Abstract: Developing a future state design for any enterprise component is a crucial step in the enterprise management lifecycle. Traditional approaches rely heavily on business stakeholder participation and input. Several problems are identified with this approach which may contribute to poor design decisions. This paper introduces two EA Management patterns which aim to incorporate both stakeholder requirements and design principles to promote elegant future state designs. The paper includes a means for both documenting and assessing the application of design patterns, a description of the patterns of good design, and a method for applying these to a future state.

1 Introduction

At some point in most enterprise architecture endeavours there is a need to develop a description or model of a future state solution. The need to develop such a design can arise at both the level of the enterprise as a whole or within the context of individual business solutions. A future state solution needs to meet the requirements of the enterprise at both strategic and operational levels and enable the enterprise to meet its strategic goals and objectives. The Open Group Architecture Framework (TOGAF) Version 9.0 [TO09a] is an example of a commonly used EA methodology. TOGAF relies heavily on the use of Business Scenarios as a means to identify business requirements and as a mechanism to identify aspects of a future state design. Conventional wisdom regarding the development of future state solutions usually includes a process of eliciting requirements and ideas via architect-hosted interviews or workshops with senior business stakeholders. In these sessions business stakeholders are encouraged to envisage or brainstorm ideal future scenarios for the enterprise and its clients. Options are then listed and prioritised. The architects then model a solution, based on their understanding of current technology, and which satisfies the ideal scenarios and requirements identified through the interviews and workshops.

However, there are at least two problems with this approach and its considerable reliance on business stakeholder input. The first issue is that each business stakeholder is likely to approach the exercise of „future state envisaging through the filter of their own set of priorities. As a result, it can be difficult to achieve a whole-of-enterprise perspective amongst business stakeholders who all have their own priorities and requirements. Furthermore, it should be remembered that some of the business stakeholders may have
been directly responsible for the current state with all its problems and shortcomings. Therefore, a future state solution based solely on stakeholder input is likely to be influenced by stakeholder competing priorities, biases and pre-conceptions about what is possible.

The second problem concerns the potential conflict between stakeholder requirements and good design. This potential conflict arises because business stakeholders are typically not designers or engineers but rather are responsible to manage the enterprise. For the purposes of this paper, good design is defined as the combination of form and function to elegantly and completely solve a given problem. The concept of good design encompasses design efficiency, effectiveness and simplicity or “economy of design”. There are well understood engineering principles which promote good design and design elegance. However, these principles will act to constrain the set of all possible solutions to a given problem. This constrained set of solutions may not include those identified through a stakeholder consultation process like the one outlined above. An extreme example of this potential conflict is the often cited “Winchester House” [W110] in which user requirements were followed blindly and without regard for principles of good design. The original owner, supposedly guided by spirits over a period of 38 years, oversaw the construction of the 160 room sprawling mansion. The resulting structure contains many examples of incoherent design.

Clearly, there is a need to identify an enterprise management pattern which accommodates the requirements and objectives of business stakeholders, and which also ensures that the future state design reflects the application of the principles of good design. To address this need, the current paper sets out two enterprise architecture management patterns. The first pattern (Design Principle Definition and Assessment) addresses the issues of how to describe design principles generally, and how to assess the extent to which a given design reflects the application of a given principle. The second pattern (Future State Solution Design) introduces the principles of good design, and outlines how these are used together with stakeholder requirements to identify elegant future state designs.
2 Pattern 1 - Design Principle Definition and Assessment

The concept „design“ is a logical level concept in that a design does not need to include implementation detail [AI09]. Indeed, a design description may actually be more useful if implementation level detail is purposely excluded. By this it is meant that a single design may be physically implemented in multiple ways.

For the purposes of this pattern, design principles are defined as statements which when followed or applied influence and constrain a design. It is recommended that design principles be used to constrain and guide the development of designs. Whereas, standards be used to constrain the implementation options of a given design. In the context of enterprise architecture, design principles should be applied to enterprise level and individual solution designs. Architectural standards on-the-other-hand should be applied to the specified implementations of these designs.

This methodology pattern describes a means to document design principles that supports the assessment of their application in any given design. The pattern is based on and extends the pattern described in [TO09b].

Intended Audience

This EA management pattern is intended to assist with the definition and application of design principles. Therefore, the pattern will be of interest to those involved in enterprise level Information Communication Technology (ICT) planning and portfolio management, as well as those involved in the development of specific business solutions (i.e. Solution Architects).

Known Uses

The following are examples of the use of this pattern.

