Simplifying Managing Stakeholder Expectations using the Nine-System Model and the Holistic Thinking Perspectives

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Abstract. The problems of stakeholder management and requirements elicitation and elucidation are complex and sometimes the roles, responsibilities and areas of concern seem difficult to identify and integrate. This paper addresses those issues and describes a systemic and systematic way of simplifying stakeholder management and requirements elicitation and elucidation in a situational example using the:

- Holistic Thinking Perspectives (HTP) to identify stakeholders.
- Nine-System Model to sort stakeholders and identify their areas of concern in order to translate their expectations into system requirements.

The paper also introduces the concept of direct and indirect stakeholders in addition to internal and external stakeholders.

1. Introduction

This paper discusses how to manage stakeholder expectations using a combination of the Holistic Thinking Perspectives (HTP) (Kasser, 2013) to identify the stakeholders, and the Nine-System Model (Kasser and Zhao, 2014) to identify the stakeholders' areas of concern in the context of the pre-System Requirements Review (SRR) activities in the Multi-Satellite Operations Control Center (MSOCC) Data Switch Replacement Project (Kasser and Mirchandani, 2005). The paper:

- Summarizes stakeholder management in the literature.
- Summarizes the pertinent information about the MSOCC Data Switch Replacement Project from the HTPs to provide the situational example.
- Shows how the HTPs could be used to identify the stakeholders.
- Shows how the Nine-System Model could be used to identify the areas of concern of each stakeholder, and abstract out non-pertinent areas of concern.
- Discusses identifying the complete set of stakeholders and their areas of concern in the context of the MSOCC data switch replacement project.

2. The MSOCC Data Switch Replacement Project

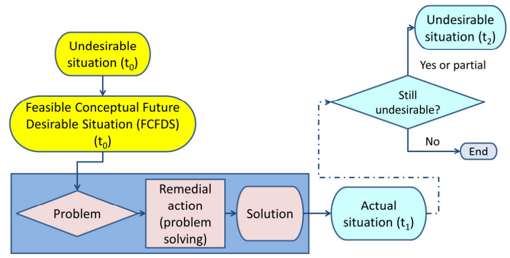

Figure 1 Holistic approach to managing problems and solutions

The MSOCC data switch replacement project (Kasser and Mirchandani, 2005) provides the context. The traditional systems engineering problem solving process in many instances begins with a statement of the problem. However, "*Problems do not present themselves as givens; they must be constructed by someone from problematic* [or undesirable[1]] *situations which are puzzling, troubling and uncertain*" (Schön, 1991). The holistic problem solving approach shown in Figure 1 takes this wider perspective and begins with an undesirable situation which first has to be converted to a Feasible Conceptual Future Desired Situation (FCFDS) and then into a solution system operating in its context, an actual situation. In the MSOCC situation:

- ***The undesirable situation*** is the perception that the MSOCC will not be able to cope with its anticipated future switching requirements coupled with some undesirable aspects of the current switching system that need to be eliminated.
- ***The Feasible Conceptual Future Desirable Situation*** (FCFDS) is an MSOCC that will be able to cope with its anticipated future switching requirements.
- ***The solution*** is an upgraded higher performance switch operating within the context of the FCFDS.
- ***The problem*** is how to manage stakeholder expectations to gain consensus on a plan to transition from the undesirable situation to the FCFDS.

The Nine-System Model (Kasser and Zhao, 2014) comprises nine situations, processes and socio-technical systems in a clearly defined interdependent manner, and each system may be used to identify a subset of the stakeholders and their area of concerns. The nine systems associated with the MSOCC data switch replacement project are:

S1. The undesirable or problematic ***situation.*** An MSOCC containing the perception that the existing NASCOM switch would not be able to cope with future anticipated switching needs coupled with the undesirable issues associated with the Send Timing (ST) signals perceived from the *Functional/Structural* perspectives and other minor undesirable issues not discussed herein.

S2. ***The process to create the FCFDS*** based on Hitchins' systems engineering process as shown in the first five blocks in Figure 2.

S3. The FCFDS that remedies the undesirable ***situation***; the MSOCC containing the MCSS.

S4. The ***process*** to plan the

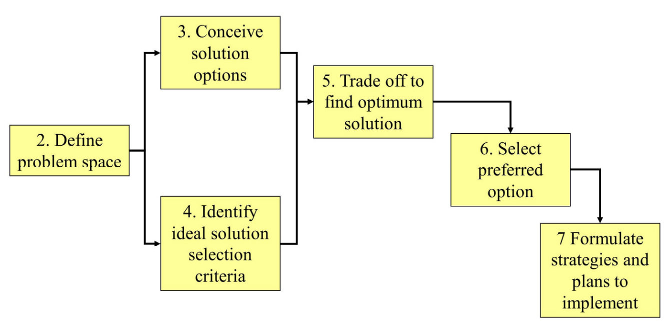

Figure 2 A systems engineering approach to problem solving (Hitchins, 2007)

[1] Author's insertion into quotation

transition from the *undesirable or problematic situation* (S1) to the FCFDS (S3). A task under the SEAS contract that would end at SRR. This is the task described in the original case study (Kasser and Mirchandani, 2005) and contains two parts[2]:

a. Determining the requirements for the MCSS (S6).
b. Determining the process to realize the transition (S5) because the integration of the MCSS into the MSOCC was non-trivial since the NASCOM switch could not be removed during the MCSS integration phase due to insufficient space in the MSOCC to hold both the NASCOM switch and the MCSS.

