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Towards a Reference Architecture of Intent for Information Systems Strategic Alignment

Richard W. Woolridge
University of Alabama, rwoolrid@cba.ua.edu

Joanne E. Hale
University of Alabama, jhale@cba.ua.edu

David P. Hale
University of Alabama, dhale@cba.ua.edu

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Richard W. Woolridge
rwoolrid@cba.ua.edu

David P. Hale
dhale@cba.ua.edu

Joanne E. Hale
jhale@cba.ua.edu

Culverhouse College of Commerce and Business Administration
The University of Alabama

ABSTRACT

Enterprise architecture enables strategic alignment through creation of a unified business and IS view of the target state of the business. Using a design science approach, this paper proposes an *intent-based* technique as an extension to existing modeling techniques for strategic alignment. The proposed approach defines a reference architecture of enterprise intent that includes vocabulary, rules, and structure for development of purposefully aligned strategic-level enterprise architecture. The proposed approach results in interacting hierarchies that can be analyzed through network science approaches.

Keywords (Required)

Enterprise Architecture, Strategic Alignment, Reference Architecture, Design Science, Network Science.

INTRODUCTION

Enterprise architecture enables strategic alignment through creation of a unified business and IS view of the target state of the business. This architecture incorporates the vision, principles, standards, guidelines and practices that govern the acquisition, use, and disposal of IS assets. Gaps between the current state of IS and the target state identified in the enterprise architecture are used to plan a path to achievement of the target state (Fournier 1999).

Strategic alignment has long been a topic in Information Systems (IS) research with the goals of determining the value of IS solutions and determining how to increase business performance (Henderson and Venkatraman 1991; Broadbent and Weill 1993; Chan and Huff 1993; Keen 1993; Sauer and Yetton 1997; Henderson and Venkatraman 1999; Smaczny 2001; Kearns and Sabherwal 2006). IS solutions have been shown to deliver value when properly applied (Reich and Benbasat 1996; Reich and Benbasat 2000; Sabherwal and Chan 2001; Oh and Pinsonneault 2007). Strategic alignment involves positioning the organization in the external environment and then organizing the internal arrangements to meet the needs of the external positioning. These researchers contend that a firm positions itself in the market (external) and arranges its functional areas (internal) to meet that market positioning. Additionally, the assertion is made that this positioning applies to IS organizations, in which IS strategy must support the firm's market positioning (external), and IS resources must support the IS strategy and the other functional areas of the firm (Henderson and Venkatraman 1991).

Much research has defined alignment gaps occurring due to the rapid rate of business change, organizational stovepipes and legacy systems that limit the firm's ability to react to changes in the environment. Some of this impedance to change can be traced to a substantial level of redundancy and rigidity in the organization's internal processes (Diepen 2000). This redundancy and rigidity leads to difficulties in meeting challenges invoked by the environment and causes the redesign of processes (Hammer and Champy 1993).

Though process models are well suited for routine tasks,) Some have described the limitation of such process approaches for complex human and organizational issues (Molani, Perini et al. 2003). Thus, creation of a strategically aligned enterprise architecture that is not solely based on process models may mitigate their associated limitations. This paper proposes that the *intent* structure of the organization may help fill that gap. The goal of this approach is to address the specific research question: "How do we model the *intents* of the organization such that the interdependencies are visible and modeled to maximize the ability to adapt as changes are warranted?" While this concept parallels *intentional* models (Deng 2006), the proposed approach has different mechanisms to address dependency, responsibility, means, and ends. The Business Motivation Model (BMM) (BRG 2007) imposes a rigid structure of "end" versus "means" while the proposed approach assumes current focus in the model determines "means" versus "ends". In addition, the proposed approach assumes open interaction of hierarchies while the BMM requires overtly stating "influence" on constructs. The i* models (Yu 1995) models the interaction of agents through intents but does not model the inter-relationships between intents. The proposed approach begins the definition of a referent architecture of organizational *intent* to provide enterprise architecture specific vocabulary, rules, and structure.

The proposed approach utilizes models as artifacts to be used in future research to build an analysis and description type of theory (Gregor 2006) in which the unit of analysis is the firm, and design science is the utilized research methodology. Conceptualization of the proposed *intent-based* approach, as shown in Figure 1, follows the design science method outlined by Gregor and Jones (2007) that includes components for Purpose and Scope, Constructs, Principles of Form and Function, and Justificatory Knowledge[1].