- Queensland Investment Corporation (QIC) EA Principles document [QI09a]. This documents sets out the principles to guide the development of QIC future state designs, and the implementation of enterprise architecture within the organisation.
- QIC Conceptual Solution Design (CSD) document [QI09b]. A CSD is developed for each IT solution within QIC. The CSD lists those principles which were applied to arrive at the given solution design.
- Queensland Health Department EA Principles document [QU08].
- TOGAF V9.0 [TOG09b]. This widely adopted EA methodology framework uses elements of this pattern.

Context

There exists an enterprise which requires a design. The design needs to be developed to reflect specific design principles and evaluated in terms of its ability to demonstrate the application of these principles.
Problem

In order to evaluate whether a given design represents the application of a given principle it is necessary to be able to identify the principle, and assess the extent to which the given principle has been applied to the design. How can the application of a given design principle be assessed?

The solution will be influenced by the following forces.

Forces

*Consistency of interpretation:* To ensure that designers identify and pre-scribe principles in a consistent fashion it is necessary that principles are clearly and succinctly defined. Design principles usually incorporate a number of concepts. To ensure consistency it is necessary to ensure that the concepts relevant to a given principle outlined in a standard fashion.

*Measurement:* The ability to quantify the requirements of each principle is necessary to enable designers to be able to assess the application of a given principle to a particular design.

*Governance:* Principles require some position of accountability to ensure appropriate application within an enterprise.

Solution

Each principle is documented using the following format:

<table>
<thead>
<tr>
<th>Name</th>
<th>The name of the principle. The name should be able to be preaced with “The principle of…”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>A concise statement of the principle.</td>
</tr>
<tr>
<td>Rationale</td>
<td>A statement of the rationale behind the principles, and why it is important.</td>
</tr>
<tr>
<td>Requirements</td>
<td>A description of the characteristics of a design to which the principle has been applied.</td>
</tr>
<tr>
<td>Assertions</td>
<td>A set of quantifiable and testable statements which can be answered true or false when applied to a design, and which relate to one or more requirements of the principle.</td>
</tr>
<tr>
<td>Sponsor</td>
<td>The role or position within the enterprise that is responsible for the maintenance of the principle definition and oversight of its application within the enterprise (e.g. Chief Enterprise Architect or Chief Information Officer).</td>
</tr>
</tbody>
</table>
The relevant design principles are identified by the architect. The assessment of the design is undertaken by determining how many principle assertions are satisfied by the given design. The design may then be rated as “Complete Implemented”, “Partially Implemented”, or “Not Evident” for each principle.

**Consequences**

**Benefits:**

- Comparison of designs. This pattern provides a mechanism to evaluate and compare designs in terms of their ability to demonstrate the application of specific design principles.
- Consistency. The pattern promotes consistency of interpretation by standardising the specification of design principles.
- Assessment and governance. The pattern also enables the assessment of the degree to which a particular principle has been applied to a design, and promotes specific governance of the application of individual design principles through the use of a sponsor role.

**Drawbacks:**

- Resources. The pattern requires that significant time and resources be allocated to the development and refinement of the definition of principles.
- Assessment. The ability to assess the application of a given principle rests on the objectivity of the assertion statements within the definition. This requires that these statements be carefully constructed and reviewed to ensure that they will be able to be understood and applied in a wide variety of contexts.
- Assessment granularity. This pattern currently only provides for three levels of application. This may well be too coarse grained to provide useful guidance. For example, there may be little in the way of useful guidance provided to the practitioner if all considered designs are assessed as “Partially Implementing” a given principle.
- Competing requirements. Conflicting requirements may arise in situations where multiple design principles are applied. This situation requires that the architect in consultation with business stakeholders make some assessment as to the relative importance of the respective principles.
- Inconsistent terminology. The wording of principles needs to undergo thorough review and evaluation to ensure that the same principle is not being described in a different way or using different terminology. Design principles need to be
worded in a manner that promotes easy identification and applicability across a wide range of contexts.

See Also

EA Management Pattern for Future State Design

EA Management Pattern - M-4 Standard Conformity Management [EA10a]

3 Pattern 2 - Future State Solution Design

This methodology pattern describes an approach to developing a future state design. The pattern incorporates business stakeholder requirements and the principles of good design. It should be noted that this pattern does not specifically address the gathering, documentation and analysis of business stakeholder requirements. It is recommended that these issues be addressed in a separate EA Management Pattern.

Intended Audience

This EA management pattern is intended to assist with the development of future state designs. Therefore, the pattern will be of interest to those involved in enterprise level ICT planning and portfolio management, as well as those involved in the development of specific business solutions (i.e. Solution Architects).