S5. The ***process*** to perform the transition from the *undesirable or problematic situation* (S1) to the *FCFDS* (S3) by providing the *solution system* (S6) according to the plan developed in the *planning process* (S4). A task to be assigned post SRR.

S6. The solution ***system*** that will operate within FCFDS: the MSOCC Communications Switching System (MCSS) and associated equipment integrated.

S7. The actual or created ***situation***: the MSOCC in its new configuration

S8. The process to determine that the realized solution remedies the evolved *undesirable situation*. The MCSS Acceptance Test after the transition process is complete.

S9. The ***organization***(s) containing the processes and providing the resources for the operation and maintenance of the processes. NASA, the SEAS and NMOS contractors.

Each of the nine systems must be viewed from each of the eight descriptive HTPs (Kasser, 2013) as appropriate. The Nine-System Model is not shown in a single figure, it is shown instead as perceptions from the following HTPs:

- ***The Functional perspective*** Figure 4, shows the relationships between the situations, systems and processes. The ***process*** to plan the transition from the *undesirable or problematic situation* (S1) to the FCFDS (S3) and the ***process*** to realize the transition from the *undesirable or problematic situation* (S1) to the *FCFDS* (S3), S4 and S5, constitute two parts of the system realization process.

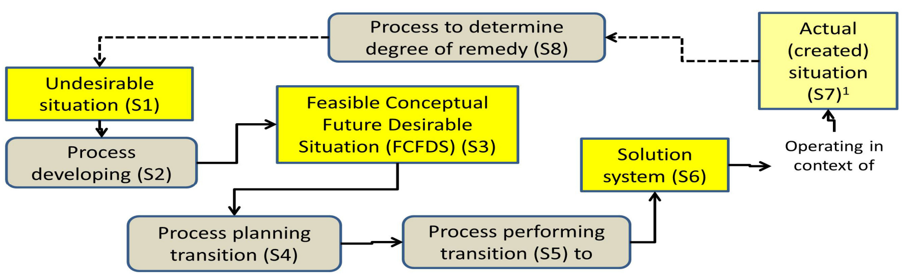

Figure 4 The nine-systems model (Functional perspective)

- ***The Structural perspective*** Figure 3, shows the hierarchical relationship between the process systems and the *solution system* with the organization(s) containing the process systems and *solution system*.

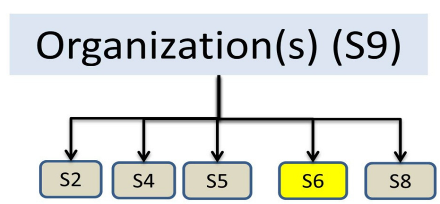

Figure 3 The nine-systems model (Structural perspective)

- ***The Temporal perspective*** Figure 5 shows how the nine systems relate in time.

[2] Note how these tasks map directly into the two problems stated in Section 2.8.

Perceive the pertinent information about the MSOCC and its stakeholders from the HTPs as follows.

2.1. Big Picture perspective

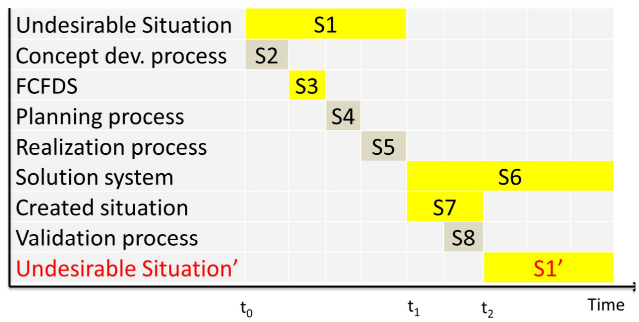

Figure 5 The nine-systems model (Temporal perspective)

In 1989, the National Aeronautics and Space Agency's (NASA) Goddard Space Flight Center (GSFC) Multi-Satellite Operations Control Center (MSOCC) was facing the problem of replacing the data switch that routed signals from multiple low earth orbit (LEO) satellites to data processing computers. At that time, the MSOCC was the major interface between the LEO data streams from the global satellite tracking network and the Telemetry Tracking and Control system at NASA's GSFC. There was minimal data capture and storage functionality in the ground stations and the NASA Communications Network (NASCOM). The MSOCC was supported by two somewhat overlapping contracts, the Systems Engineering and Services (SEAS) contract and the Network Maintenance and Operations Support (NMOS) contract.

