formal Team Meetings
22 Formal SHO Teaching
23 Teaching Medical Students/ Other
24 Attending Clinics
25 Audit Activities
26 Reading Journals/ Research/ Private Study
27 Appraisals
28 Presentations
29 Empty time



While there are a number of problems with this analysis, mostly deriving from the quality and accuracy of the time-use data, there are clear implications:

a. There appears to be a relatively large proportion of "slack" in the system (almost 50%): time that could be either reduced (perhaps questioning the need for a doctor to be on duty) or put to better use. Perhaps some of this "empty" time could be spent educationally, either in personal study or skills labs. While no one is (nor should be) 100% productive, the slack identified above is significant.

b. A relatively high proportion of aggregate time is spent on tasks such as patient related administration and routine non-complex clinical tasks that could either be made more efficient or in part be supplemented by other members of the team (e.g. doctors' support workers) thus freeing up more time for service and education.

Inevitably, the validity and reliability of these results could be greatly enhanced by more accurate and detailed data, but interestingly, the 23% figure is similar to the current assumptions made by many clinicians regarding SHO training, and the 45% figure is close to the target amount of time that SHOs *should* spend "in training" (according to funding splits and *Modernising Medical Careers* guidelines). This discrepancy illustrates how statistics and conclusions from studies can be "massaged" to suit, if accurate data is not collected. Although appreciated that this shadowing data is not representative, nor complete, due to the lack of resources, this is the only data of this type currently available for PHNT. It is used here to help provide an indication of the training/ service balance for SHOs, and a good starting point for quantifying some of the relationships in the model, that previously haven't been able to be measured in this way.

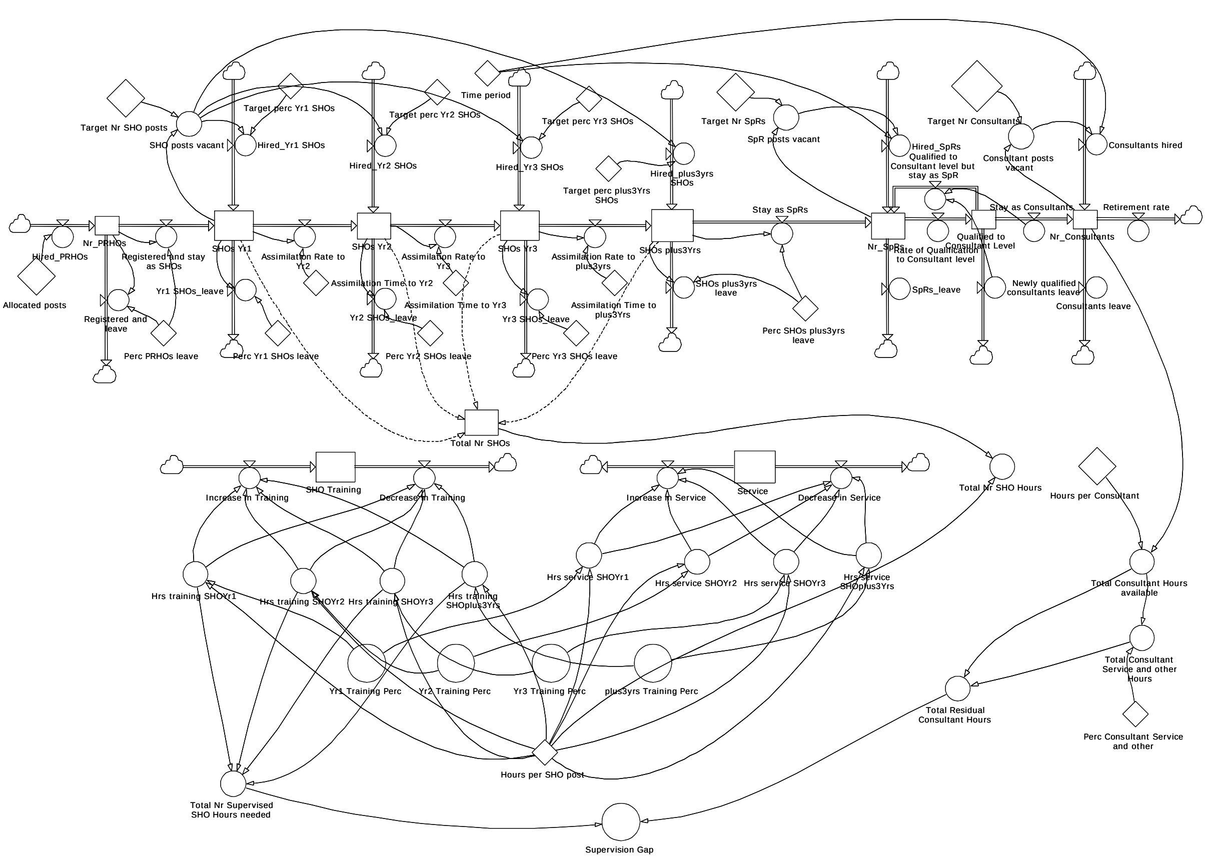
Work on the development of measures of "effectiveness" in the junior doctor training and service is still underway, employing cognitive mapping techniques. Results of this will further enhance understanding of the problem in areas that are currently not universally formulated in the Trust or elsewhere in the NHS, and aid the development of the system dynamics model as a representation of the problem as perceived by the problem stakeholders.

