Framing Elements for Data Collection in Army Field Environments – Problem Structuring for Acquisition of the Right Data Right

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Abstract: Good Problem Structuring Methods (PSM) practice involves the use of agreed methods within an appropriate study environment that ensures sound process is applied in a holistic manner. This is particularly valuable where the Operations Research (OR) issue relates to an Ackoff problem or mess and where there will be different viewpoints, value sets, perceptions and positions. Many Australian Army studies fall into this category. Despite the nature of such complicated issues, progress on such considerations as equipment acquisition or improved procedures must still be made. In our view, partnership between the client (the "problem" owner) and the analytical community is key to this process. Typically the study owner would engage the Operations Researchers to develop an agreed analytical campaign of which Army field data collection would be an integral part.

In this paper we investigated if development of an agreed trial data collection plan would be amenable to such a "soft" OR approach. The notion here is that if a set of "invisibles" relating to gaining an understanding of the system of study as a whole are achieved, then the actual process of formulating a field data collection plan becomes relatively straightforward and more likely to fulfil the study owners' needs. The challenge in this case is twofold – knowing what data to collect ("the right data") and how to collect it ("the data right"). In this paper we describe our experiences in developing a data acquisition model. We detail how an agreed analytical data acquisition campaign can be designed through an appreciation of a set of *framing elements*: system understanding, stakeholder needs, analyst needs and data collection opportunities.

Adherence to this protocol means the next stage of actual identification of the key discriminating features (data) and a field data collection plan already include the twin PSM goals of a credible process and delivering a usable product. Inherent to the process are agreement of a study plan and definition of the roles and responsibilities of the study sponsor and the analysts. This paper describes how the initial framing elements can be used as a basis for developing a working model of the system, identification of the critical features and shared data collection plan which focusses attention on the discriminating factors. This data collection plan becomes part of the overall analytical study and thus contributes to providing credible, auditable and transparent insights to address the overall study question. While this paper is based on experience with Army, the concept should be applicable to other military domains.

Because of the adherence to a sound plan, the study owner can have confidence that the credibility of the process will provide protection from unhelpful criticism by other parties. It is our belief that there is a significant gap in the literature, and that papers such as this one, will help develop a Code of Best Practice for trial data collection.

Keywords: *Data collection, problem structuring, Defence*

1. INTRODUCTION

Good problem structuring practice (NATO RTO SAS-087, 2012a) involves the use of agreed methods within an appropriate study environment that ensures sound process is applied in a holistic manner. For instance, the established Problem Structuring Methods (PSM) (Ackermann, 2012, Mingers, 2011, Rosenhead, 2006, White, 2009) embedded within Soft Systems Methodology, Strategic Options Development and Analysis and Strategic Choice Analysis are enhanced through inclusion of such things as workshops and interviews where stakeholder goals, interests, values and beliefs will be shared and used to form the context of the study. Such aspects also increase the credibility of the study through exposure to interested parties prior to the final report and also to the likely acceptability through the active involvement of stakeholders. At the same time it is important to recognise that these "invisibles" (Ch 8 in (NATO RTO SAS-087, 2012a) need a concrete element that is a fixed and agreed part of the study process. For instance it has been proposed that a "substrate" model (Curtis, Rajesh and Moon, submitted for publication) can be treated as a "transitional object" (as reported in (Franco and Rouwette, 2011)) to support the process. Such a model would complement the soft OR process and provide a template on which to base the analytical study. Given this notion of a common reference product and our interest in data collection in difficult environments (Curtis, Rees and Hobbs, 2013, Hobbs and Curtis, 2011, Rees, Lush and Stanton, 2009) we looked to see if the development of a shared data collection plan could also be achieved using this model.

Advice on equipment acquisition or doctrine development involves more than just technical evaluation in a laboratory setting. Instead, the emphasis needs to be on operational usage in a field environment which thus introduces a whole range of additional features such as consideration of the environment, the operators and concurrency. Our continuing issue is that we need to make best use of exercise (Curtis, Rees and Hobbs, 2013) or experiment/trial (Hobbs and Curtis, 2011) opportunities to provide data to populate models, provide insights into the relative merits of acquisition options or to explore tactics, techniques and procedures. The issues are twofold. First we need to understand the system under investigation, identify the goals of the study, determine what data is required and second to propose a collection regime. Of course, the imitations of suitable events (eg trials) mean that the first stage is not treated in isolation and likely opportunities need to be taken into account in the overall study campaign. In passing, we note that we have a very broad interpretation of "data" – it could include participants' subjective personal observations, speculation by subject matter advisers or objective quantitative material (Hobbs and Curtis, 2011).

