Emerging Opportunities for System Dynamics in UK Health and Social care
- The Market-Pull for Systemic Thinking

Eric Wolstenholme, (Director Symmetric SD and Professor of Business Learning, London South Bank University),
Douglas McKelvie, (Associate Symmetric SD)
David Monk, (Director Symmetric SD),
David Todd (Symmetric SD)
Dr Carol Brady, General Manager Psychological Therapies and Primary Care, Lincolnshire Partnership Foundation NHS Trust

Abstract

The field of health and social care in the UK has been very receptive to systemic thinking in recent years and has been extensively and successfully modelled. This paper describes two trends in health care thinking in the UK which build upon this receptivity and are creating market pulls for whole systems ideas. These are the related areas of health needs analysis and service-line reporting, two concepts that are in search of a language and methodology to help deliver their potential. The paper describes how system dynamics is being applied to both these trends. The work is creating a natural progression for communicating system dynamics models and improving their impact on the thinking of clinicians and managers, particularly in mental health as epitomized by the contribution to this paper of the general manager responsible for the case study used.

Introduction

There have been numerous highly successful applications of system dynamics in health in recent years. These have covered health reform (Hirsch et al, 2005), capacity planning (Lacey, 2005; Lane et al, 2000; Royston, 1999; Taylor and Dangerfield, 2005), older people's services (Wolstenholme, 1993, 1996, 1999, 2007, 2008), disease management (Dangerfield and Roberts, 1999) and mental health (Wolstenholme et al, 20054, 2008).

Much of the modelling effort to date has been to create composite models of multiple health delivery systems. It has long been the contention of the authors here that whilst this approach can be successful the resultant models can often be too complex to counter their main purpose, which is to develop the mental models of clinicians and managers.

We are not alone in recognising this problem. The introduction of modifications to the system dynamics method, such as systems thinking (Senge, 1990) and strategy dynamics (Warren, 2002) are ways that exist to improve the realisation of the systemic objectives of the method. However, these methods achieve their aim by eliminating some components of system dynamics - systems thinking by leaving out stocks and flows and simulation, and strategy dynamics by largely leaving out feedback.

Health and social care has long recognised the need for a whole systems view of the world and created a market for systemic thinking in health. There are now trends emerging in health management in the UK which take a further step in this direction and provide a natural way of improving the communication and impact on thinking of the full system dynamics method.

There is a growing trend in UK health, particularly mental health, toward understanding how services can be better targeted at specific patient needs. There is an urgent search for an agreed set of needs-based clusters – often referred to as currency – and the service lines or care pathways along which people flow to receive treatment based on their allocation of service needs. Further there is a focus on service line reporting (Monitor, 2006a and 2006b) to help design services and monitor service performance.

These trends require an understanding of both the dynamics of need and service delivery that system dynamics is well-placed to satisfy. However, in the past, system dynamics models in health either tended to focus on needs dynamics, with little attention to service dynamics, or vice versa. Models in UK health are now being increasingly developed as a balanced 'matrix' of need and service.

Further, service models have tended to move quickly to multiple services. Now models increasingly concentrate on individual service lines first. This approach is proving very beneficial in its own right as these models can incorporate other UK health initiatives such as the idea of payment by results (rather than the more traditional payment by block contract) and patient choice. They can also help improve service line performance and understanding. One of the major benefits is that the modelling of service lines provides a platform for introducing the full system dynamics method through simple steps, without eliminating components and whilst maintaining management touch with model components. Progressive development of individual service models into more complex composite models of service delivery can then be achieved much more fluently and the real benefits of whole system thinking across services more easily realised.

The paper will discuss in detail the way in which service-line reporting and needs analysis thinking are being supported by system dynamics modelling and how these concepts are providing a much needed platform to enhance realisation of the benefits of system dynamics modelling.

Recent trends in thinking about health service delivery in the UK

Service-line Reporting

In recent years health and social care have recognised the need for better understanding of patient movements through care delivery systems. Since the "care in the community" reforms of the early 1990's, health and social care providers in the UK have increasingly been required to plan and deliver services jointly. Although delivery models vary substantially, it has become much more important to form a shared understanding of patient movements through the different delivery systems. Initially, process mapping and business reengineering

were used to improve the description of patient journeys and the idea of 'patient pathways' introduced.

Recent trends take these ideas further and involve thinking about developing patient pathways as service delivery lines and even as service 'products'. The study of patient pathways in this way is known as service-line reporting (SLR). The origins of SLR lie in the development of both health service delivery and health service commissioning (the purchasers of health services by Primary Care Trusts). In health delivery, hospitals in England are being transformed into Foundation Trusts with powers to control their own finances. In health commissioning there are moves toward awarding contracts on a 'payment-by-results' basis, rather than traditional block contracts, and towards improving patient choice.

For improved performance and quality in both monitoring and delivery, both types of stakeholders need to quantify all service-lines in terms of costs and tariffs.

The challenges for service providers are to:

1. think about whether to define service-lines along existing specialties or to group services into new business units
2. create shared understanding of service-lines between managers, clinicians and operational management across a range of service-modes
3. define appropriate key performance indicators (KPIs) to align behaviour and performance across the whole service-line
4. avoid unintended consequences and perverse incentives
5. create a balance between tariff, commissioning demand and patient choice

SLR has particular consequences for information needs and performance measurement. Service providers need to understand the gap between the information needs of their organisation and the existing management information and to decide whether to adapt existing information systems or to re-engineer a patient level information process.

Service-line reporting and system dynamics

System Dynamics provides a ready-made language of stocks and flows through which it is possible to define rigorously the patient states in, and flows through, the service-line and its resource needs.

By the use of mapping and simulation, system dynamics assists shared understanding of service-lines and the testing of operational and financial outcomes under different policies, information and demand/choice scenarios. Rather than simply developing the services in real life and then making costly adjustments as problems emerge, simulation and scenario analysis can help to predict and consider any unintended consequences from the beginning. This process, which merges strategic thinking with operational outcomes, minimises risk and promotes early realisation of benefits.