The emerging SD model(s)

At the most basic level, this problem is about matching the number of junior doctors as they pass through the training process, senior medical staff and the hours they work, and modelling the impacts of changes in these on the training provided and service delivered. Therefore, the main structure is based on a classic progression model. An 'ageing chain' of junior doctors, and their progression through postgraduate medical education, has been developed, with inflows and outflows at each level depicting the arrival and departure of junior doctors in addition to the internal progression flows. This was deemed the most appropriate starting point, as the physical stocks of "doctors" were easy for the problem stakeholders to relate to, as well as the progression through the system that was most evident. Further, the number of doctors in various grades, and thus their availability for service provision, or supervision in the case of senior medical staff, has been a high profile issue. This represented a tailored, yet fairly generic progression chain, as has been previously employed in human resource models (Sterman, 2000). It was determined that the most appropriate way to show impacts on training and service would be to create two co-flows of training and service, that increase or decrease, depending on (a) the number of junior doctors at each level arriving and leaving the system, and (b) the proportion of their time that was being spent "in training" and "in service" that is calculated in analysis previously mentioned. Thus, more experienced junior doctors, such as those who had been in post for more than 3 years, take proportionately more service hours from the stock when they left (and less training hours) than first year SHOs. There is further scope to feed in sub-models, which calculate the training/service percentage in the time spent, depending on how many of each of the SHO activities were being experienced and whether this is under supervision. (Although, in the version of the model shown in Figure 8, the training/ service percentages are shown as constants.)