2.2. Operational perspective

The MSOCC received and forwarded data in several scenarios documents in the concept of operations (CONOPS). The data streams from the LEO satellites contained data telemetered from onboard experiments and instruments. These data were supplied to Principal Investigators (PI) who would be very upset if they lost scientific data during the time period that the data switch was in transition. It was thus not acceptable to close down the MSOCC during the replacement of the NASCOM switch.

2.3. Functional perspective

The MSOCC used a switching system known as the NASCOM switch to route serial asynchronous digital data between NASCOM and the computer equipment within MSOCC and external facilities.

2.4. The Structural perspective

The *Structural* perspective is shown in Figure 6[3]. The NASCOM Switch shown as a single entity in Figure 6, really consisted of a number of subsystems including three separate switches controlled by a central Data Operations Control System (DOCS). The first switch connected some of the MSOCC equipment to the NASCOM lines and the second the remainder. The third switch handled connections between the Mission Planning Terminal (MPT), the Command Management Facility (CMF), the Deep Space Network (DSN), NASCOM and the Attached Shuttle Payload Center (ASPC). Each switch also contained a patch panel to allow the NASCOM lines to be

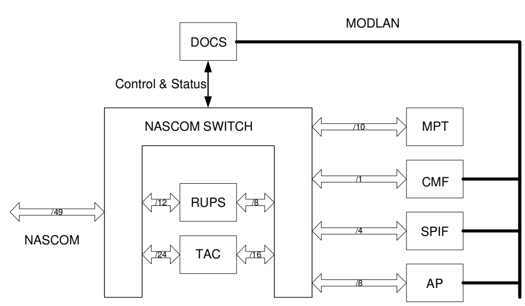

Figure 6 The MSOCC

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[3] Since the functions are mapped into the physical units, the same figure can be used to represent both perspectives.

tested, patched to another circuit, or looped back to NASCOM or to MSOCC equipment. To complicate the situation:

1. The MSOCC forward link equipment sourcing uplink data to the LEO spacecraft did not generate the Send Timing (ST) signals (synchronizing pulses) to accompany the data. As a result, ST for this data was generated by a timing signal generator called a Clock Buffer located in each switch.
2. The NASCOM switch could not be removed during the MCSS integration phase due to insufficient space in the MSOCC to hold both the NASCOM switch and the MCSS.

2.5. Quantitative Perspective

The three switches were identical, each having a capacity of 62 full duplex 1.544 MHz serial asynchronous RS-422A digital data ports. The switches had been custom-designed for the MSOCC and were not commercially available. Crossovers were used to connect Switch numbers 1 and 2. Switch number 3 was independent of the other two. As a result of using ports for crossovers, only 112 duplex connections could be made through the first two switches.

2.6. Temporal perspective

Each of the three NASCOM switches had been added to the MSOCC over time in an incremental upgrade manner as the requirements for additional communications ports exceeded the number of ports available at the time the upgrade took place.

As a result of deficiencies perceived from the *Quantitative* perspective the need for a single switch to replace the three switches was recognized. The new switch system was to be named the MCSS.

2.7. Continuum perspective

The *Continuum* perspective identified a number of differences including:

- ***Differences in the stakeholder interests***. Different stakeholders have different areas of concern. As such, not every stakeholder is interested in all the aspects of the MCSS replacement project.
- ***Differences between stakeholders and customers***. While the stakeholders may levy requirements on the MCSS, the customer[4] is the entity that funds the realization of those requirements. Consequently, the customer makes the decision to accept or reject requirements levelled by the stakeholders.
- ***Differences between the stakeholder communications and control interfaces***. The communications interface passes information about stakeholder cares, concerns and needs. The control or contractual information flows from the stakeholders to the customer and then to the contractor as shown in Figure 7. In this instance, the figure also provides information from the *Quantitative* perspective by using the size of the box to roughly represent the importance/influence of the stakeholder which can be used to prioritize the impact of the stakeholder on the project by adjusting the weighting on the decisions accordingly.

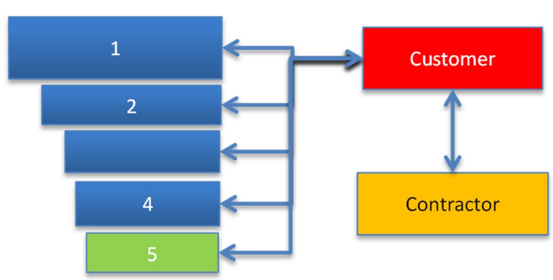

Figure 7 Contractual interface

[4] The customer was the NASA GSFC Associate Technical Representative (ATR) known as the Contracting Officer's Technical Representation (COTR) in other agencies.