Justificatory knowledge identifies the theoretical grounding that provides evidence to the consistency and completeness of the artifact (Gregor and Jones 2007). The theoretical grounding for the approach can be found in Sciences of the Artificial (Simon 1996) and Aristotle's four causes as illustrated by Heidegger (1977).

- The first grounding of the approach into theory comes from Sciences of the Artificial. Fulfillment of purpose (see Figure 1, Intent Outcome) involves the relationship between the purpose or goal, the character of the artifact, and the environment in which it operates. The purpose or goal is identified by the Intent. The character of the artifact is represented by the Condition of Satisfaction and its associated structure. The structure defines the Intent Outcome. The environment in which the Intent Outcome operates is defined by the Rationale Intent that uses the Intent for some higher-level goal. Thus, this approach addresses all the requirements for Purpose as defined by Sciences of the Artificial.
- The second theoretical grounding of the proposed approach comes from Aristotle and Heidegger. As will be shown, the approach conforms to the four causes identified by Aristotle (from a translation by Hooker 1996) and illustrated using the silver chalice by Heidegger. The four causes, and their reference within the proposed model are (Heidegger 1977):
    - The *causa finalis* – the end, the use of the chalice
        - This cause is represented by the Rationale and the hierarchical relationship between Conditions of Satisfaction (COS).
    - The *causa materialis* – the material, the silver used to make the chalice
        - This cause is represented by the Resource utilization in the Intent Outcome definition and the Resource Attributes whose Desired Values are used to achieve the intent.
    - The *causa formalis* – the form, the shape of the chalice
        - This cause is represented by the state of the Resource and its emergent properties as defined by the Intent Outcome.
    - The *causa efficiens* – that which brings about the finished product, the silversmith
        - This cause is represented by the Agent that is responsible for the occurrence of the Intent Outcome and the COS Agents that are responsible for the occurrence of the Conditions of Satisfaction.

[1] Due to space limitations, Artifact Mutability and Testable Propositions are discussed briefly in the limitations section; Expository Instantiation (other than through embedded illustrations) and Principles of Implementation are left for future work.

PURPOSE AND SCOPE

The purpose and scope of the proposed approach describe the uses and boundaries (Gregor and Jones 2007). While the purpose is detailed in the Introduction section, this section defines scope -- the boundaries and environment to which these models are expected to apply.

Though the proposed approach is illustrated using concepts consistent with a profit maximizing organization performing in the market, it is not limited to the internal environment defined by the organizational boundary of the firm, and may include the environment in which the firm operates. The proposed approach is intended to apply to the business domain of the firm and not the firm's software domain, though it is expected that the extensibility of the models to the software domain will be apparent. The proposed approach describes the desired intent state of the organization. The specific methods used to make intent achievement decisions that are not within the scope of this proposal can range from subjective to probabilistic to objective, but in the final analysis a decision is made. This constraint serves to limit the approach's complexity during development. It is expected that that the models will be extended to more complex methods in which "maybe" is a decision.

The proposed models contained within the construct Intent Outcome in Figure 1 fit within a higher-level model (Scope Model) that more precisely describes the artifact environment within which it is to operate. The quadrants of the Scope Model separate the model along a Focus and Purpose axis and a Conceptual and Definitional axis. The Focus part of the model identifies what concepts are of immediate interest and the Purpose identifies why those concepts are of interest. The Conceptual part of the model identifies the concepts with minimal attribution necessary to uniquely identify the concept and attributes that will be discussed presently. In the Definitional part of the model, concepts are concretely defined. This use of identity independent of attribution was described by Bunge (1979).

The environment described within the Scope Model is anchored in prior research. Each of the four quadrants described in the scope model is based on Peirce's *Thirdness* (Peirce 1891), where *Thirdness* is represented by Intent and Rationale in the left hand side and Outcome in the right hand side of the Scope Model. Peirce and Whitehead noted that an entity is classified based on intention (*Thirdness*) of some perceiving agent (Sowa 2000). Entity is represented by Object in the left hand (Conceptual) side and Resource in the right hand (Definitional) side of the Scope Model and the agent is represented by Observer in the left hand side and Agent in the right hand side of the Scope Model.