Further, by allowing comparisons of the difference between mental and computer simulations, system dynamics helps clinicians and managers with understanding the gap between the information needs of service-lines and existing management information.

Health Needs Analysis

A growing trend in UK health services is the issue of how better to relate service delivery to patient need. Patient need arises from a number of sources, for example socio-economic factors or their particular state within the condition from which they suffer. To target health delivery more appropriately to the right people, commissioners and service providers need to think about how both needs clusters and whole systems of service delivery together.

To perform needs analysis health system must be broken down into 'needs progression' and 'service progression':

1. 'needs progression' – is the natural progression of people over time, through a series of states of need. Such a progression represents for example the epidemiology of a condition if no treatment services exist.

2. 'service progression' – is the progression of diagnosed patients through a variety of capacity constrained human intervention treatment states or patient pathways, each with different diagnostic and treatment times, available to differing cohorts of patients.

Diagnostics and treatments have two effects on the progression of need. If successful, they can slow down the progression or, additionally, for some needs such as non-degenerative conditions, can move patients back upstream to less intense states of need.

Analysis in health and social care has strongly developed the concept of 'service progression', but often ignored 'needs progression'. The reason for this is that for many common needs, health service clinicians and managers usually perceive only service progressions, because these are the whole focus of their work. They also sometimes confuse need progressions with service progressions. Health professionals often have little knowledge of the numbers of people in each state of need. This is particularly true for conditions characterised by very large numbers of people in a healthy state, many of whom make one-off use of health treatment with little 'repeat treatment'.

There are numerous needs which are almost closed systems, where the population of people with the need in any locality tend to be relatively small and known in number, essentially static and tend to cycle between treatment and health. Conditions such as the more severe forms of mental illness, diabetes, etc. fall into this category

By contrast, people move through the various levels of depression and anxiety more frequently, and in both directions (improving as well as deteriorating). Although for many sufferers these are long-term needs, there is not a fixed population, and full recovery is possible.

Health Needs Analysis and System Dynamics

System dynamics modelling in health has the capability of embracing both 'need progression' using 'need chains' and 'service progressions' using 'service chains'.

From a needs clustering point of view, system dynamics provides assistance from its contribution to 'aggregation' thinking. One of the main problems in modelling patient pathways is that of defining appropriate grouping for the types of patients who can access any service. There will always be a certain degree of variability in patients, but more often there are multiple populations of patients with quite differing characteristics. For example, there are 'simple' and 'complex' cohorts of people progressing through hospitals, characterised by significantly different treatment times and differing needs for downstream services such as post-hospital social care (Wolstenholme, et al, 2007). Aggregation thinking allows definition of the smallest possible number of clusters to create insight, commensurate with retaining simplicity.

The 'needs chain' is a variant of the generic 'aging chain' structure of system dynamics, extensively used in modelling a variety of fields from asset management to workforce planning. This construct has some interesting characteristics in health and social care. The progression within the chain can be bi-directional involving both natural deterioration and improvement in condition or need.

In the past, system dynamics models in health have tended to reflect the data limitations of needs analysis. They have usually focussed on 'needs chains' with little attention to 'service chains', or vice versa. However, with better information now available on needs progressions, particularly for mental health conditions, this situation is changing.

Consequently, health professionals are increasingly attracted to maps and models which include 'matrix' representations of both needs and service states and which allow understanding of how patients progress over time through different states of need and along and between states of service. In this way a better understanding can be developed of how services can be better targeted at needs.

However, whilst the move towards matrix representation in models has strong potential to develop understanding and comprehensively capture health and social issues, matrix models can themselves still easily become overly complex. Moreover, they can postulate treatment states that do not yet exist and can be difficult to populate with data. Nonetheless, they can be extremely useful and their usefulness is often more to do with designing future structures and data needs of heath and social care than solving issues within known data limits.

SLR and conditions models in practice – an example

Designing service clusters and their performance

Figure 1 shows the system dynamics language used to describe and design a gropu of new services in mental health – a field relatively new to SLR thinking. The example used is the development of a new intermediate step in the delivery of mental health services. The current mental health system is essentially a two step service with patients either receiving help from their general practitioner in primary care or being referred to a specialist Mental Health Trust, where they may have to wait a long time to receive a complex treatment (Wolstenholme et al, 2006).

The new step comprises two service clusters referred to as case management and psychological therapy and is aimed at people with a mild/moderate condition of depression or anxiety. Although the techniques at the heart of this service cluster have been approved for clinical efficacy (NICE, 2004), the economics and resource needs of the patient pathways need to be economically designed and evaluated for SLR implementation. Describing the new service cluster involves the following components and data:

1. demand
2. wait time
3. staffing supply
4. review, further treatment and treatment switching
5. post treatment monitoring and review
6. length of stay in monitoring
7. remittance
8. step up or down to more or less intense treatments