- ***Difference between "no loss of data" and "no downtime" during the transition***. Recognition of this difference allows for the switching system to be taken off-line for short periods of time with due prior notice.

2.8. Generic Perspective

The *Generic* perspective indicates that the process to address the stakeholders' areas of concern and convert stakeholder's requests to requirements[5] is an instance of the change management process. In the change management process, requests for changes are made because something is undesirable due to the system:

1. Not doing what it should be doing, because:
    a. Something is broken
    b. Something does not have capability any more (it is overloaded)
2. Not doing something it could be doing.
3. Doing something, but not as well as it could be doing it.
4. Doing something it should not be doing.

The *Functional* perspective of the change management process shown in Figure 8 consists of the following activities:

1. Convert the stakeholder area of concern into a requirement/change request.
2. Assign an identification (ID) number to the requirement/change request.
3. Prioritize the requirement request with respect to the other requirement/change requests.
4. Determine if a contradiction exists between the requirement/change requests and existing accepted requirements/changes.
5. Perform an impact assessment which must:
    - Estimate the cost/schedule to implement the requirement/change request[6].
    - Determine the cost/schedule drivers – the factors that are responsible for the greatest part of the cost/schedule implementing the requirement/change.
    - Perform a sensitivity analysis on the cost/schedule drivers.
    - Determine if the high cost/schedule drivers are really necessary and how much negotiating the requirement/change request with stakeholders can make modifications to the high cost/schedule drivers based on the results of the sensitivity analysis.

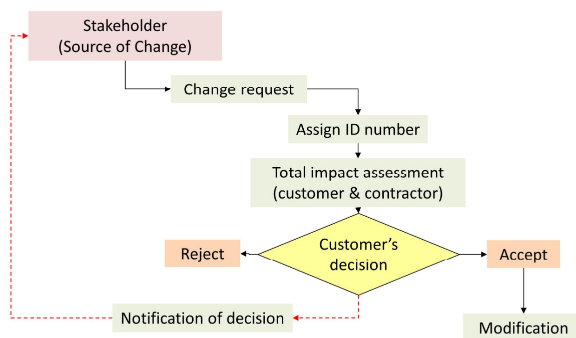

Figure 8 Functional view of the generic change management process

[5] The term 'request for requirement' is used because the stakeholder's requests must not become requirements until the customer has agreed to accept the request and fund the realization of the request.
[6] In this pre-SRR situation, there is no need to determine the cost and schedule for every requirement. Applying the quantitative perspective in the form of the Pareto principle, it can be perceived that the cost and schedule impact only needs to be determined for the most expensive and longest time to realize requests (Hari, Shoval and Kasser, 2008).

6. Make the customer's decision to accept, accept with modifications, or reject the request.
7. Notify the stakeholder of the decision.
8. Document the decision(s) in the requirement/change repository.
9. If the requirement/change request is accepted, allocate the implementation to a specific future version of the system, modifying the appropriate documentation appropriately.

2.9. Scientific perspective

After examining the situation from the eight descriptive HTPs, the conclusion was that the problem of how to transition the MSOCC from the undesirable situation to the FCFDS could be split into the following two well-structured problems, each having its own and shared stakeholders:

1. Determine the requirements for the MCSS; a well-structured non-complex problem since the CONOPS for S3 will be an upgraded version of the existing CONOPS for S1; as is common in an upgrade situation (*Generic* perspective).
2. Convert the stakeholder plurality of opinions on the transition from the existing switch to the replacement switch to a consensus on an approach. This was a well-structured complex problem with a prime directive of "no loss of satellite data" during the transition.

The problematic or uncertain situation posed a well-structured problem, namely:

1. There were only seven pertinent systems since S2 had been completed, and the activities were taking place in S4.
2. The CONOPS in the FCFDS (S3) was almost identical to that in the original undesirable situation (S1):
   - This is standard in an upgrade situation (Generic perspective).
   - The requirements for the MCSS (S6) were based on the anticipated number of input data streams and data processing equipment in the FCFDS. A quick check of several potential switch vendors identified COTS switches that could meet the MCSS requirements for the numbers of inputs and outputs at a price that was well-within the budget. This removed the uncertainty associated with S6
   - The uncertainty was restricted to the transition plan (S5).
   - The remaining complexity was abstracted out and the project just needed to focus on gaining a consensus on S5.

3. Stakeholder management in the literature

Given the problem of managing the stakeholder expectations in the MSOCC Data Switch Replacement Project, the first activity was to research the literature to determine how other projects managed their stakeholders. The literature published on the Internet is full of helpful advice on how to manage stakeholders with comments such as:

- "*Stakeholder management is the process of managing the expectation of anyone that has an interest in a project or will be effected by its deliverables or outputs*" (Project Smart, 2013).