It is our opinion that a significant gap in the literature lies in the area of effective and efficient preparation for data collection in field environments. While common practice is to include a data element in any study, it is in the coherence and targetting of the collection plan where we believe a sound and documented procedure should be proposed. Thus, the needs of the study owners and operators of the field activity (whether trial, exercise or experiment, see later), and the analysts need to be incorporated. This may be compared with a simple (and sterile) process of problem definition, model formulation, data collection, interpretation and implementation that may be found in an Operations Research text book. This approach would be appropriate if the issues are well understood and it would be more apparent what data to collect at the onset. In contrast, for less well defined Ackoff problems and messes (Ackoff, 1979, NATO RTO SAS-087, 2012a), data collection is an integral part of analysis and the identification of what data to collect should become part of the problem structuring process. To some extent, the shared data collection plan becomes an area of stability to be contrasted with the soft OR treatment of a mess. We also note that the problem structuring phase can be split into two (Curtis, Dortmans and Ciuk, 2006): identification of how to do the "right" problem, and once having discovered this, how to do the study "right". In data collection terms, this becomes how to identify the "right" data needs in the context of the study, and how it might be collected "right". Together these aspects should lead to development of a product (the shared data collection plan) that is agreed by all parties and is seen as a fixed element which governs the data aspects of the overall study.

In this paper, we discuss the steps required to arrive at the "shared data collection plan". In particular we discuss how four framing elements relating to: 1) understanding the stakeholders' needs, 2) the Army system under study, 3) the dictates of the analytical procedures (analyst needs) and 4) the opportunities (and limitations) of Army field events come together to produce an agreed and common way-forward to guide both data collection and provide support to the overall study (Figure 1). Taken together these provide the reference material to "collecting the right data right". As will be seen there is a contrast to the guiding principles inherent to the framing elements with the more tangible data collection process.

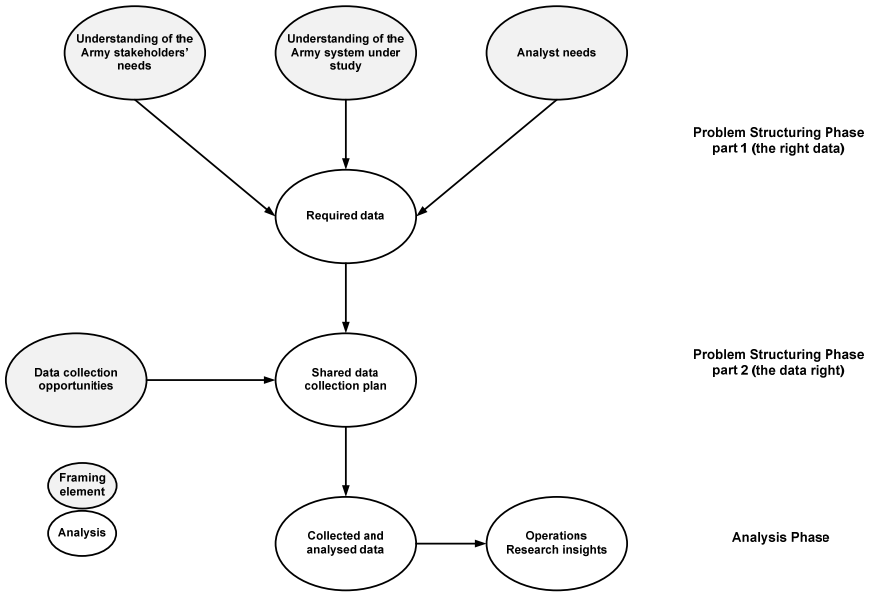

Figure 1: Schematic of a Problem Structuring Method Approach to Data Collection

2. THE OVERALL STUDY PLAN

Data collection is part of the overall study plan directed towards a decision being taken by someone about something, such as an acquisition. Ackoff problems and messes can be characterised by the observation that it is not possible for a decision maker to make a purely objective call on which choice to make. Instead judgement should be used to combine subjective and objective data relating to the several aspects that need to be considered (NATO RTO SAS-087, 2012a). The confounding variables in such studies include the following.