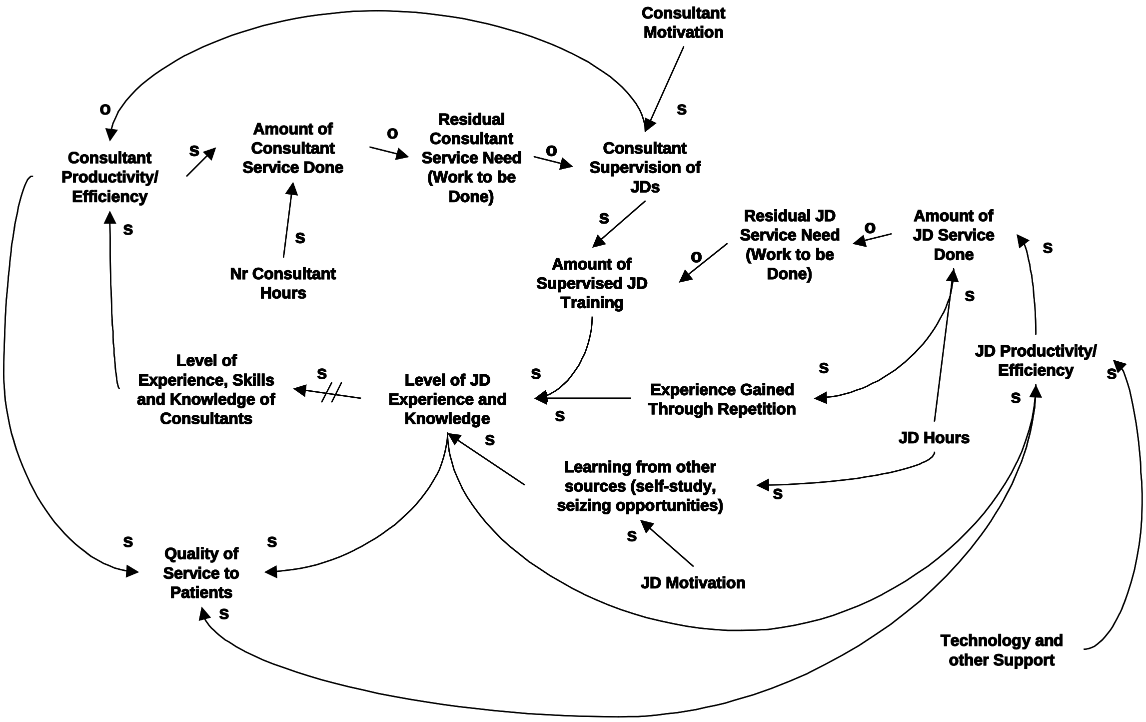
After developing this initial structure with the project team, it quickly became apparent that it had two drawbacks at this stage of the project. Firstly, the level of complexity was growing faster than was necessary for showing the overall feedback relationships and impacts. While separating out each grade of junior doctor, and even sub-grades for the SHO grade, enabled the decision makers to really identify with the model in its representation of the real-life "stocks", it meant that they were focusing on very detailed operational issues too early on, rather than focusing on the bigger picture. Secondly, it was in trying to capture the co-flows of training and service that it became more important to look beyond just the impacts on junior doctors, and their "training" and "service" hours, but to also focus on the consultants and other senior medical staff that were being affected by changes in the junior grade. This is a distinct advantage of building a systemic model: having to think beyond the immediate area of concern. Building in consultant hours and how time was being spent is possible with this model, but again this would raise the level of complexity in the model, as consultants would be supervising several grades of junior doctors, often simultaneously, while providing their own hours of "service", as well as other duties. Defining the impact of lack of supervision on future training/ service percentages was also a challenge in this version of the model.

Figure 8 – The initial system dynamics model



It was agreed therefore that while this full progression relationship would ultimately be needed to support decision-making, in order to first enhance understanding of the inter-relationships and their impact on training and service provision and developing a simple insight model should be developed. In order to keep the focus of attention on the whole system, rather than operational detail, a causal loop diagram was developed which summarised all the major feedback loops and relationships. This still reflects some of the more important day-to-day issues (e.g. bleep policies, doctors assistant roles) but also incorporates qualitative elements (motivation, seeking learning opportunities) that had been raised in the earlier focus groups. The CLD has been accepted as a good representation of the broad system at the aggregate, overview level. (See Figure 9).