Known Uses

- QIC Conceptual Solution Design (CSD) document [QI09b]. A CSD is developed for each IT solution within QIC. The CSD lists those principles which were applied to arrive at the given solution design.
- QIC EA Methodology and Governance Framework [QI10]. This document outlines the methods used to implement and govern EA within QIC.
- Methodologies and paradigms which strongly reflect aspects of this pattern are:
  - Object Orient Programming
  - Service Oriented Architecture
  - Lean Business Process Management
  - Coherency Management [DO08]

Context

There exists an enterprise in which ICT or enterprise planning is undertaken for which a future state design is required. The design may be for the enterprise landscape as a whole or a component of this. This pattern is one of a number of methodology patterns that together outline a methodology for enterprise planning. The processes of ICT or enterprise planning, and business stakeholder requirements analysis are not described within this pattern. 6
Problem

A future state design needs to address both function and form requirements. How does an enterprise architect identify a future state design which reflects the principles of good design from amongst the range of all possible designs?

The solution is influenced by the forces listed below.

Forces

*Addressing business stakeholder requirements:* Stakeholder requirements will be reflected in the solution functionality. Stakeholder requirements can also affect the form of the solution. Traditionally, these have been described as functional and non-functional requirements.

*Applying principles of good design:* There are many design principles which might be selected to guide the development of a given design. However, there are certain principles which are evident in all good designs. These principles are reflected in features of a solution design that address effectiveness, efficiency and form. Good designs have longevity, and are functionally effective and efficient. Design longevity is achieved through maintainability, flexibility and completeness. Moreover, the principles of good design need to apply to the design as a whole as well as its components. It is these principles of good design that this pattern seeks to identify.

*The role of enterprise specific design principles:* In addition to generic principles of good design there are also likely to be design principles that are specific to an individual enterprise or practice domain (e.g. software development, building construction). The principles of good design listed in this pattern should be used to supplement any enterprise specific principles. Enterprise specific design principles should be documented using the EA Management Pattern - Design Principle Definition and Assessment.

*The role of architectural standards:* Such standards will act to limit the possible implementations of a given the future state design. The architectural standards will identify which technologies or methodologies will be used.

Solution

The solution to this problem follows an iterative five phase methodology. The first phase identifies business stakeholder requirements. The second phase develops one or more possible future state designs. The third phase is concerned with the application of principles of good design, and any enterprise specific design principles to identify a preferred future state design. The fourth phase provides a means for stakeholders to provide feedback on the preferred design. The fifth phase involves the assessment of proposed design against architectural standards to identify the preferred implementation.

The scope of iterations will vary depending on the underlying development paradigm. Agile approaches will typically use this pattern with shorter iterations and with a strictly
constrained scope. "Waterfall" methodologies are likely to make use of the pattern but with iterations of much longer duration and broader scope.

**Phase 1 - Stakeholder requirements:** Requirements are gathered from an analysis of relevant strategic documentation. Further requirements are added to this initial set through direct engagement with stakeholders via interviews or workshops. Through this process stakeholders should be encouraged to envisage their version of the ideal solution. Where this pattern is applied at the level of individual business solutions, stakeholders should also be encouraged to "walk through the solution in terms of the actors involved and the outcomes and behaviour they could expect."

A key output of this phase is the identification of the purpose or objective of the future state design. The stated purpose, together with the requirements gathered fully specifies the problem space to be addressed by the future state design.

**Phase 2 – Generate future state design alternatives:** In this phase the architect is responsible to develop several future state designs that meet the stakeholder requirements. The extent to which a given stakeholder requirement is addressed may vary between the proposed designs. Any design that meets stakeholder requirements should be considered for inclusion at this point. The architect is not as concerned with the relative merits of each design during this phase as with the need to identify as many designs as possible within the time available. Within an agile approach consideration should be given to selecting alternatives that address the immediate problem only and specifically do not address issues that might be thought to be likely to arise as development is further progressed. The principles of good design and any enterprise specific design principles should be used as guides to narrow the number of potential designs considered during this phase.

**Phase 3 – Application of the principles of good design:** The application of the principles of good design is an iterative process in which greater compliance with the requirements of the principles is achieved in successive iterations as the initially proposed future state designs are further refined.

