Risk Factors to be considered in conceptual space mission design

HORM program
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Based on an empirical analysis of conceptual space mission design at the JPL and NASA sites, the following are a set of factors that have been determined to lead to potential risk.

I. Incongruent methodologies

Processes and methodologies can be unique to an organization and are often not documented. As a result, they are not communicated outside the boundaries of each organization. In distributed design, the use of different methodologies can lead different teams to link together inconsistent data. This can contribute to inconsistencies in design.

Analysis:
Before design session starts:
  a. Compare teams’ methodology across sites. Choose relevant parameters to compare. Assess significance of differences. Assessing methodologies includes checking that assumptions about the design from different organizations are congruent.

II. Contribution of relevant expertise

Expertise in space mission design is not always contributed by the relevant person at the time it is needed. Empirical findings showed that in distributed design sessions, one site dominated the discussion, even when other sites were expected to contribute based on their expertise. Also, most verbal information across sites is passed through facilitators. This may preclude the verbal contribution of relevant expertise from the appropriate experts. The absence of an up-to-date list of all participants across sites, their function in the design, and their contact information may also impede getting the right expertise to contribute in a timely manner.

Analysis:
  a. Is the responsible site participating in the public discussion of the design, when it falls within that site’s area of expertise?
  b. Is the communication technology supporting the dominance of one site at the sake of other site’s expertise?
  c. Within each site, is the right expert participating in the public discussion of the design, when it falls within that expert’s area of expertise?

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1 The research described in this publication was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration
b. If an expert feels they cannot contribute their expertise (at the appropriate time, or later) ask the expert their view of the reason for this, e.g.:
   a. Organizational hierarchy has interfered
   b. Communication technology made it difficult to contribute
   c. Relative size of teams
   d. Other (specify)

III. Limitations of data-sharing technology across sites

Data sharing technology offers a limited ability to incorporate free-form information, such as whiteboard sketches. Thus, the ability to share different design representations and design rationale across distance is limited.

Analysis:
   a. Did any team members provide feedback about changes/additions to the shared spreadsheet? Was this feedback incorporated into the spreadsheet? Was this feedback recorded for future review?
   b. Are shared sheets visible in full detail at remote sites?
   c. Did any team member need to share a representation with other sites and did the existing technology support this sharing (e.g., whiteboard sketches or diagrams)?

IV. Shared data across sites lacks meta-information

The spreadsheets, which are shared across sites via application sharing, lack important meta-information that enables team members to distinguish starter, intermediary, and final design values of the parameters. This creates the potential for risk: team members cannot quickly assess missing design values. Team members can overlook parameters that have partial information or missing data. The burden of responsibility falls mainly on the facilitator to inform the team of which parameter values are still needed. Having the responsibility fall on one or a few people increases the potential of risk. Meta-information would enable more team members to become aware of errors or gaps in the design. A lack of awareness of the current state of the design can contribute to wrong assumptions and inconsistent designs. There exists the potential for a "blind trust in the technology", i.e. if the parameter appears on the spreadsheet, there is an assumption that it must be the final and correct parameter.

Analysis:
   a. Can the team member distinguish starter, intermediary, and final design values in the spreadsheet, i.e. is the team member aware of what the value in the spreadsheet represents?
   b. Does the team member monitor changes to intermediary values, in order to assess impact on his/her design?
   c. Is the team member aware of who is responsible for what?
d. If an error or inconsistency in the space mission design is discovered, how was it discovered, i.e., during public discussion (VTC), from a sidebar discussion, directly noticed on the public spreadsheet, or other?

V. Lack of sidebar awareness

Empirical results show that there is a lack of awareness on the part of team members of 1) what sidebars are taking place, especially across sites, and 2) what the results of the sidebar are. With respect to point (1), this lack of awareness limits each participant's understanding of the design, their view of design possibilities, and potentially can lead to inconsistent aspects of the design. Those already participating in sidebars have limited monitoring capabilities and may not be aware of other sidebars that are of relevance to them. Observations showed that those participating in sidebars may miss out on the flow of information at the main meeting. Similarly, those in the main meeting miss out on the opportunity to contribute their expertise to a sidebar, if they are unaware of it.

With respect to point (2), if the sidebar does not report results to the main meeting, the rest of the team lacks not only the results (which may get updated into the spreadsheet at a later time) but also important design rationale. Such design rationale can be reused in future meetings.

Analysis:
  a. Is the team member aware of all ongoing sidebars relevant to his/her aspect of the design?
  b. Is the team member aware of the impact of sidebar discussions and negotiations on his/her design?
  c. Is the sidebar participant sharing information discussed in the sidebar with all those to whom the information is relevant?

VI. Lack of action item awareness

The team does not track action items; therefore, action items may not be executed, or executed action items may not be reported. Though "TBD" is written on the public spreadsheet, it does not express meta-information about the action item: e.g. its status, the responsible party, or the due date. Not tracking action items can lead to the failure that they get carried out. Having the facilitator take sole responsibility of the action item status can lead to risk in design. Without meta-information, team members cannot assess whether the action item has been carried out, or its results.

Analysis:
  a. Is the team member aware of relevant agreed-upon action items, their status, the responsible party, and the due date?
  b. Is meta-information about the action item available for public viewing?
c. Did the person who was responsible for the action item report its results to the team?