Figure 9 Stakeholder circles (Recklies, 2001)

- Stakeholders are entities that can level requirements on the system.
- Stakeholders will include project sponsors, team members, etc.
- Involve stakeholders early in the project to get their support. However, the literature does not state that some of the stakeholders have tacit knowledge that you will need throughout the project life cycle.
- Identify stakeholders by looking at the formal and informal relationships envisioning the stakeholder environment as a set of inner and outer circles as shown in Figure 9. The inner circles stand for the most important stakeholders who have the highest influence (Recklies, 2001). While the figure identifies categories of stakeholders, it is not that helpful in determining which of them have a stake in a specific project.
- Provides the traditional view of stakeholders as shown in Figure 10. While the figure identifies the stakeholders and shows that there is a relationship between the stakeholders, the figure does not provide any information about the nature of the relationships, nor how to manage them.

  In general, the literature is helpful but incomplete.

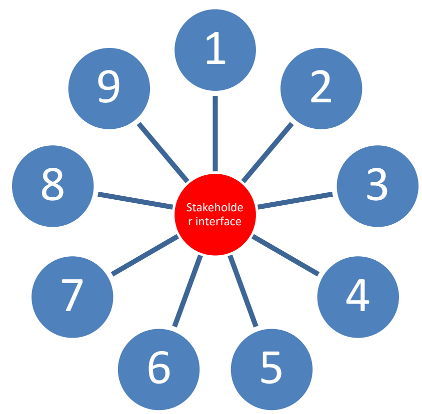

Figure 10 Traditional view of stakeholders

4. Managing stakeholder expectations

Managing stakeholder concerns can be considered as a process containing the following activities:

1. Identifying the stakeholders.
2. Identifying the areas of concern of each stakeholder.
3. Addressing the areas of concern of each stakeholder.
4. Converting stakeholder concerns to requirements.
5. Informing the stakeholders how their areas of concern were considered.
6. Gaining stakeholder consensus on the outcome.
7. Maintaining stakeholder consensus.

Perceiving the situation from the HTPs identified the stakeholders and the process to manage stakeholder concerns, when turning them into requirement-requests, but did not identify the stakeholder's areas of concerns.

4.1. Identifying the stakeholders

The stakeholders can be identified from the information in the *Big Picture*, *Operational* and *Functional* perspectives of each of the nine systems in the Nine-System Model of the MSOCC. The external HTPs, the *Big Picture* and *Operational* perspectives identify the external stakeholders, while the internal HTP, the *Functional* perspective identifies the internal stakeholders. The identified stakeholders were:

- MSOCC Operators, identified from the *Functional* perspective.
- NASA Managers, identified from the *Big Picture* perspective.
- SEAS and NMOS managers, identified from the *Operational* perspective.
- Hardware and Software developers and testers, identified from the *Functional* perspective.
- NASCOM personnel, identified from the *Operational* perspective.
- Experiment PIs, identified from the *Big Picture* perspective.

4.2. Identifying stakeholders' areas of concern

The problems identified in the *Scientific* perspective in Section 2.8 only concern two of the nine systems; the *MCSS* (S6) and the *transition process* (S5). However, the pre-SRR activities are taking place in S4, and these are the activities that create the *transition process* (S5) and the *MCSS* (S6). Consequently, the stakeholders with the information pertinent to the MCSS upgrade are those with an interest in the *undesirable situation* (S1), the *FCFDS* (S3), and the situation in which the MCSS will operate (S7) as well as the *transition process* (S5) and the *MCSS* (S6). This finding simplified stakeholder management because S2, S4, and S9 could be abstracted out as not being of any major concern (at least during the initial phase).

The areas of concern of each of the stakeholders can be matched to one or more of the nine systems using the assumption that the stakeholder will be concerned about the aspect of the MCSS upgrade in which they are located. This assumption can be validated during discussions with the stakeholder in subsequent phases.

When sorted by the areas of stakeholder concern, a table can be drawn up such as the example presented in Table 1. S2 and S4 are shaded in the Table because S2 is history, having been completed when the FCFDS (S3) was created and these pre-SRR activities are taking place in S4. The X's and O's in the Table show which of the nine systems is associated with the specific stakeholders. For example, using fictitious names:

Table 1 Representation of some of the stakeholder interests

Stakeholder	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
Dr Principle Investigator							O		
Oswald Operator	X		X		X	X	X		
Ollie Operator	X		X		X	X	X		
Danny Developer		X			X	X	X		
Debora Developer					X				
Development Manager		X		X	X		X		X
Tammy Tester	X		X						
Tomas Tester								X	
Others not listed									

- The developers are concerned with the processes (S5) and the solution system (S6) developed by those processes. Deborah Developer, as an example, will only be working in S5 which limits her area of concern to S5.
- The operators are concerned with the undesirable situation (S1), the transition process (S5), the MCSS (S6) and the upgraded MSOCC (S7).
- The testers are concerned with the testing aspects of the project, and upon discussions, we determined that Tammy Tester has a stake in S1 and S3 while Thomas Tester is only concerned with the final acceptance test (S8).
- The development (process) managers are concerned with the management aspects of the processes (S2, S4, S5 and S8).
- Dr Principle Investigator is only concerned with the MCSS upgrade project if he fails to receive his data, hence the 'O' in his column in the Table.