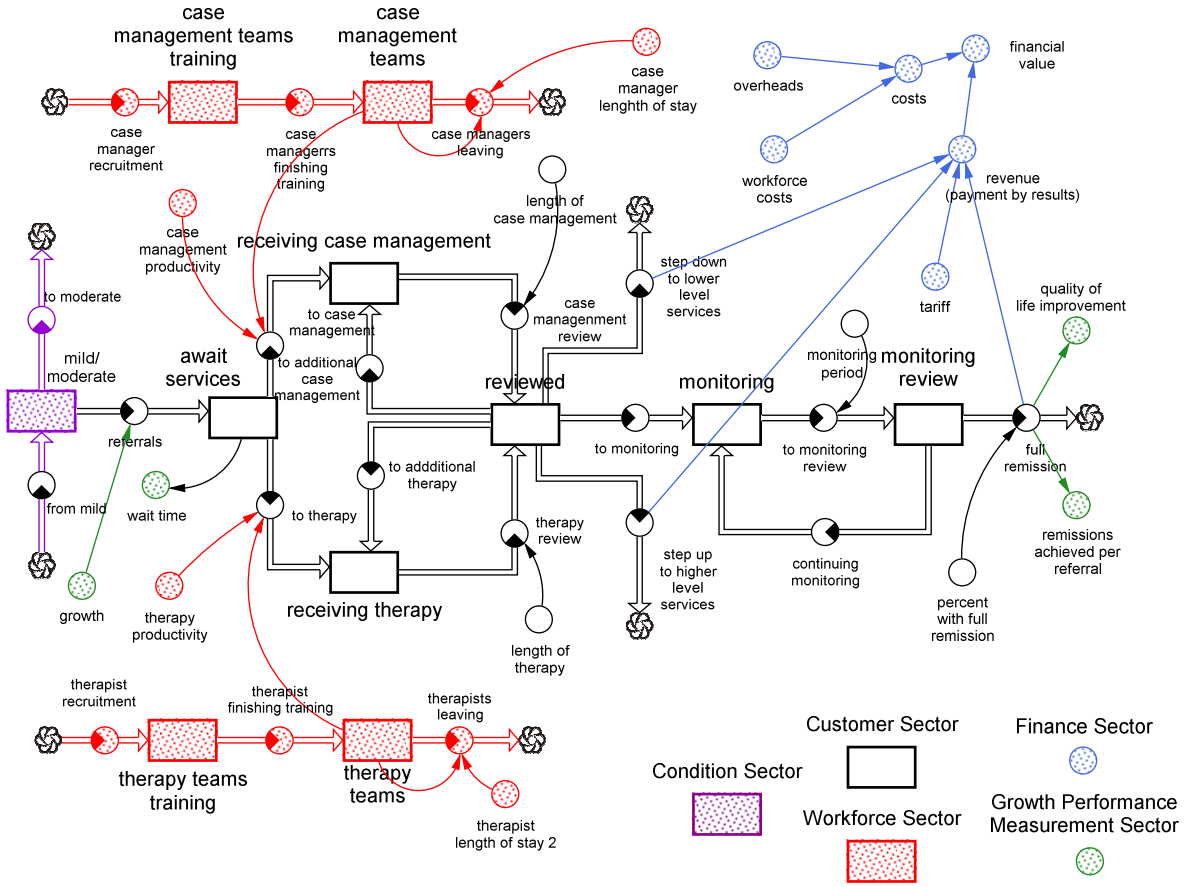


Figure 1: Example of Service Pathway Model Representation of New Primary Care Stepped Service for Depression and Anxiety

The unique attribute of system dynamics demonstrated in Figure 1 is the ability to link together the dynamics of needs progression with the dynamics of service progression, covering all operational and financial facets of the service grouping. The model is sectored for clarity into needs states and service states, with the latter additionally broken down by sectors of the balanced scorecard to assist performance monitoring.

The design of the new service group is dynamically complex and initially requires data estimates which can be refined as pilot studies and real practice take place. By creating a system dynamics model of the service cluster, confidence can be gained as to levels of staff resources and costs required for treatment and monitoring under different assumptions about demand, acceptable wait times and length of stay to achieve a given level of successful remittance. The model also enables data needs to be defined for performance monitoring. There is also the added bonus of running the model 2 ways. One to see how many people can be treated and remitted under given costs and how much service investment is required to treat a given demand. Such information is vital both to the service provider offering a treatment capability and to the commissioners to the commissioners purchasing the service.

Multiple Service Matrix Models in action – A Case Study - Modelling Stepped Care Services for Depression, Anxiety and Post-Traumatic Stress Disorder in Lincolnshire, UK.

Although the testing of SLR service groups is useful in its own right, one of the major benefits of a system dynamics model is to provide a means of amalgamating service groups into complete treatment delivery systems for specific health communities. In particular, this is where analysis of the viability of each service group can really be tested against the dynamics of the needs chain and assistance given to the analysis of service against need.