Each of the principles identified below is applied to address specific characteristics of good design. In summary, the Principle of the Separation of Concerns [RE89] is used to identify "logical" components within the design that each address discrete issues, features or characteristics within the problem space. Consideration of component autonomy will determine the logical boundaries between components, or groupings of components within the design. The Principle of Optimisation [PA00] is applied to the logical components to determine the configuration of maximal efficiency and effectiveness. Note that the efficiency of a design can be considered separately to the efficiency of a particular implementation of that design. The Principle of Coherency (see [DO08] for enterprise-wide application, and [CO68] for software application) is applied to identify unnecessary redundancy or complexity of the design configuration or logical components. This principle ensures that all components contribute to the accomplishment of the design’s overall purpose.
The principles of good design are listed below using the EA Management Pattern - Design Principle Definition and Assessment.

<table>
<thead>
<tr>
<th>Name</th>
<th>Principle of the Separation of Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>A design should be comprised of a set of independent components each of which addresses a discrete function within the problem space.</td>
</tr>
<tr>
<td>Rationale</td>
<td>This principle addresses the issues of component delineation and modularity. This principle promotes a designs that are resilient, responsive to change and easily maintainable.</td>
</tr>
<tr>
<td>Requirements</td>
<td>Components within a solution should be designed to be autonomous and include sufficient redundancy and management of error conditions to minimise the impact of failure on other components.</td>
</tr>
<tr>
<td></td>
<td>Interfaces between components should be designed to promote loose coupling between components to:</td>
</tr>
<tr>
<td></td>
<td>reduce dependencies on other components or entities external to the solution.</td>
</tr>
<tr>
<td></td>
<td>promote compose-ability and facilitate re-orchestration of components.</td>
</tr>
<tr>
<td></td>
<td>promote ease of maintenance and longevity by enabling straightforward exchange or replacement of components.</td>
</tr>
<tr>
<td>Assertions</td>
<td>There is a one-to-one matching between design components and functions within the problem space.</td>
</tr>
<tr>
<td></td>
<td>Replacement of any one component does not compromise the design as a whole.</td>
</tr>
<tr>
<td></td>
<td>Interfaces between components comply with documented standards.</td>
</tr>
<tr>
<td>Sponsor</td>
<td>Enterprise Architect</td>
</tr>
<tr>
<td>References</td>
<td>[RE89]</td>
</tr>
</tbody>
</table>

Table 2. Principle of the Separation of Concerns

<table>
<thead>
<tr>
<th>Name</th>
<th>Principle of Optimisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>A design should provide a complete solution for the problem space and achieve economy of both components and resource usage.</td>
</tr>
<tr>
<td>Rationale</td>
<td>This principle promotes designs that are both effective and efficient.</td>
</tr>
</tbody>
</table>
| Requirements | • The solution design should address as much of the problem space as possible.  
• Each component within a design should encapsulate a single discrete function within the complete problem space.  
• The solution designs should minimise consumption of resources and execution time.  
• Components should be designed to promote appropriate cost effective re-use.  
• Components should be re-used where possible. |
| Assertions   | • The problem functional space is completely supported by the solution design.  
• There are no unnecessary or redundant components within the design.  
• All opportunities to re-use components are realized within the design.  
• Given the scope of the problems functional space addressed by the design, the design is evidently the most efficient in terms of resource consumption and execution time. |
| Sponsor      | Enterprise Architect |
| References   | [PA00] |

Table 3. Principle of Optimisation

<table>
<thead>
<tr>
<th>Name</th>
<th>Principle of Coherency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>The design components should be harmonised with the design purpose.</td>
</tr>
<tr>
<td>Rationale</td>
<td>This principle addresses the issue of alignment of components with the purpose of an entity as a whole. This principle acts to balance the design characteristics of the previous two principles. This principle also addresses the issue of sufficient complexity. That is, designs maybe complex, but only to the degree to which is required to achieve the solution design’s purpose. Unnecessary complexity or functionality does not represent good design.</td>
</tr>
</tbody>
</table>
| Requirements  | • The components of the solution design should work together as a whole to achieve the design purpose.  
• A design should include only components that support the design purpose.  
• Design complexity and functionality is driven by requirements of the solution design.  
• Each component should be able to demonstrate a relationship |
The solution design has a documented and well understood purpose.
- The solution design requirements derive directly from the design purpose.
- Each component has a ‘line-of-sight’ with at least one requirement of the solution design.

<table>
<thead>
<tr>
<th>Sponsor</th>
<th>Enterprise Architect</th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>[DO08], [CO68]</td>
</tr>
</tbody>
</table>

Table 4. Principle of Coherency

The application of each of these principles is assessed in terms of the degree to which its requirements are evident in the particular future state design under consideration. Assessment is conducted as described in the EA Management Pattern - Design Principle Definition and Assessment.

This phase should also see the application of any enterprise specific design principles. These principles too should be applied using the EA Management Pattern - Design Principle Definition and Assessment.