Figure 9 – Causal Loop Diagram of the problem



The causal loop diagram contains four loops: one negative and three positive. It centres around the level of junior doctor experience and knowledge, which is at the heart of the problem. Earlier analysis revealed that one of the major contributors to the level of junior doctor experience and knowledge is the amount of supervised training they receive from senior medical colleagues. Supervision, or the lack thereof due to the EU WTD and revised working patterns, has been a much debated issue in this problem. Looking at this issue, and the feedback loop depicted in this area, it clearly shows how the reduction in hours of consultants and the continuing, and even increasing demands on service, impacts on the availability of consultants for junior doctor supervision. The amount of service consultants can provide to patients (be it in the form of clinics, operations, ward rounds, or other activities depending on the specialty) is directly related to the number of hours they work, and their productivity or efficiency. This naturally decreases the residual service (i.e. work that still needs to be done). The less outstanding work there is for consultants to complete, the more likely they are to take the time to spend supervising their junior doctors. This concept is an interesting one - the likelihood of a consultant providing quality supervision really has two factors. Firstly, they need to be available to put in the time. After talking to senior medical staff, it is clear that service to patients is the dominant priority, especially with the national governmental move towards a consultant-led service. However, as became apparent in the focus groups, even if consultants are able to supervise and teach their juniors, a second factor that has to be present is their willingness to do so. Individual attitudes and motivation vary from one doctor to the next – some being more keen to train their juniors than others – so the individual's motivation has to be present too. When the consultant is willing and able to supervise and train their junior doctor, this contributes to an increase in the level of junior doctors' experience and knowledge. However, it is universally appreciated that performing a task while simultaneously engaged in training takes more time than simple completing the task. Some of the doctors have estimated that this could reduce their productivity by approximately 30%. Therefore, while supervision increases junior doctors' knowledge, it decreases consultant productivity, which negatively impacts the amount of service they can provide, and thus likelihood of future supervision. However, this supervision is also important, as it increases the junior doctor knowledge, which means they will become more skilled consultants in the long run, which increases long-term consultant productivity/ efficiency. This is clearly a case of two re-enforcing feedback loops, which are acting at odds to each other.

Similarly, on the junior doctor side, the number of hours they work impacts on the amount of service they can provide to patients. The more work they do, the less there is to be done, and the more time they have available to spend with consultants under supervision. This represents the classic tension between service provision and supervision. Depending on how much work there is to do (i.e. number of patients to be seen, forms to be filled, investigations to be chased) they then have the time to spend asking their consultants questions or observing procedures. Working more hours and performing more service means that junior doctors are also increasing their experience through the repetition of activities, which is essential to their level of experience and knowledge. This is one of the areas that is of most concern regarding the reduction in hours - it is feared the junior doctors are simply not getting the same amount of "practice" and are seeing fewer patients and performing fewer operations and procedures.