- A complicated system involving people, technology, terrain, operational environments, day-to-day variability and a changeable threat
- A variety of stakeholders with different goals and positions
- An inability to cover the entire issue space
- Incomplete initial understanding of the system and data requirements
- Data will be sparse and only partially available through the normal collection procedures of trials, exercises, interviews and logs
- Data will be a mix of objective measurement, subjective opinions and informed speculation
- Trade-offs and compromises will exist
- Statistics will play only a minor role. The variables are numerous, data points will be few and experimental design flaws, such as learning by trial participants, will be apparent
- Judgement will play a major role
- The need for a senior decision maker to have the freedom to make a decision, not to be presented with a straitjacket

The consequence of these statements is that both the overall study and data collection become activities shared between the study customer, the analysts and where possible, the other stakeholders, all conducted within a sound, soft (judgement-based) OR approach. The objective of such an approach is to provide the decision makers with fit-for-purpose information that is credible and which protects the study sponsor from destructive criticism (NATO RTO SAS-087, 2012b).

As described above, if the object of the study is to support an acquisition then the item of interest is intended to be used in some way or other. Thus the study should include analysis of actual usage as well as any theoretical calculations or the use of wargames. Further, the system under study should be "the object used in an operational context" not just technical details of "the object" (though this would be an important aspect). The consequence of this is the further "softness" is introduced, such as to describe features of capability,

weightings, trade-offs and extrapolation across a likely set of use cases. In addition, the system becomes amenable to a variety of modelling approaches, for instance based on structures or actions (Bowley, et al., 1998). As will be seen it also demands that the human aspects of usage must be included in the data collection phase.

The format of the rest of this paper is as follows. First, we discuss the four framing elements (Figure 1) which to us describe the methodology of the soft OR context to the study (sections 3 to 6). Then we show how this approach guides the development of the study itself (sections 7 and 8) and thus leads to a concrete action plan which will include both trial and non-trials elements. It might be noted that the actual field aspects of the data collection plan are not discussed until section 6. While the order of presentation of the four framing elements is arbitrary (it is not a linear process) it was felt appropriate to provide sufficient context of the overall study before detail on the data collection was discussed.

3. UNDERSTANDING OF THE SYSTEM UNDER STUDY

The critical features of the initial problem structuring phase (Figure 1) are to gain consensus and a common understanding of the issues among the stakeholder and analysts. Broadly this is a learning activity that lends confidence that the "right problem" is being addressed. The key components are listed below and all can be considered common features of the framing elements.

- Scope and nature of the system
- Nature of the problematic situation and the objectives of the study (ie the question)
- Working models
- Assumptions
- Terminology
- Broad analytic strategy

There are several PSMs available that may be applicable to such studies ((Pidd, 2003, Rosenhead and Mingers, 2002)). For the purposes of this we note that PSMs can have two roles: for understanding (this section) and for investigation (section 7). In another dimension we note that PSMs also provide both product and process (Checkland and Winter, 2006).

Whatever methodology is used, the fundamental goal of the initial phase is to position the analyst so that decisive and relevant actions may be taken, in this case for the data collection in the field. Given that the system under study involves an activity then it is appropriate for instance to consider an operation conducted within an environment for a purpose. Rich pictures are valuable in this respect (Bell and Morse, 2013). Other SSM elements such as CATWOE elements and root definitions allow a structured construction of a shared understanding of the system. Understanding is then complemented by an activity model of the action under investigation, such as through the use of IDEF0 diagrams. Such models allow identification of discrete actions, potential issues, the effect of context, ownership of stages etc to be identified.

Of course, the unique demands of any study mean that it is of little value to dictate a specific course of action, or prescribe the use of certain tools or methods. Instead we will describe a generic process that illustrates the principles. Thus for instance a concept map (Journey Making) may substitute for a rich picture (Soft System Methodology) in portraying a military action. It should, however, be stressed that the nature of best practice in the use of PSM is to combine product (eg a rich picture) with sound process (eg verification of the rich picture by SMEs) (NATO RTO SAS-097, 2012a).

4. STAKEHOLDER NEEDS

Soft OR should be seen more in terms of a partnership rather a provider/requester relationship. For soft studies the stakeholders are diverse and not limited to the study sponsor. In addition, inclusion needs to be made of the study client (who may be different to the sponsor), the decision makers and the end users (NATO RTO SAS-087, 2012a). All will have specific needs, but these can be summarised in these four areas.

- Visibility and understanding of the process
- Confidence that their position is being represented
- Opportunity to provide specialised input

- The ability to provide informed guidance on the form and likely usage of the final product (the study report)

To achieve these goals two actions needs to be followed. First the analyst will seek approval of the study plan. Such a plan is likely to be written after the initial exploration of the problematic situation and may well only be possible after discussions (including workshops) with the stakeholder groups. This approval ensures that the study client is aware of what will be delivered at the analysis and how confident he/she will be that the work will withstand potential criticism within the wider decision making circles. The level of detail in the plan will vary of course and is likely to require revision during the course of the study. Second, the stakeholders may be involved in the longer term trajectory of the study plan, for instance through attending workshops, providing data or subject matter experts and commenting on progress reports. Part of this process will be the agreed assumptions that need to be included. Soft OR studies will invariably involve the use of judgemental issues such as methods to describe "ility" terms (eg lethality), identification of weightings or opinions on priorities. While the analyst will provide rigour to these terms, the credibility will be significantly reduced without stakeholder involvement.