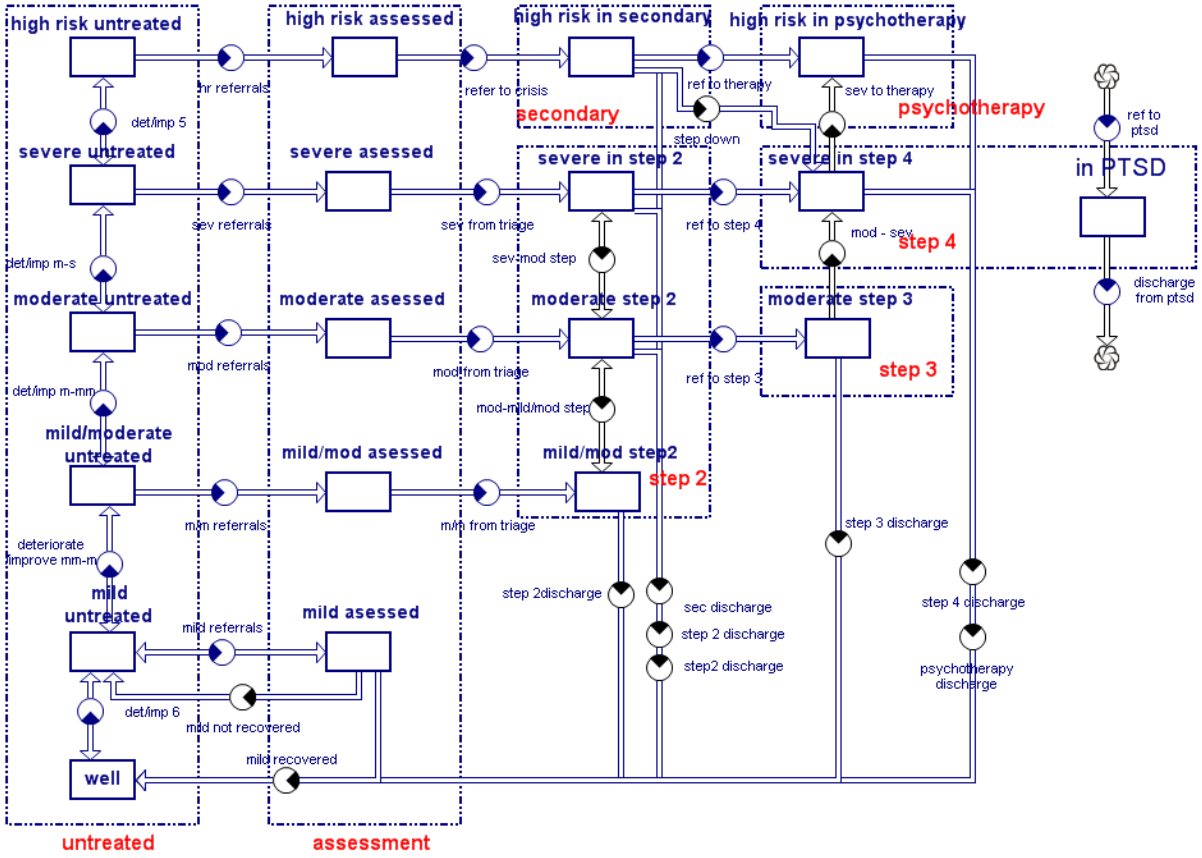
The Issue

Two years prior to the project to be described, a new service model had been put in place within part of the county. This changed the work practices of staff working in primary care mental health, delivered shorter waits, and was well received both locally and nationally, as an example of good practice. However, this service did not address the level of service which dealt with more severe and complex cases, and there remained bottlenecks and long waits for psychology. This new service had developed in response to pressure from the commissioners about waiting lists, and had been achieved without significant additional investment. The reconfigured service therefore continued to work under considerable pressure. The service was evaluated after 8 months of operation, and a decision taken to "roll out" this way of working across the county. Staffing was calculated based on a population based extrapolation from that within the pilot area. The expansion still took no account of the whole system, and only focussed on the Primary Care Mental Health service – within the current paper steps 2 and 3.

This more traditional approach to service development lacked systemic thinking. The systems dynamic work offered an opportunity to take a whole system view and put this right. The resulting model describes a proposed new configuration of services, rather than the system "as is". It represents the entire working age adult population of the community, in relation to whether or not they suffer from depression / anxiety, and, if so, whether and where they were in the treatment system.

The model, shown in simplified overview form in Figure 2 ('waiting for treatment' stocks in each service sector have been omitted), takes the form of a matrix representing the complete proposed service system for depression/anxiety/ Post Traumatic Stress Disorder (PTSD) in Lincolnshire. This model was used mainly to determine the way in which staffing complement should be allocated across service groupings in stepped care to achieve an improved quality of life for patients, under assumptions about demand, patient presentation rates, patient choice, patient allocation to service groupings, estimates of the proportions of patients stepping up, stepping down and remitted after diagnosis and treatment (Wolstenholme et al, 2006).

Figure 2: Stock-Flow Diagram Representing Proposed new Clinical Model for Treating Mild to Severe Depression and Anxiety, and PTSD, in Lincolnshire



The model was built as a group learning process by a modelling group representing clinicians, informatics staff, managers and, the service commissioner. The group met monthly

over an initial series of five meetings, crucially, retaining a consistent attendance. The model was built iteratively by combining service-line models of each treatment (for example, each Step in Figure 2 effectively subsumes the service clusters outlined in Figure 1) and contributed towards the group achieving a remarkable degree of consensus about how services should be configured. It is interesting to note however that not all conditions are linked to all treatments.

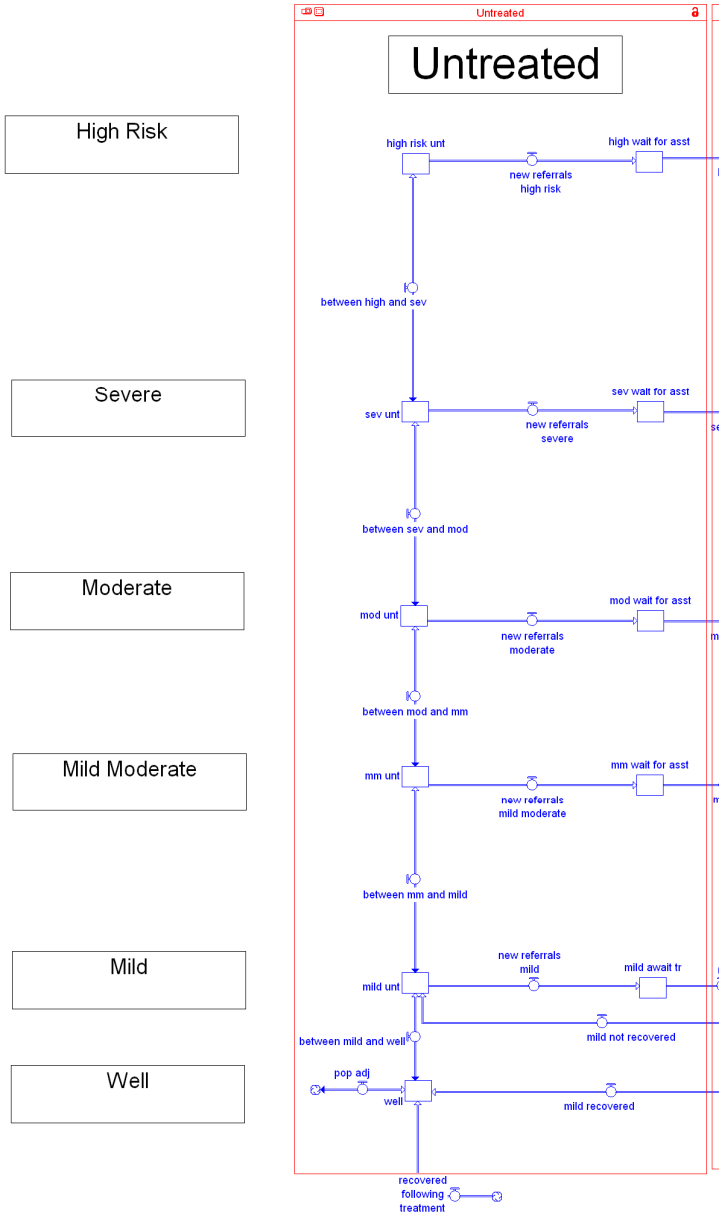
This was in contrast to the usual approach to service design, which is be as inclusive as possible, but which can be cumbersome, and difficult to manage. The direction of travel for the service was clear from national policy, and so only key personnel were included on the modelling group. The modelling was based on assumptions drawn from the emerging evidence on stepped care. The process of the groups resulted in much debate and discussion of how services operate and how clinicians, managers and commissioners wanted them to work.