The key output from this stage will be the preferred future state design. This design will reflect the application of the principles of good design, and any enterprise specific design principles to the greatest extent.

**Phase 4 – Stakeholder review:** This phase provides the business stakeholders with an opportunity to provide feedback on the preferred design. The review may be a formal review or conducted informally. Stakeholders should be encouraged to test the design to ensure that their particular requirements are satisfactorily addressed.

Where stakeholder feedback indicates that there are concerns about the preferred design the architect will need to review the concerns and ensure they are addressed by returning to undertake a further iteration of Phase 3. In this instance there should also be an additional stakeholder review. This review may be limited to only those stakeholders who initially raised concerns.

**Phase 5 – Design implementation:** In order to determine how the preferred design is to be implemented within the enterprise it is necessary to assess it against the relevant enterprise architecture standards. This assessment will identify which technologies and/or methodologies will be used to implement the design. The key output from this phase is a design implementation specification.
At the conclusion of the methodology a preferred design and its implementation should have been identified and documented. In addition, the preferred design will have been assessed in terms of its completeness, and longevity through the application of the principles of good design.

**Consequences**

**Benefits:**
- This pattern promotes the development of elegant future state solution designs by identifying the principles of good design, and providing a means to evaluate their application.
- The pattern provides a means to compare a number of future state designs and identify a preferred design.
- The pattern provides a means to balance stakeholder requirements with the requirements of the principles of good design.
- The pattern conceptually distinguishes between the role that principles and standards play in the development of future state designs and their implementation.

**Drawbacks:**
- Phase sequencing. The sequence of phases described in this pattern is idealised and presented as a guide. In real world use the sequence is likely to be iterative and non-linear. The precise sequencing and the number of iterations will need to be determined by the architect and the underlying development paradigm.
- Resources: The application of this pattern is likely to require significant time, resources, and expertise on the part of the architect.
- Comprehensiveness of the principles: This pattern is likely to require further refinement over time as there are possibly aspects of good design that are not adequately addressed by the principles as currently identified or worded. Similarly, the listed requirements or assertions within an individual definition may be incomplete. However, the current principles have been developed after review of a number of sources.
- Generation of alternatives: This is a crucial phase in the methodology, and is entirely reliant on the expertise and experience of the architect. Preference needs to be given to alternatives that do not „lock if’ solution implementations, but rather leave a number of alternative viable pathways open.
- Generation of equal alternatives: The pattern may result in the identification of two equally meritorious future state designs. In this situation it is recommended that the architect consult with business stakeholders to determine the preferred design.
- Addressing stakeholder requirements: There is a need to develop an EA Management Pattern for the eliciting, collating and analysis of business stakeholder requirements.
- The role of architectural standards: There is likely to be a tension between the preferred design and architectural standards. However, this can be minimised
where there is a clear distinction made between standards for implementation (i.e. architectural standards), and principles of good design. Ideally, architectural standards should not constrain design, but rather provide strict guidance on the implementation requirements of a given design. Even so, it is possible that a preferred design may become untenable in light of the implementation requirements of the relevant architecture standards.

See Also

EA Management Pattern - M-4 Standard Conformity Management [EA10a]

EA Management Pattern - M-14 Development of Plan and Target Landscape [EA10b]

EA Management Pattern for Design Principle Definition and Assessment

4 Conclusion

The methodology patterns presented in this paper have been developed to provide guidance regarding the principles of good design and to formalise the use of design principles. The patterns provide both a means to apply the principles to future state design and a means to evaluate their application. This is an important step within the overall EA lifecycle, but one on which there is often limited available guidance. Traditional approaches place an understandable emphasis on the use of stakeholder requirements to define future state design. However, several issues have been identified in this paper where stakeholder requirements provide the sole input to the design process. Importantly, it should be noted that the patterns do not negate the need to gather and identify user requirements.

The Future State Solution Design pattern is extensible, and there are undoubtedly other design principles that might be considered for inclusion. However, in the author’s experience, a number of other design principles (e.g. loosely coupled components, component autonomy, component redundancy etc.) are ultimately extensions or requirements of the principles currently included in the pattern. To this end a further refinement of the pattern might be to identify the current principles as a core primary set, and then to identify additional secondary principles that are derived from the primary set.

Although the current patterns and principles address a number of design „themes” within a number of well established design paradigms, they have had limited use as a formalised pattern. Furthermore, the patterns described in this paper are not a replacement for architectural design expertise. Therefore, the patterns as described within this paper will benefit from further research, testing and refinement. However, given the significance of the process of future state design within the field of enterprise architecture the importance of these patterns within an overall EA Management framework is clear.
References