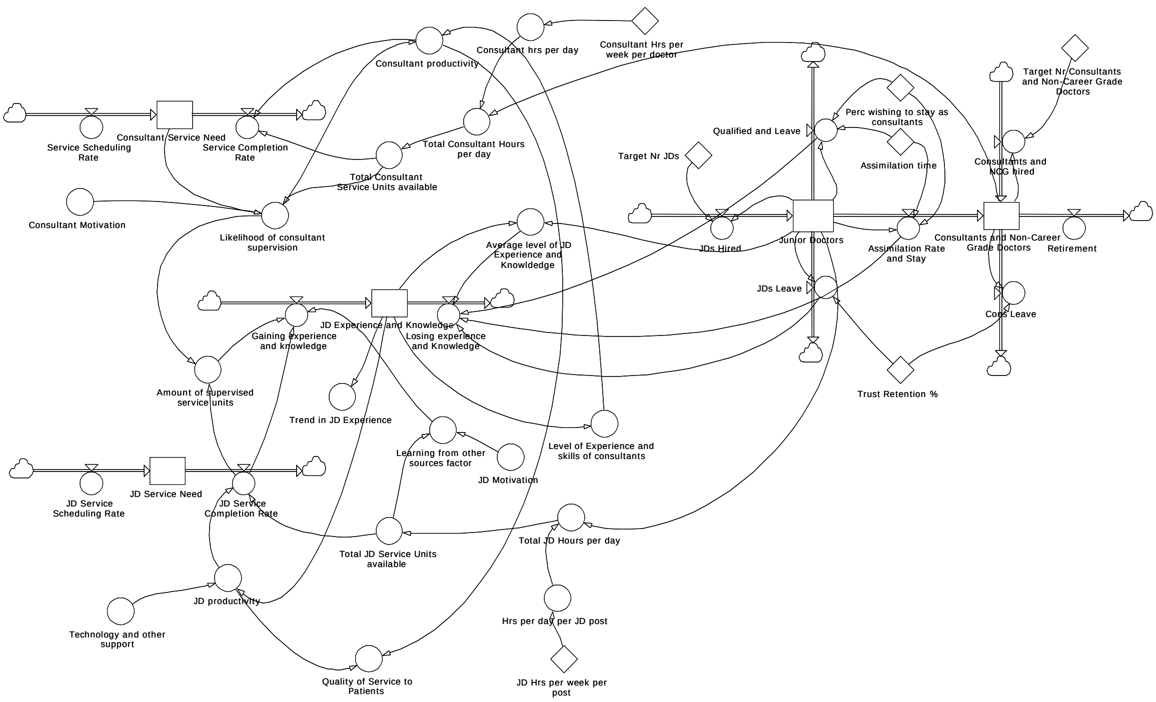
Similar to consultants, junior doctor productivity and efficiency must also be considered. The more efficient and productive junior doctors are the more service they can provide, which has the knock-on beneficial effects on their training, by making best use of their time. There are two things that are perceived to be influencing junior doctor productivity. At an operational level there have been a number of issues that are decreasing the efficiency. These include the ineffective method of communication with doctors via bleeps, which entails someone bleeping the doctor, the doctor having to find a phone and call back, often to find the line engaged, or the wrong doctor being contacted, often for inappropriate reasons. In preliminary investigations and data collection during job shadowing on this project, it was estimated that across the 24-hour day, up to 80% of bleep calls can be for reasons not requiring immediate medical attention of the junior doctor. However, with the current technology in use, it is not possible to differentiate between reasons, nor urgency of contact. Further, as shown in the time-use analysis referred to earlier, it was shown that approximately 20% of junior doctor time is spent on patient related administration and routine clinical tasks (such as ECGs or taking blood). These are tasks that do not require medical education and could easily be performed by a support role. Additional operational issues, such as waiting and chasing results, the number of switchboard staff, ineffective communication with support roles, and lack of support staff, all have surfaced regarding efficient junior doctor working. In the causal loop diagram, these have been summarised as "technology and other support", an increase in which would have a beneficial impact on junior doctor productivity and efficiency, which has positive impacts on junior doctor experience and knowledge. To close this loop, the more experienced and knowledgeable a junior doctor is, the more efficient he will be in providing service, as he will be able to perform procedures, take medical histories and diagnose quicker and more accurately, with less duplication of effort.

Another aspect of the acquisition of junior doctor experience and knowledge is the importance of learning from other sources. In particular, this relates to making the effort to attend teaching sessions, self-directed study and seizing opportunities to learn “on-the-shop floor” when they arise, as opposed to waiting for training to be “delivered”. Again, making the best use of opportunities and experiences to maximize learning and the knowledge to be gained from them is strongly dependent on the individual junior doctors’ attitudes and motivation and this varies hugely from one individual to the next. A change in culture and explicit definition of responsibility for education would be one way to increase the benefits of this.

One final aspect of the problem is the quality of service provided to patients. “Quality” has been poorly defined in the literature to date, and definitions vary from medical outcomes (Gottlieb et al., 1991) to qualitative encounters of patient experience (McKee and Black, 1992; Jones et al, 1992). However, in this problem, it has arisen in relation to the impacts of reduced hours working, through the reduced level of junior doctor experience and knowledge, and consultant and junior doctors’ efficiency. The more efficient doctors are, the better the quality of service to patients, as they are not waiting around unnecessarily for tests to be administered, procedures to be carried out or waiting in clinics for appointments. Of course compounding this is the fact that the more experienced the doctors are the better quality of service to patients, not only by increasing efficiency, but also by the reduction in errors and better clinical decision-making.