Using a small group of the people with the knowledge facilitated the process, in that meetings could be set up with less difficulty, with a consistent membership.

The vertical dimension of the model in Figure 2 represents levels of severity of depression, and the horizontal dimension represents treatment stages (or steps).

The diagrams that follow describe sectors of the model within Figure 2.

Figure 3: The Untreated Population



This part of the model represents the potential demand for services. To the extent that people are unwell and not in service, it also represents unmet need.

The stocks on the left hand column represent people at all levels, who are not in service.

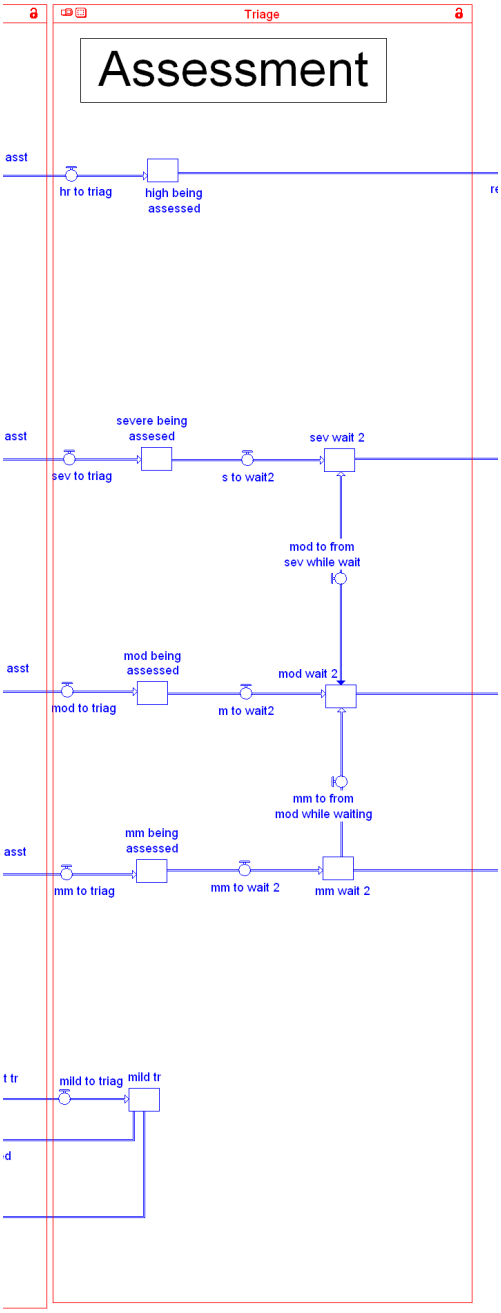
At all times, people flow in both directions between the different levels. In any time step some people will go from being moderately to severely depressed, or the other way, even although not being treated.

This represents something of a challenge in estimating data inputs for these rates, because such transitions were not captured in any public health data known to the group. The progression / deterioration rates were calibrated to ensure the best possible fit with what is known about the prevalence of depression in the population.

The stocks in the right hand column represent people who have sought help and are being referred into the single point of access to primary care mental health.

Normally, there would be very few people in these "waiting" stocks, because the capacity of the single point of access is such that new assessments can generally be done on demand.

Figure 4: Assessment



All new referrals go to be Assessed.

The purpose of the assessment is to identify need and formulate a treatment plan, including determining the severity of the condition.

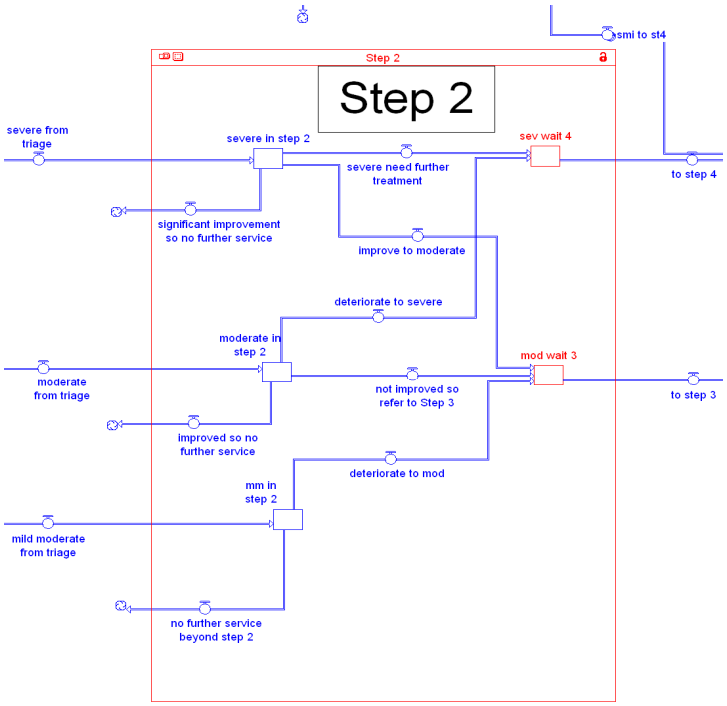
In cases of mild depression/anxiety, some advice is given and the individual is referred back to the GP for support.

High risk cases are referred immediately to specialist secondary services. Because the model is concerned with primary, stepped care services secondary services are not modelled in detail.