5. ANALYST NEEDS

In several ways the analyst's needs mirror that of the stakeholders. Agreement of the study plan means that the analyst can develop an analytic strategy without major changes imposed along the way. This is especially critical if the study is time or resource limited. Similarly, data will be relatively free from challenge if the provenance is agreed. Of course this does not mean that changes cannot be accommodated as a process will have been introduced as part of the partnership strategy. Nor should the analyst expect that the study will not be challenged, particularly by a stakeholder other than the study sponsor. The nature of soft OR is to inform debate not deliver definitive facts.

The second key aspect is that studies are usually dependent on access to documented material, expertise or opportunities to collect data. An initial commitment to provide this helps the analyst to design the study accordingly. For instance if data is not available then a parametric study may be needed. Similarly, if accesses to SMEs or opportunities to observe field events are guaranteed then the fine details of study can be proposed earlier. Access to SMEs also leads to an enhanced ability to formulate the issues, seek endorsement of models and to provide informed participation in the study activities (eg a workshop to determine use cases or priorities). Indeed, workshops can be seen as research activities not just information gathering activities (Shaw, 2006).

Finally the analyst needs to guarantee the rigour of the overall strategy, the application of techniques and the analysis and interpretation. For soft OR a case needs to be made based along the lines of the following.

- What are the needs of the study?
- What methodologies and methods have been used previously (and have been reported)?
- Why was the present approach taken?

Analytical credibility is maintained if these questions are addressed as threats to any study may come from external peer review and scrutiny. The methods of soft OR may not be apparent, particularly to decision makers, and thus justification is a key element.

6. DATA COLLECTION OPPORTUNITES

The final framing element comes from the opportunities for field data collection. These can be conveniently grouped into three: experiments, trials and exercises, with decreasing levels of analyst control. There are also differing objectives with experiments tending to be more exploratory (what would happen if you had this equipment?), trials usually directed towards learning something (compare options A and B) and exercises used to practice an operation. In the context of the present paper, we are more concerned with identifying design principles leading to detailed plans for trials. While exercises may be the source of more realism (Curtis, Rees and Hobbs, 2013) there are far less opportunities to collect data in a planned manner. Both the experiment and trial environments may, however, be used as sources of material to develop and populate models (as described in section 3).

Trials may be conducted at a variety of levels and may include several aspects with an exemplar shown in Figure 2. In this example, we show how specific actions may be looked at (eg the aiming procedure in using a rifle) up to the full vignette (eg how a new aiming device would affect the outcome of the engagement). Such a vignette would need to be consistent with the material decided in section 3 and this issue of testability needs to be considered at that stage. Environmental variables, also identified at this phase, might include the red force threat, the terrain or visibility. There may also be different foci, arising from the System Instantiation Comparison Method (SICM) (see section 7.2) or the overall study strategy and, for instance, specific observations may be made on the technical capability and the human factors aspects of useability.