4.3. Addressing the areas of concern of each stakeholder

The *Generic* perspective indicated that the process to address the areas of concern and convert stakeholder's requests to requirements[7] is an instance of the generic change management process. Part of the Nine-System Model S4 carries out these activities with all of the pertinent stakeholders as discussed herein. These activities first necessitated arranging a number of meetings with the different stakeholders at their offices at the GSFC. To save time, the discussions covered stakeholder concerns about both of the problems identified in Section 2.8. The meetings:

- Were short, taking less than an hour.
- Began with an overview of the methodology being used in the task.
- Discussed the needs and concerns.
- Summarized the concerns, if appropriate, as applying to:
    1. The MCSS (S6).
    2. Conceptual approaches and selection criteria for the transition from the NASCOM switch to the MCSS (S5).

4.4. Converting stakeholder concerns to requirements

As part of the discussion about stakeholder concerns and needs, stakeholders were asked to provide two categories of requirement requests based on their needs; mandatory and "wishes". The "wish" category was one where if a decision had to be made to implement a mandatory requirement, and a "wish" could be implemented with little or no extra cost, the "wish" would be taken into account. During the discussion with the stakeholders, the critical questions asked were:

- What is good about the current system?
- What is bad about the current system?
- What would you change, and why?

When the responses from the different stakeholders to the questions were compared, we found that some of the answers were complementary and some were contradictory. As each requirement request was identified it was:

- Assigned an ID number.
- Prioritized with respect to the other requirement requests.
- Examined to determine if a contradiction exists between the requirements request and requirement requests from other stakeholders. In the rare instances where there was a contradiction, we met with the stakeholders concerned, discussed and resolved the contradictions.
- Tagged with acceptance criteria. These criteria were obtained by asking the stakeholders "how will you know when the requirement is met?" This question avoids ambiguous requirements. The response to the question provides the acceptance criteria that will be used in developing the acceptance tests.
- Inserted into the draft MCSS requirements document without performing the impact assessment since this was an initial state rather than a change to an existing system.

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[7] The term 'request for requirement' is used because the stakeholder's requests must not become requirements until the customer has agreed to accept the request and fund the realization of the request.

Once the requirement request was accepted by the customer it became a requirement and all three attributes: the requirement, the corresponding acceptance criteria and the stakeholder identification, were stored in the requirements database. The stakeholder information is to be used when the need for additional information to resolve issues concerning the design, testing or modification of the parts of the system whose purpose is to meet the requirement arise.

4.4.1. **The MCSS**

Once the draft MCSS requirements document was complete, we determined that nearly all the requirements requests[8] for the MCSS (S6):

1. Were based on the CONOPS of the MSOCC (S7) switching the anticipated future LEO satellite data streams in a manner that was compatible with the existing control system in the DOCS, coupled with improvements suggested by the stakeholders to overcome irritations and deficiencies in the use of the existing switch.
2. Could be met by commercial-off-the-shelf (COTS) switches with a price that was well within the budget. All COTS switches could meet the data throughput needs; the deficiencies were in the command and control functionality. When this was pointed out to the stakeholders and customer, after some negotiation, the stakeholders agreed to limit their requirement requests to the functionality provided by the COTS switch so as to remain within the budget. This determination meant that since the COTS switch would be purchased, there was no need to perform the impact assessment to determine the effect on cost and schedule of each requirement request which reduced the duration and cost of the project.

4.4.2. **The transition plan (S5)**

The process to develop the transition plan (S5) conformed to that shown in Figure 2. Recognizing that something would have to move temporarily to allow parts of the NASCOM switch and the MCSS to be installed simultaneously in the MSOCC, the conceptual candidate transition approaches identified different MSOCC systems as candidates for temporary removal.

We recognized that the prime directive of "no loss of data" did not equate to "no down time" (*Continuum* perspective). There were short periods of time when no data were being received and these times could be determined in advance. Thus each candidate conceptual transition approach could incorporate some down time when data sources and sinks were being rerouted to the replacement MCSS. We met with the stakeholders again at their convenience and discussed the advantages and disadvantages of each of conceptual candidate transition approaches and their other concerns. These issues became the selection criteria for the recommended transition approach.

At this point in time, somewhere in the MSOCC S4, we:

1. Knew who the stakeholders were from the HTPs of the MSOCC.
2. Knew their areas of concern from the Nine-System Model, and confirmed by discussion.
3. Had identified candidate transition approaches by discussion with the stakeholders.
4. Had identified transition approach selection criteria by discussion with the stakeholders.