Those in between (mild moderate, moderate or severe) should enter stepped care. In this case, it is proposed that every new referral to stepped care should be to Step 2. Depending on the outcome of that intervention, people are then referred on to other parts of the stepped care system.

The stocks in the left hand column represent people being assessed (this normally takes place at a single appointment). The stocks in the right hand column represent people who have been assessed as needing stepped care, but who have not yet commenced their treatment. If there is limited capacity in step 2, people will wait in these stocks.

Figure 5: Step 2



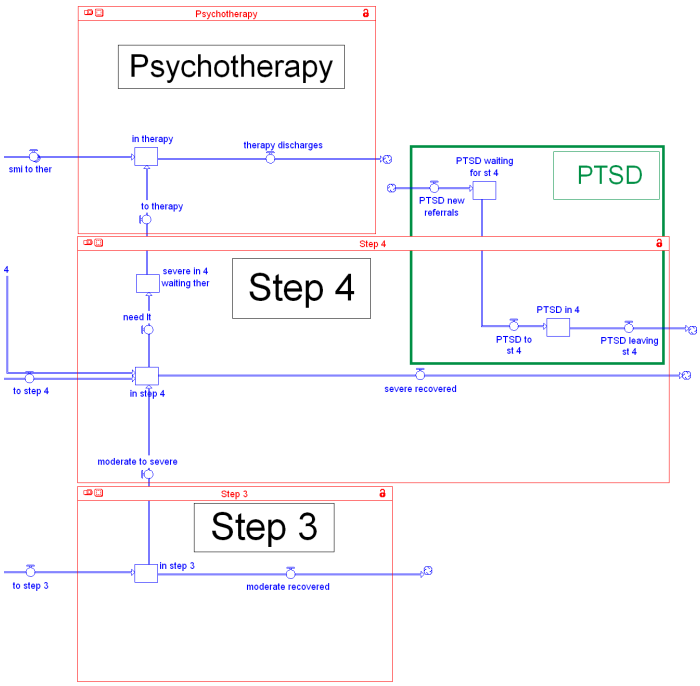
Step 2 is probably the most complicated service, because it includes people at three different levels of severity. Although not clear from the diagram, it also incorporates three different treatment modalities.

Everyone entering step 2 is offered an appropriate course of treatment. On completion, people are either discharged back to GP (if sufficiently recovered) or referred on to step 3 or step 4 according to their level of depression at the end of step 2.

So people might enter step 2 as mild-moderate, and complete step 2 either as recovered, or having deteriorated to moderate (in which case they will be directed towards step 3).

Similarly, people entering as moderate might either exit to no further service, show no improvement so need step 3, or deteriorate and need step 4. Those entering as severe might similarly have improved to the point of needing no further service, improve to the point of now requiring step 3, or show no improvement and require step 4. The waiting stocks on the right hand side show people waiting for steps 3 and 4 respectively. Note that people waiting in step 2 (if steps 3 or 4 lack capacity) are offered some step 2 service, in the form of group therapy, until they move on.

Figure 6: Steps 3 and 4



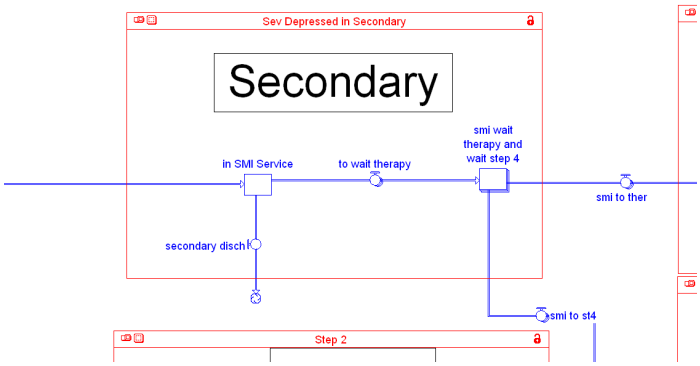
Progression beyond step 2 depends on severity of condition. Whereas step 2 takes people suffering from different degrees of depression/anxiety, the other treatment steps correspond to a particular level.

Those who are moderate are referred to step 3. on completion of step 3, where they either recover, and so return to the care of the GP, or deteriorate to severe, in which case they step-up to step 4.

Those who are severe on completion of step 2 are referred to step 4. On completion, they either return to care of GP, or, in a small number of cases, are referred to the long-term psychotherapy service, which is built into the model as an extension to step 4.

Note that both psychotherapy and step 4 services also take people being referred from secondary services (stepping down). The Post Traumatic Stress Disorder PTSD sector exemplifies a point made earlier; that some services cater for different populations of service users. In this case, people suffering from PTSD also use stepped care services, but only step 4. They are represented as a separate stock-flow chain, which also flows through step 4.

Figure 7: People Suffering from Depression and in Secondary Services



The focus of the model is primary (stepped) care, so it is not necessary to go into detail about what happens within secondary services (a mixture of specialist community and hospital in-patient services, dealing mainly with psychosis). However, it is necessary to have a stock representing all of the people with depression who are using these services. The most depressed service users will be referred to secondary services, and many will step-down (to step 4 or to psychotherapy) entering the stepped care system through a different entry point from most users (who gain access through the assessment-to-step 2 route. The number of people using secondary services in this model does not represent all, or even the majority of users of secondary services; it represents only people on the depression/anxiety continuum plus PTSD. A wide range of other service users use secondary services.

So, the settings governing what happens in secondary services are somewhat simplified. The diagram on the right shows the settings that have normally been used when the model is run.

Model set up and experiments

The key components of the capacity calculations in the model consisted of a series of inputs which calculated the number of people who can be "in service" at any given time and the length of time for which people remain in the service

Step 2 is the most complicated step, because step 2 staff provided three service modalities and some service users use more than one modality. These were, individual counselling / guided self-help, computer based CBT and groupwork

The model factored in:-

- The total number of staff employed and time off for annual leave and sickness
- The fraction of contact time that was devoted to each modality (which can be varied)
- Non client-contact time
- The percentage of service users who would use each modality (everyone uses at least one, but some people use more than one)
- The amount of staff time taken to provide each modality (e.g. two hours per group session, and up to 12 service users per group)
- The average number of sessions which service users use for each modality
- Frequency of contact with service (weekly, fortnightly, etc.)