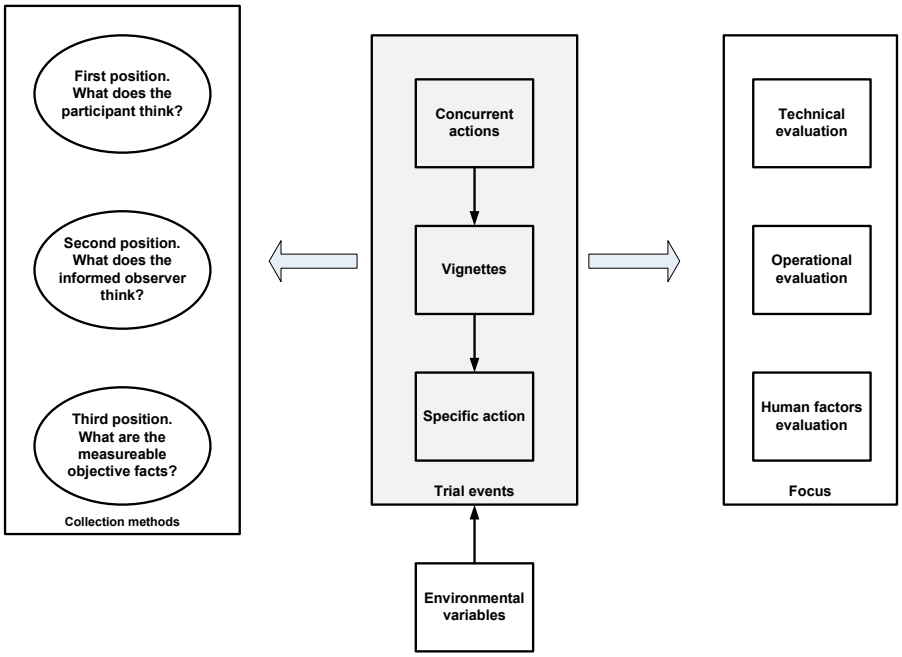

Figure 2: Typical elements of a field data collection activity (eg a trial)

Finally we note that as we are looking at a complicated system with many degrees of freedom (eg operators, environments, missions), a trap to fall in is to rely solely on objectively measured data. While such material is superficially attractive in terms of statistics it will suffer from many flaws such as operator learning and variability, and providing an insight into only a small part of the overall landscape. The issue then becomes one of credibility (Rees, to be published) and what is acceptable to the decision makers. To this end we note an alternative – go for breadth rather than depth. We have used the notion of three perceptual positions (LHS of Figure 2) that allows other insights (Hobbs and Curtis, 2011). These include questionnaires and interviews of the participants (first position) and making full use of knowledgeable subject matter advisers (SMAs) as to the generalisability of specific observations, providing informed advice about minor changes in procedure applicable to a new device, and providing "if I was in their shoes" speculation etc (second position). These complement the third position objective measurements and lead to a much richer data source for the study.

7. REQUIRED DATA

After the application of the four framing elements we are now in a position to derive an agreed program of work, of which some will involve the collection of data in the field. Broadly, we propose these three aspects to identify the data needs of the study.

- Further exploration of the space leading to a working model of the system
- Identification of the critical discriminating features
- A data collection plan derived from the gap between existing and required knowledge and opportunities for field access

7.1 A working model of the system

Again there are several possible methods, most (if not all) of which will involve the use of a methodology, methods, models and interactive discussions with the client and subject matter experts to develop a working

model of the system. In our experience, one method and model is rarely enough to gain the required understanding of the system or to identify those features that should be relevant to the overall study. Thus, different viewpoints need to be sought. Again the differences with a harder OR approach need to be stressed. One output of a problem structuring activity is a list of issues to learn something about the system under study, and for this reason it is perfectly acceptable to express the same or similar items in more than one way. This would contrast with an expected value approach where the system is reduced to discrete components and for which "double dipping" might be questioned if the same issue appears under two separate headings.

It is commonly said (attributable to Box) that "all models are wrong but some are useful" and thus the use made of the model should be considered when undertaking this stage. Our feeling is that these four elements must be addressed.

- Is it endorsed by all stakeholders as fit for purpose?
- Can it be used to discover pertinent features?
- Can it be used to identify and agree weightings?
- Is it compatible with the notion of vignettes that allow exploration of typical use cases?

We find that an activity based model, such as IDEF0 based on sequential actions, is especially useful in gaining acceptance of stakeholders and in portraying the elements in a manner that is familiar to all stakeholders (Curtis, Dortmans and Ciuk, 2006) particularly when addressing a reasonably well understand system (Curtis, Rajesh and Moon, submitted for publication). Sources of such models could be through field observation or via reading of doctrine. Whether such a model is prepared by the analysts or by the analysts in collaboration with Army practitioners will depend on the situation though at some stage it will need to be endorsed by subject matter experts (SMEs).