Overall, there are many interrelated issues at hand in this problem, but the development of this CLD was very helpful in focussing attention on the key issued. Translating this into a stock-flow diagram has resulted in the current version of the insight model shown in Figure 10.

Figure 10 – The revised SD model based on the causal loop diagram



As can be seen, this SD model employs four stock-flow structures, with representation of doctors, consultant service, junior doctor service and junior doctor experience and knowledge, only the last of which is “artificial” in its concepts. The equations behind the model link the number of junior doctors and consultants to the amount of service, by the completion rate. The scheduling rate of consultant and service is set by hospital demand, which can be modified for future simulation runs. Crucial auxiliaries in this are also the number of hours worked, which translate into service units.

The Doctors

This part of the model depicts a fairly generic progression chain, showing stocks of junior doctors and consultants, who are either hired or leave the Trust, with target numbers of each that is determined by workforce planning groups and funding available. While in reality there are several grades of junior doctors, and it is tempting to reflect this in an ageing chain, it was decided for simplicity and the problems with complexity encountered with the earlier version of the model, to leave this as junior doctors and senior medical staff as the two separate groups. One major assumption that this model version makes is of a “conveyor belt” nature between junior doctors and consultants, in that all those junior doctors who qualify and wish to stay on as consultants do, instead of the competitive nature of interviewing for jobs displayed in reality. This is an acceptable assumption at this stage of the project, the reality of which can be incorporated later.

Consultant and Junior Doctor Service

Stocks of “service” with inflows and outflows named “scheduling rate” and “completion rate” represent the amount of service outstanding for consultants and juniors to partake in. At this stage, this is measured in service units, each unit of service representing 2.5 hours, as this is how consultants have had their contracts and work schedules outlined. Further development of the model could include the move to specify the exact activities outstanding such as clinics, operating list or patient admissions. The advantages of using service units as a reference unit are that they are translatable in to time, are familiar to senior medical staff and can be used as a basis for the creation of the “artificial” units of knowledge and experience for junior doctors. For both, completion rates are calculated as a product of total available service units (derived from number of doctors and hours that they work) and a productivity or efficiency factor, as described in the causal loop diagram. On the consultant side, the residual service need (i.e. the stock of service), along with consultant motivation factor, determines the likelihood of consultant supervision, which is used to calculate the number of supervised junior doctor service units. On the junior doctor side, completion rates are used to calculate supervised service units and contribute to the rate at which experience is gained.

JD Experience and Knowledge

This stock has an inflow, called “gaining experience and knowledge” which is influenced by the number of supervised units, completion rate of junior doctor service and a factor of learning from other sources, which in turn is influenced by junior doctor motivation. It is most applicable to use a factor for the learning from other sources, as the appreciation and effort doctors put into learning what they can from a situation and seizing opportunities applies to everything they do, rather than a set amount of units. In the steady state, the loss of Experience and Knowledge as doctors progress through and out of the system should be replaced so that the level stays at the desired level.

At present, these four sets of stocks have been identified, with additional concepts represented by auxiliaries or constants. There are two dummy variables, regarding consultant and junior doctor motivation, which it was decided are either present or not for the time being, but this can be transformed into a factor or scale if the need arises during the validation process.

The beauty of this model is that is shows the problem with all of its implications and its relatively concise set of interrelated variables, comprehensible to the problem stakeholders, while the stock-flow representation, specifying concrete relationships, provides an additional level of insight. The equations behind the model have been derived from information that was gathered in the "prongs of attack" used to inform the construction of this model, and thus it gives this work added stance. For example, the junior doctor productivity factor is currently 0.5, as earlier analyses indicated that only 50% of the 24 hour period that junior doctors are available for work are actually spent on junior doctor activities. Of course, this can be changed if, junior doctor experience and knowledge is increased beyond the current levels, or technology and support mechanism are put into place to facilitate better time use.