We then identified the appropriate decision-making tools to use and selected to use the two-part approach in which we would identify the relative importance (i.e. which was more

[8] Since the initial set was to be presented at the SRR for consensus on acceptance, the set constituted requirements requests rather than requirements.

important than the other on a scale of 1-8, with 8 being the most important) and absolute importance (how important each was in itself on a scale of 1-10) of the transition approach selection criteria.

We then formally surveyed the stakeholders as to their preferences. Since the preferences of the stakeholders in the system, being a plurality, had different impacts, we identified a weighting scheme for prioritizing the preferences of the stakeholders[9]. The survey requesting that the evaluation criteria be ranked by the respondent, both in the order of relative importance and standalone importance, was sent to the MSOCC operations, maintenance and engineering personnel.

4.5. Informing the stakeholders how their areas of concern were addressed.

Once the areas of concern had been identified and their concerns translated to requirement requests. The two sets of meetings with the stakeholders allowed us to discuss their concerns and in a few instances how their concerns contradicted other stakeholders' concerns and more importantly, why their concern was noted but not acted upon.

Where the stakeholders' requirements requests for MCSS command and control functions contradicted other requirements requests, we met with the stakeholders, discussed and resolved the contradictions well before the SRR. From the *Generic* perspective this is a standard negotiating technique where the persons involved in the negotiations do not meet directly but pass their concerns through a middleman or negotiator.

Informal meetings to report on stakeholder concerns should be held between the formal milestone reviews.

4.6. Gaining stakeholder consensus on the outcome

The traditional formal System Development Process (SDP) meetings in the form of Milestone reviews such as the System Design Review, Test Readiness Review and Delivery Readiness Review provide opportunities for demonstrating consensus that the stakeholder concerns have been addressed and the *system being developed* (S6) *operating in its context* (S7) will remedy known undesirable aspects of the situation that will exist at the time the *system* (S6) is to be deployed.

Consensus was gained in the informal meetings, so when the SRR was held at GSFC and covered both the requirements for the *MCSS* (S6) and the transition plan (S5), all requirement requests were accepted without a single Review Item Discrepancy (RID).

4.7. Maintaining stakeholder consensus

The same approach using informal and formal meetings should be used in the later phases of the SDP following the SRR to:

- Update stakeholders as to the status of the way their concerns are being addressed.
- Manage changes in the stakeholder concerns as they evolve during the SDP.

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[9] We assigned a higher weighting to the stakeholder closest to the system. For example, the operators concerns received a higher weighting than the managers. Although we stated that the survey results had been weighted we never actually provided the weighting scheme, nor were we asked for it.

5. Managing indirect stakeholders

While the literature provides lists of potential stakeholders it is not very helpful in identifying whose concerns need to be managed. The HTPs and the Nine-System Model can be used to identify stakeholders using the *Structural* and *Temporal* perspectives as follows.

First of all consider stakeholders in the:

- MCSS (S6) and MSOCC (S7) during S4 as direct stakeholders.
- MCSS (S6) and MSOCC (S7) prior to S4 as indirect stakeholders.
- MSOCC (S7) metasystems as indirect stakeholders.

Section 4 discussed managing direct stakeholder expectation. Indirect stakeholders can be managed using perspectives from HTPs as follows.

5.1. The *Structural* perspective

From the *Structural* perspective, identify the systems of interest using the principle of hierarchies as follows:

- The MCSS is S6 in the MSOCC (S7).
- The MSOCC is S6 in the NASA GSFC (S7).
- The GSFC is S6 in NASA (S7).
- And so on up the levels in the hierarchy of systems as appropriate.

You could now:

1. Use the HTPs to examine each S6 and S7 at each level of the hierarchy to identify potential stakeholders in the same manner as the identification of the internal and external MCSS stakeholders.
2. Create a Table similar to Table 1 and use the same approach discussed in the rest of Section 4.4.

However, the *Generic* perspective indicates that this should have already been done in the different levels of the hierarchy of systems.

5.2. The *Generic* perspective

From the *Generic* perspective, just as the MCSS system level requirements flow down into the switch, control and other subsystems of the MCSS, the stakeholder concerns flow up and down into the MSOCC and MCSS. This is because the concerns of the external stakeholders in the metasystems should have been addressed at their metasystem or subsystem level, and any applicable concerns should have been passed on as concerns from the stakeholders at the MCSS and MSOCC levels in the system hierarchy.

5.3. The *Temporal* perspective

From the *Temporal* perspective, consider Figure 9 as a representation of a short list of potential stakeholders extracted from an unspecific longer list but without any additional information as to the phase of the SDP in which the stakeholders may have a stake. As a project passes though the different stages of the SDP, from conception to termination, the stakeholders change; stakeholders from the previous phase fall away, new stakeholders appear, and some of the previous stakeholders sometimes remain.