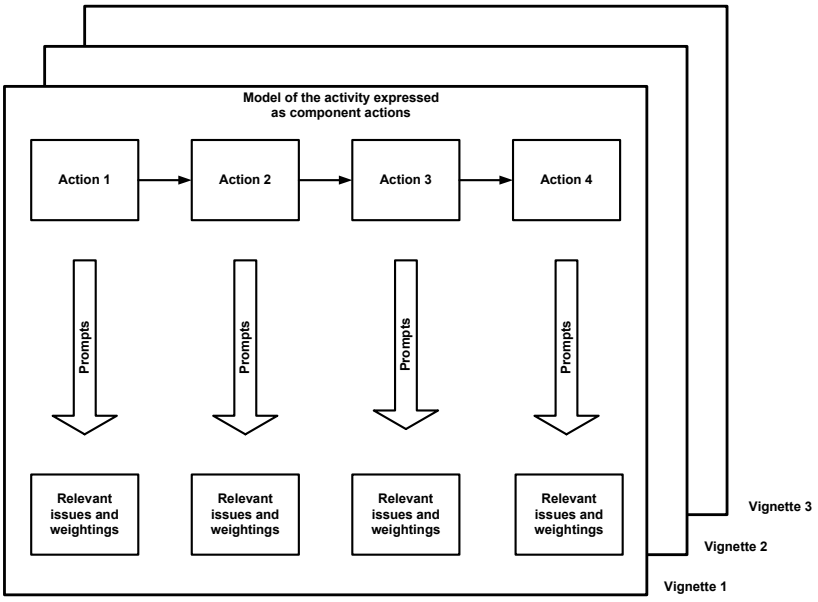

Figure 3: Schematic showing a substrate model (of the activity under study) as a source of issues across three vignettes

Actual acceptance of the model is probably best achieved through practical application for instance in a seminar wargame (or "Bunch Of Guys Sitting Around a Table", BOGSAT (Rubel, 2006)). Thus analysts and Army experts would mentally play through the situation and identify issues of concern, including levels of importance or deficiency, as they arose. If this is structured, for instance through the use of prompts Figure 3 then demonstrable rigour is introduced particularly if a skilled and impartial facilitator was used (Ch 4 in (NATO RTO SAS-087, 2012a)). Typical prompts might be the use of core skills (Curtis, Dortmans and Ciuk, 2006) or adopting a pessimistic analysis (why wouldn't it work?) approach (Curtis, 2000). An agreed set of use cases (tactical vignettes) would allow the study to be focussed on "real life" examples (Murray, Curtis and Pincombe, 2012). Derivation of the vignette set would include the following considerations.

- The issues of concern were all covered within the vignette set
- Specific (required) combinations of the issues were represented

- The vignettes were sufficiently different to allow discrimination to be made about candidate equipment options

Such model development and informed usage imposes considerable requirements on the study owner and stakeholder group. The reasons are twofold. First, expertise must be provided in the form of users or trainers (preferably both) to advise on how the action is done or could be done under a variety of situations. The second is that the analyst seeks credibility through involvement by, and thus tacit acceptance of the stakeholder group.

7.2 Critical features

The common PSM techniques described in the introduction can be applied to discovery of the critical features to a greater or lesser extent. One method that we have found useful, and which was based on Soft Systems Methodology is that SICM (Rees and Bowden, 2007)). The procedure (Table 1, Figure 4) involves first defining a System, identifying an Operational Requirement and using this develop further understanding through a set of different aspects. The Operational Requirement provides a task-based context and can be expressed in different ways according to the decision being informed; this is particularly so in military systems which may provide a number of capabilities.

Table 1: Interrogative form of the System Instantiation Comparison Method (SICM)

Element	Guiding question
Operational Requirement	How does the system as whole attempt to influence the external environment (ie outside of the system boundary)?
Critical Component	What is it that the whole system needs to achieve the operational requirement?
System Functions	How does the system use the critical components to meet its operational requirement?
Enablers	How does the system use the available resources to meet the operational requirement?

The System Definition, particularly the System Boundaries, provides an initial basis for answering the four questions of SICM. The system model (within the inner box in Figure 4) may be refined iteratively as understanding of the task develops. The SICM framework does not prescribe any particular system model; the decision being informed, the nature of the system and time available, among other factors, should guide the selection of model appropriate to the task. For instance, the BOGSAT approach described above with a sequential analysis model may be appropriate. Examination of the Critical Components may lead to the identification of acceptable metrics that the system needs to achieve. Again the involvement of SME is a pre-requisite for success in this stage.

A key aspect of this process, as it is applied in this paper, is the System Boundary. Discussion between the stakeholders and the analysts will lead to a decision on what is to be considered and what is not. This is a potential source of conflict though it is usually accepted that the study owner is responsible for the assumptions though the analyst is free to challenge them. Short timescales or strategic constraints may also assist in limiting the scope of the study.