Because the model describes some processes that had not been systematically measured in the past (such as the rates of transition between levels of depression/anxiety of the "untreated" population, and service pathways which do not yet exist), it was necessary to estimate many of the model inputs, where possible by extrapolating from other sources.

Many such data items were estimated from Department of Health data about prevalence rates of depression in the general population and local data was derived from analysis of field trials which covered a discrete part of the community.

Mental health communities are increasingly investing in new services to reduce waits for mental health treatment and to increase the numbers of patients treated and one of the important sets of experiments for which this model was designed were to test out the implications of assigning more staff to each step in the depression service. The model scenarios were run interactively in a workshop, where group members iteratively work towards a configuration of service resources that produce a satisfactory outcome. In most cases, this meant achieving zero waiting times for all of the stepped care services.

The model was set-up to run for a period of 4 years, and the time step within the model was days. The model is being used for many experiments at present.

In the lifetime of the project, the group conducted many experiments using a range of assumptions about service demand and required capacity. The graphs shown below are from a model run which predicated a rise in the rate of presentation for service, which had been

observed during the time for which this project was running. At the start of the model run, sufficient staff were "recruited" to enable the model to run without any waits.

One of the most surprising results for managers and of interest to the theme of this paper was that the significant investment in capacity needed to ensure zero waiting times for most[1] services could probably be reduced one or two years into the simulation. This is a good example of limits to growth (and often in health a limited growth is of more benefit than an unlimited); if services are effective, and if previously untreated depression / anxiety is now treated, this results in a gradual improvement in the mental health of the general population, and eventually to fewer people who require the service. This result could only be observed in a model of both needs and service progression. To illustrate the point, the Figures 8, 9 and 10 show the numbers of people in each service step in this scenario

[1] Empirically, the psychotherapy service had a significant backlog which, with existing staffing, would take several years to clear

Figure 8: Numbers in Step 2 Against Capacity

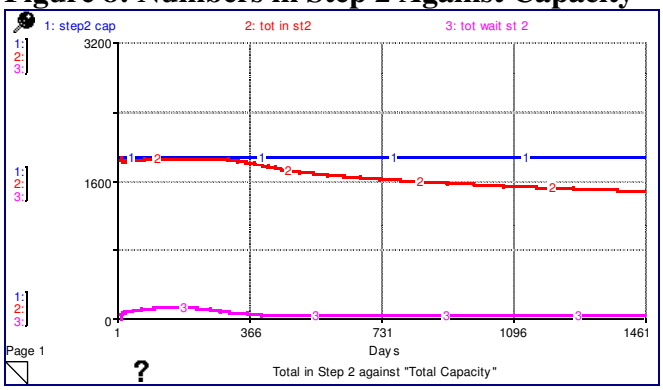


Figure 9: Numbers in Steps 3 and 4 Against Capacity

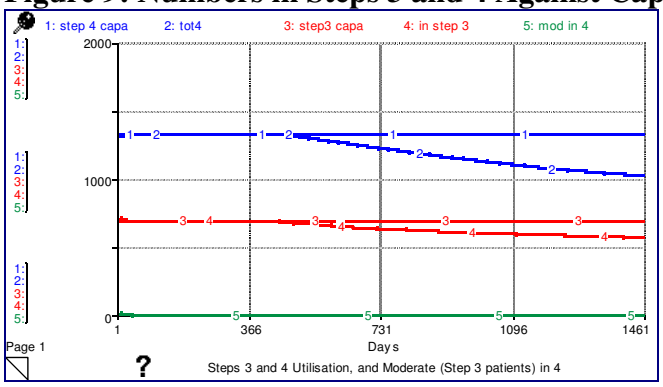
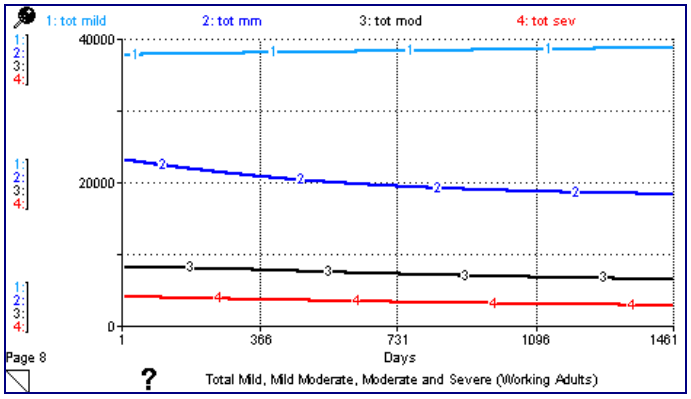


Figure 10: Prevalence of Different Levels of Depression in Working Adult Population



What these graphs show is that each stepped care service runs more or less at capacity for the first year (step 2) or slightly longer (steps 3 and 4) before tailing off, most notably step 4.

The reason is that the increased numbers of people in treatment are leading to a faster rate of recovery, meaning that the general mental health of the population is improving, as illustrated in the next graph showing the different numbers of people in each category of depression. There are significant reductions at all levels, with the exception of mild depression, which slightly increases.

The increase in mild depression is counter-intuitive. In terms of what is happening in the model, the reason is that the increased numbers of people being treated leads to an increase in the Not Depressed population. However, because there is a fixed percentage rate of people moving from Not Depressed to mildly depressed, the higher the number who are Not Depressed, the greater will be the flow into mild depression.

The model does not include any assumption that the people in the Not Depressed stock who have had a previous episode of depression that was successfully treated, have a different rate of new episodes than people who have never been depressed (or never treated).