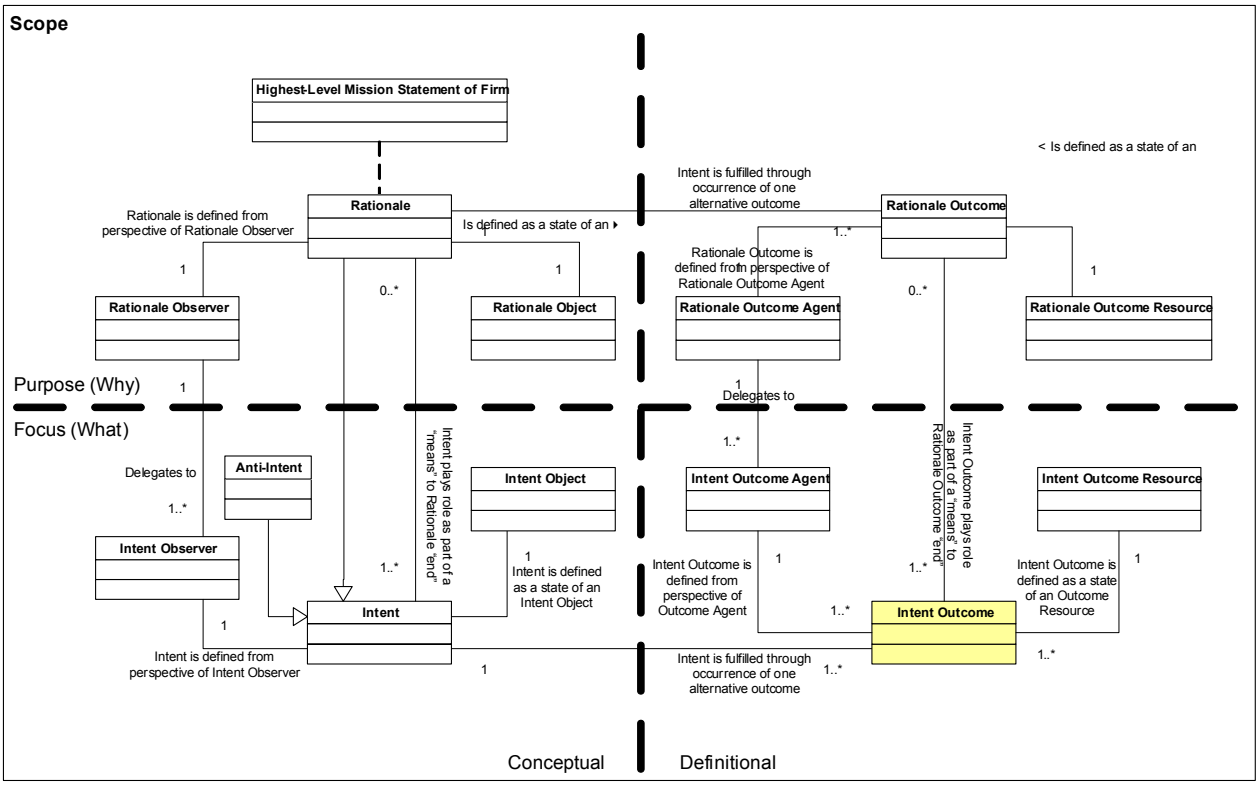

Figure 1: Scope Model of Intent Outcome

The Conceptual Focus quadrant contains four entities. Two of the entities (Intent Observer and Intent Object) have been previously defined based on Peirce and Whitehead's observations. The Intent construct, previously defined as Peirce's *Thirdness*, is more specifically defined according to Searle's intentionality definition: "intentionality is that property of many mental states and events by which they are directed at or about or of objects and state of affairs of the world" (Searle 1983). The construct Intent in this model is defined as the desired state of an object (Intent Object) from the perspective and mental state of the observer (Intent Observer). Intent in the model provides the lens through which success is measured and is a desired state of the world to be sought. Anti-Intent is a special case of Intent such that where an Intent is desired and sought, an Anti-Intent is not desired and is avoided (e.g. litigation or bankruptcy, etc.).