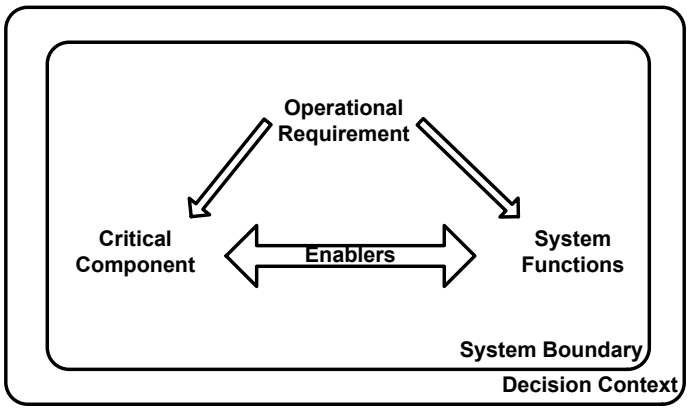

Figure 4: Schematic of the System Instantiation Comparison Method (SICM) (redrawn from (Rees and Stanton, submitted))

7.3 The data collection plan

The final stage is the merging of the data collection needs (section 7.2) with the collection opportunities (section 4) as described in Figure 2 based on the System InvestiGation through Navigation, Understanding and Perspective (SIGNUP) model. Our belief is that the process proposed in Figure 5 is iterative and that a practical way forward is to develop an initial working plan for data collection based on the Operational Requirements, Critical Components (from SICM, Figure 4) and the constraints imposed by a sound understanding of the desired capability (section 7.1).

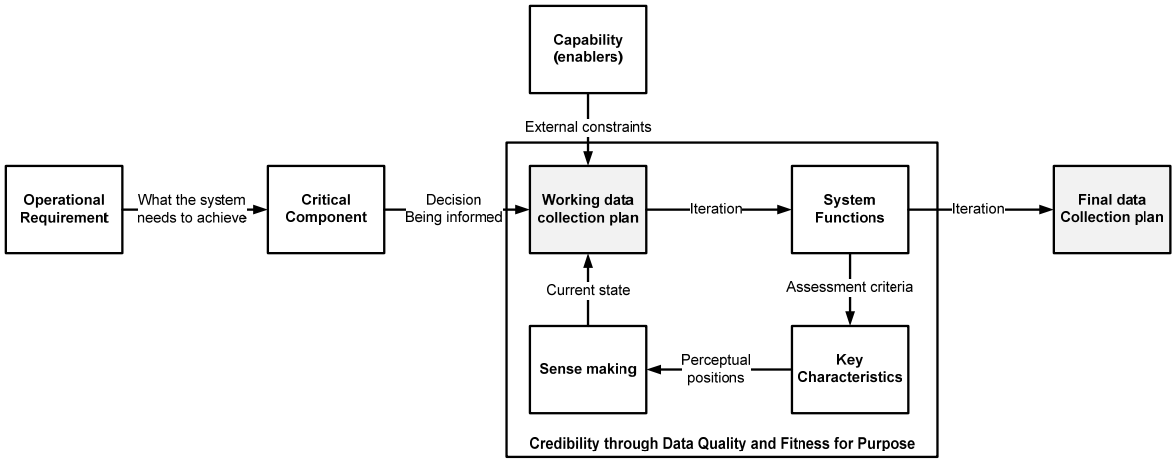

Figure 5: System InvestiGation through Navigation, Understanding and Perspective (SIGNUP)

The data collection plan is then developed by identification of the Key Characteristics which describe the Critical Component in the particular cases defined by combinations of the Systems Functions and Enablers. In simple terms these are the key metrics to examine. Further information is gained by detailed examination of the system model (section 7.1) such as through the technique shown in Figure 3 and this helps to identify which of the Key Characteristics are likely to be the source of discrimination, such as between equipment options. Knowledge of potential trial opportunities and analyst experience of previous field activities (Figure 2) allow a synthesis, or "sense making" to be made of the situation. This "sense making" involves the use of an individual's past experiences in similar situations to help in understanding the current one (Louis, 1980).

The process of refinement can be as detailed as time or resources allow. The critical feature is that any collection plan must fulfil the data credibility requirements of stakeholders and must be "fit for purpose". This last term ensures that reality dictates the final form of the data collection plan; there is a consensus that it conforms with the overall needs of the study, all stakeholders contribute and agree to its preparation and it must be achievable. Both the analyst and stakeholder group must therefore contribute to this phase. From past experience, we have also found that it is important to involve trial participants prior to any field activity (Curtis, Rees and Hobbs, 2013) and such involvement in the SIGNUP process would serve this goal.

To some extent the process shown in Figure 5 is a microcosm of the entire study philosophy espoused in this paper. Adherence to a sound procedure gives auditability and transparency to the process and product. In particular both the hard and soft aspects to the study are acknowledged. While the protocol may seem extensive and time-consuming, our experience is that it can be accomplished in a few days at the earliest phases of a study carrying out this work also contributes to a max rapid attainment of a system understanding and potential effectiveness sand efficiencies in data collection.