Observations and conclusions and the road ahead

What has already become evident from the work on this project and the models produced to date is that this is a complex system, where system dynamics can be a valuable analysis and decision-making tool, for strategic and operational planning. Further, it is a system, of both quantitative and qualitative elements, whose interrelationships need to be made explicit, because even seemingly "soft" concepts such as junior doctor experience and knowledge have very real "hard" impacts on current and future service provision. Before the modelling could really begin it was necessary to research a number of the fundamental areas that impact on the training/service balance in junior doctor training. These have included how the divide is perceived by various system players, whether most if not all the activities that junior doctors do comprise at least an element of both, if so how does it split for various activities and for the group as a whole, and what constitutes efficiency and effectiveness in the training and supervision regime. The issue of efficient use of doctors' in terms of being diverted by unnecessary bleep-calls was highlighted, and the data and analysis from this phase also supported the hospital's successful bid for separate funding to trial a system for beep-call screening, which could increased the efficiency of doctors time use by passing to them only necessary calls with juniors or other medical staff, or non-medical staff, handling calls where possible. Results of this project have also supported wider initiatives at the hospital regarding new ways of working, including a "hospitals at night" project, which seeks to staff the hospital with a multi-disciplinary team during the out-of-hours period, and the possibility of developing a new doctors' assistant role.

Once modelling began, it became evident that an ideal consulting-context development process that might comprise qualitative analysis, then simple insight model, then a fully detailed model (Lyneis, 1999) would not be appropriate. The first modelling efforts were actually focussed on representing the full detail of the progression or 'hard' elements of the system. This was desirable so that the medical members of the team, who were the direct owners of the problem, could appreciate how the training system would be captured, that it was a true reflection of actual processes rather than a regression-based representation, how the junior doctors would eventually progress to being full doctors - first as registrars then consultants, and finally how the consultant level interfaces back with the other grades through their training supervision roles. This is consistent with an observation by Winch (1990) that in large consulting projects, especially with a disparate client group, a sub-optimal modelling approach is often needed, and models may have to be over-engineered to gain buy-in from all. This model (or model sector) is now largely complete and does reflect both the progression of internal candidates as well as the recruitment of external doctors, including those at SHO level, to maintain staffing establishments. The modelling process has also helped the team better understand the interactions with tricky but important detail, like doctors who have technically qualified to proceed to higher grades, but who stay at lower levels either while awaiting internal or external vacancies, but also to reflect what is evident a growing trend of some doctors wanting to stay in more junior posts for lifestyle and/or personal reasons. In terms of gaining maximum output in terms of both training and service in a progressively constrained system, use of these mechanisms are likely to become more important in doctor resource management at the hospital.

The second modelling phase effectively reverted to the insight phase. By mutual agreement it was felt that rather than continue progressively add layers and layers of detail onto the progression sub-model, it would be preferable to first get a better appreciation of the interaction between the 'hard' part of the system (doctor progression) with the less tangible elements including experience, efficiency, quality, and junior doctors' tendency to seek self-directed learning opportunities. This involved integrating difficult concepts and drawing a simple CLD before attempting to create stock-flow structures was found the most effective route.

Immediate and longer-term development plans include a wider validation process with different stakeholders within the Trust and governing bodies, such as the Southwest Peninsula Strategic Health Authority and Deanery, with regional responsibility for the provision of patient services and junior doctor training. This includes the validation of both structure and behaviour of the model, with modifications as necessary. It is also anticipated that the model will include more detail, incorporating junior doctors activities, which are currently all classed in terms of service units, and the additional factors that were identified in the focus groups as affecting the execution of these activities, and thus the potential benefit to experience and knowledge to be gained from them. This will aid operational decision making in addition to informing more strategic and longer-term concerns.

The project has already yielded significant insights and provided valuable support to those wrestling with the seemingly impossible task of maintaining quality and depth in the training of junior doctors at Derriford Hospital while also, and most importantly, delivering required levels of medical service to patients. It is also highlighting some of the special challenges of projects where there are many stakeholders, political agendas, and a continuously changing environment – and decisions, which are literally a matter of life and death.

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