The group's own reflections on the process were that the process of the groups resulted in much debate and discussion about how services operate and how clinicians, managers and commissioners wanted them to work. Although initially feeling confused by some of the technical / mathematical aspects of system dynamics modelling, everyone involved experienced the moment, when "the model starts to talk to you". Frequently, predictions

made by group members about how the model would operate with particular staffing levels, turned out to be wrong, typically based on assumptions which were not system-based. It was only when team members began to understand how the model as a whole worked, and began to think systemically, that they could agree that results which seemed counter-intuitive, were in fact, correct.

There had been a "common sense" view that services, and the staffing required should be pyramid shaped, with less required at the higher levels. But this failed to take account of the increased demand per patient at higher levels of complexity, and in fact the shape adopted by the model was of an hour glass, needing considerably more staff at step 4 than currently. At times, this felt like something of a leap of faith, when it has been counter-intuitive. However, service development has typically been undertaken by "best guesses" based on available public health information coupled with trial and error in real life, and it is reassuring to be able to do a simulation based on more scientific principles.

Another major benefit has been that the model variables are being linked to the information system, so that future monitoring of service performance can be reported against the stock-flow structure, and even mapped onto a diagram of the model.

Conclusions

This paper has described the role of service-line reporting and health needs analysis in UK health commissioning and delivery and suggested that:

1. system dynamics provides a much needed language and tool set to realise the benefits of service-line reporting and needs analysis and
2. service-line reporting and needs analysis thinking provide a natural and welcoming platform for system dynamics modelling.

Incorporation of both patient needs and services into whole system models is fundamental to achieving better understand of the economics of service/needs analysis in health. It is the conclusion of the authors of this paper that whilst whole system service delivery models have enormous contributions to make to health thinking (Wolstenholme et al, 2006), moving straight to them in the first instance is just too big a leap for most managers and implementation can suffer due to lack of detailed understanding of the subsumed service-lines. It is being found that involvement of managers and clinicians in the construction of individual service-line models and their aggregation into whole service delivery models has the potential to improve the role, impact and implementation of both types of model.

By engaging managers in service delivery and commissioning by amalgamating models of service-line groups, an important need is satisfied for SLR whilst at the same time the way is paved for better understanding of the use of the system dynamics method for strategic shifts in total service delivery. The concepts of SLR and needs analysis gives credence to the time spent on really understanding individual service groups and the way they relate to specific needs.

There is much evidence from the recent past that the health service in the UK is making great strides in embracing complexity and understanding the benefits of systemic analysis. The links with SLR and health needs analysis take this many stages further.

The main insight is that the benefits of system dynamics will always be better realised by integration with current major initiatives which have strong management focus (market pull), than by applying it directly in its own right for its own sake (methodology push).

References

Dangerfield B, Roberts C 1999. Optimisation as a statistical estimation tool: an example in estimating the AIDS treatment free incubation period distribution*, System Dynamics Review*, Vol. 15, No. 3.

Hirsch G, Homer J, McDonnell G, Milstein B. 2005. Achieving Health Care Reform in the United States: Towards a Whole System Understanding*, Proceedings of the International System Dynamics Conference*, Boston, USA.

Lacey P (2005). Futures through the Eyes of a Health System Simulator *Proceedings of the International System Dynamics Conference*, Boston, USA.

Lane D C, Monefeldt C, Rosenhead J V. 2000. Looking in the Wrong Place for Healthcare Improvements: A system dynamics study of an accident and emergency department, *Journal of the Operational Research Society* 51(5): 518-531).

Manley W, Homer J, Hoard M 2005. A dynamic model to support surge capacity planning in a rural hospital. *, Proceedings of the International System Dynamics Conference*, Boston, USA.

Monitor – Independent Regulator of NHS Foundation Trusts (2006a) Guide to Developing Reliable Financial Data for Service-Line Reporting, Monitor, London, UK

Monitor – Independent Regulator of NHS Foundation Trusts (2006b) How Service-Line Reporting can Improve the Productivity and Performance of NHS Foundation Trusts, Monitor, London, UK

National Institute for Clinical Excellence Depression: management of depression in primary and secondary care - NICE guidance, National Clinical Practice Guideline Number 23, December 2004

Roysten G, Dost A, Townsend J, Turner H. 1999. Using System Dynamics to help develop and implement policies and programmes in Health Care in England*, System Dynamics Review,* Vol. 15, No 3.

Senge, P. (1990) *The Fifth Discipline* Doubleday.

Taylor K, Dangerfield B. *2005* Modelling the feedback effects of reconfiguring health services, *JORS* Vol.56 pp658-675.

Warren K (2003) Competitive Strategy Dynamics, Wiley, Chichester

Wolstenholme E F. 1993 A Case Study in Community Care using Systems Thinking*, Journal of the Operational Research Society*, Vol. 44 No. 9, September, pp 925-934.

Wolstenholme EF. 1996. A Management Flight Simulator for Community Care, In *Enhancing Decision Making in the NHS*, Ed. S. Cropper, Open University Press, Milton Keynes

Wolstenholme E F. 1999. A Patient Flow Perspective of UK Health Service, *System Dynamics Review.* Vol. 15, no. 3, 253-273.

Wolstenholme E F Repper D Monk D Todd D McKelvie D (2006) Reforming Mental Health Services in the UK - Using System Dynamics to support the Design and Implementation of a Stepped Care approach to Depression in North West England. Proceedings of the 2006 System Dynamics Conference, Nijmegen, Netherlands

Wolstenholme E F Monk D, McKelvie D 2007, 'Influencing and Interpreting Health and Social Care Policy in the UK' in Complex Decision Making: Theory and Practice Ed. Qudrat-Ullah H Spector M J & Davidsen P I. Springer-Verlag, US.

Wolstenholme E F, Monk D, McKelvie D, Todd D, Arnold A 2007,Coping but not Coping in Health and Social Care - masking the reality of running organisations beyond safe design capacity. SDR, Vol, 23. Number 4 Winter 2007 pp371-389.