8. DISCUSSION

This paper shows how due attention to the framing elements of: system understanding, stakeholder needs, analyst needs and data collection opportunities will lead to both a sound product (the data collection plan) and a transparent process. The wider view of the analytic study (as opposed to just the trial) shows how considerable value adding occurs in identifying both the methodology and the roles and responsibilities of the study owners/stakeholders and analysts (Table 2). As can be seen while most actions are initiated and led by the analysts, the study owner must commit considerable expertise and the use of facilities/resources to achieve credible outputs and outcomes.

Table 2: Roles and responsibilities of the study owner and the analysts for a typical data collection trial

Issue	Study owner/stakeholders	Analysts
Problem enunciation and overall strategy	Stakeholders made available for consultation	**Initiated and developed using specialist skill**
Initial study plan	Agree as fit for purpose	**Prepared according to analytical rules and procedures**
Model formulation	Provide subject matter expertise and acceptance	**Initiated and developed using specialist skill**
Model manipulation	Provide subject matter expertise	**Initiated and conducted through (eg) workshop. Assign impartial facilitator and record results**
Trials opportunities	**Advise on availability of sites, personnel and equipment**	Use material to guide trial planning phase
Data needs identification	Provide subject matter expertise	**Lead using fit for purpose models and rigorous process**
Trial planning	Provide subject matter expertise	**Lead and conduct activity in (eg) a workshop. Assign impartial facilitator and record results. Prepare trials plan**
Trial conduct	**Provide subject matter advisers to comment on 2nd position data and arrange access to participants (1st position)**	**Assign analysts and prepare 1st and 3rd position data collection instruments**
Interpret trials data in the light of the overall study		**Conducted using specialist skill**
Study report	Provide advice on formal format	**Written using specialist skill**

Note: the lead (or joint lead) agency is shown in bold

The actual process can be summarised as follows. The framing elements lead to a working understanding of the system and "what needs to be done" in the study. A convenient place to pause and seek study owner agreement is in preparation of a study plan (Figure 6) and this is probably best done after the four framing elements are completed. Then the stages described in section 7 can be applied to identification of the missing data and development of a plan (including trials) to gain the required material and complete the study.

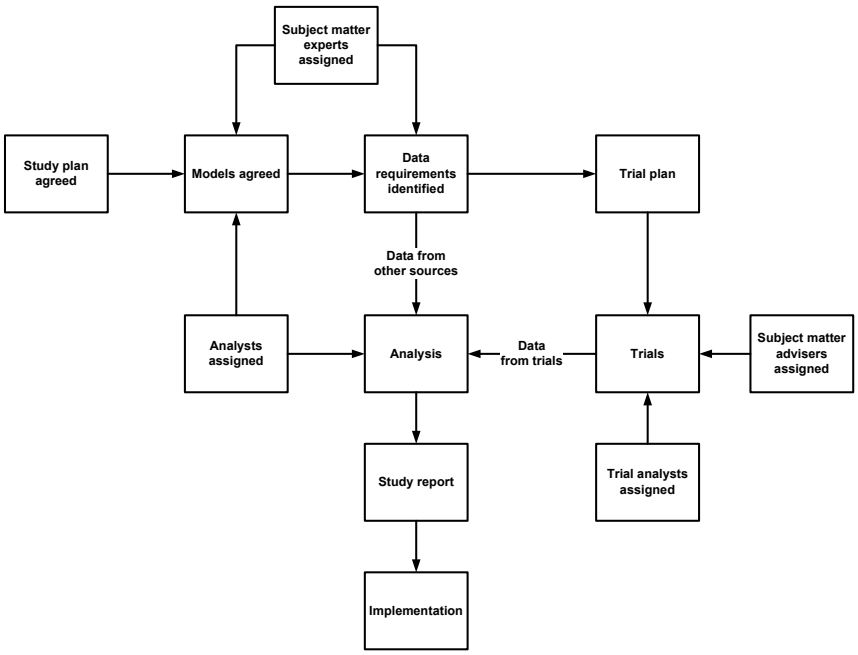

Figure 6: The position of the trial within an overall study

Finally, we note that there is only limited material in the literature about the steps necessary in developing a sound trial data collection plan. Such a plan has to strike a balance between practicality and credibility. The practical aspects are that given limited access to equipment, sites, trial personnel then the best use must be

made of scarce resources and opportunities. Credibility is achieved through engagement with the stakeholders and adherence to an established process and this will protect the study owner from unhelpful criticism (NATO RTO SAS-087, 2012b). With time it is hoped that the material reported in this paper will form the basis of a Code of Best Practice for trial data collection

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