Stakeholder concerns from the previous phases of the SDP must be addressed even if the stakeholders cease to have an active interest in the SDP because a failure to do so will probably result in new stakeholders having the same concerns or as the SDP transitions from S1 to S7, the concerned stakeholders in S1 become concerned stakeholders in S7.

6. Discussion

The ultimate goal in managing stakeholders is to satisfy all stakeholders' expectations. However, in practice, generally, all stakeholders' expectations cannot be completely fulfilled. Thus, the goal in managing stakeholders often ends in a form of negotiated agreement with the stakeholders. That is to say, the difficulty in managing stakeholders is not about how to meet all the stakeholders' requests, but help all the stakeholders gain maximal satisfaction at the same time. Achieving stakeholder satisfaction is a continual activity for the entire SDP.

This paper introduced the HTPs and the Nine-System Model as tools for facilitating the process of managing stakeholder expectation and illustrated the use of the tools in the MSOCC situation. Even though the paper discussed the case as sequential activities, many iterations of the process may take place.

Achieving one stakeholder's satisfaction doesn't always mean that another stakeholder has to sacrifice. In general stakeholders have different concerns and a final win-win agreement can often be achieved after several rounds of discussion or negotiations.

7. Summary

The problems of stakeholder management and requirements elicitation and elucidation are complex and sometimes the roles, responsibilities and areas of concern seem difficult to identify and integrate. This paper addressed those issues and described a systemic and systematic way of simplifying stakeholder management and requirements elicitation and elucidation in a situational example using the:

- Holistic Thinking Perspectives (HTP) to identify stakeholders.
- Nine-System Model to sort stakeholders and identify their areas of concern in order to translate their expectations into system requirements.

The paper also introduced the concept of direct and indirect stakeholders in addition to internal and external stakeholders.

8. Biographies

Joseph Kasser has been a practicing systems engineer for more than 40 years and an academic for about 16 years. He is a Fellow of the Institution of Engineering and Technology (IET), an INCOSE Fellow, the author of *"Holistic thinking: creating innovative solutions to complex problems"*, "*A Framework for Understanding Systems Engineering*" and "*Applying Total Quality Management to Systems Engineering"*, and many INCOSE symposia papers. He is a recipient of NASA's Manned Space Flight Awareness Award (Silver Snoopy) for quality and technical excellence for performing and directing systems engineering and other awards. He holds a Doctor of Science in Engineering Management from The George Washington University. He is a Certified Manager and holds a Certified Membership of the Association for Learning Technology. He also started and served as the inaugural president of INCOSE Australia and served as a Region VI Representative to the INCOSE Member Board. He has performed and directed systems engineering in the UK, USA, Israel and Australia. He gave up his positions as a Deputy Director and DSTO Associate Research Professor at the Systems Engineering and Evaluation Centre at the University of South Australia in early 2007 to move to the UK to develop the world's first immersion course in systems engineering as a Leverhulme Visiting Professor at Cranfield University. He is currently a Visiting Associate Professor at the National University of Singapore.

Yang-Yang Zhao is currently an Associate Professor in the Norwegian Institute of System Engineering at Buskerud and Vestfold University College. She received her Ph.D. degree from the National University of Singapore in June 2013, previously having earned a master's degree in System Design and Management there in July 2009. She received her first master's degree in Engineering Management from the City University of Hong Kong then worked as a research assistant at its Department of Manufacturing Engineering and Engineering Management. Her research interests include system engineering, technology management and innovation strategy, and her work has appeared in the Journal of System Engineering, the Journal of Technology and Engineering Management, Total Quality Management & Business Excellence Journal and refereed international conferences.

Chandru Mirchandani: Received his ME in Electrical Engineering from Rensselaer Polytechnic Institute, Troy NY, MS in Reliability & Systems Engineering at the University of Maryland, College Park, MD, and PhD in Systems Engineering from George Washington University, Washington DC; and has over 20 years of professional experience in the engineering field.. Worked in the research and development of integrated circuits and devices at the Monolithic Devices Laboratory, Hewlett-Packard, Colorado Springs, Colorado. Working for Lockheed-Martin Space Operations, supported NASA/GSFC, as a Senior Staff Engineer in the research, development, design and integration of VLSI-based telemetry systems using state-of-the-art technologies in ASIC design, FPGA design, PCB design and data transfer & storage. Currently, with Lockheed-Martin IS&GS - Civil, as a Qualified System Architect and System Engineering Lead in Reliability, Maintainability and Availability Engineer, on the En-Route Traffic Management System and the Next Generation Identification System. He is an INCOSE Fellow, an Associate Fellow of AIAA and Senior Member of IEEE, and a regular reviewer of technical papers. Member of the Working Group updating the MIL-STD 217 and led the effort for Discrete Devices. Interests: research, design and model development of systems based on reliability, performance and cost; fault-tolerant systems; Bayesian processes and decision theory.

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