The Conceptual Intent uses the same definitions for constructs as Conceptual Focus, with additional relationships. Rationale is an Intent which represents the reason a lower-level Intent is desired. The relationship between Rationale and Intent expresses that an Intent plays a role as "part of a means" to achieve the Rationale "end", or from a Rationale point of view, a Rationale is achieved through achievement of one or more Intents. A Rationale Observer may delegate responsibility for Intent achievement to another Intent Observer or may delegate that responsibility to himself, or herself. The hierarchical relationship continues upward to the highest-level mission statement of the firm as represented by the dashed relationship line between it and the Rational construct. The use of a hierarchical structure to represent complex systems was described by Simon (Simon 1996).

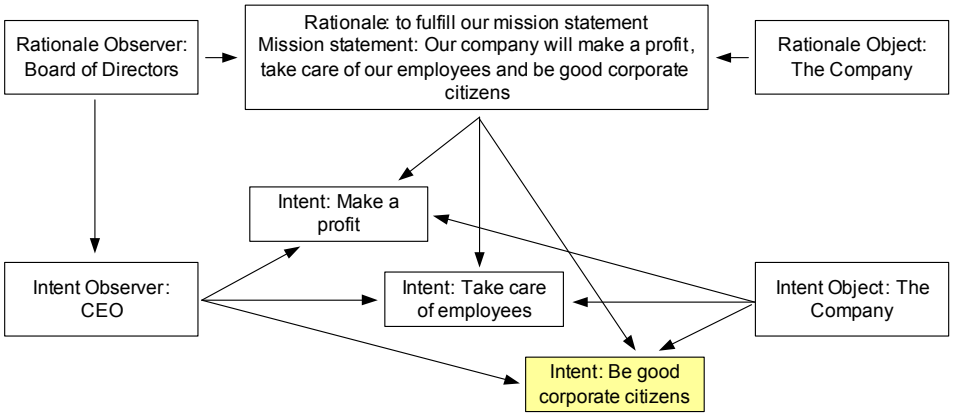

Figure 2: First-Level Conceptual Example

Scope instantiations of the left two quadrants of Figure 1 are shown in Figure 2 and 3. The highest-level Rationale is to achieve the company mission where the Rationale Observer is the Board of Directors and the Rationale Object is the Company. In the example shown in Figure 3, the "Achieve Mission Statement" Rationale is broken down into three Intents: make profit, take care of employees, and be good corporate citizens. The Board of Directors delegate responsibility of the Intents to the Chief Executive Officer (CEO) and all of the Intents are states of the Company, which is the Intent Object. Achievement of the Rationale will require achievement of each of the Intents. This is a recursive structure as shown in the relationship between Figure 2 and Figure 3.

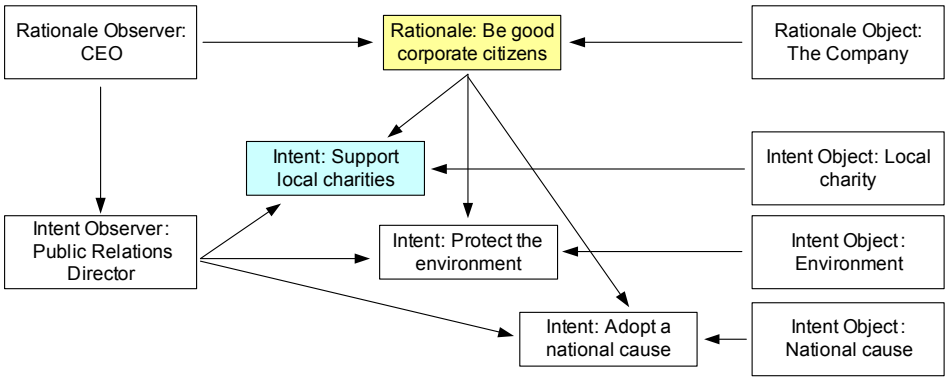

Figure 3: Second-Level Conceptual Example

The Conceptual Focus and Intent definitions are similar to those of Definitional Focus and Intent, but with notable exceptions. While the Conceptual constructs contain minimalistic attribution, the Definitional constructs are fully attributed.

Because they are fully attributed, Definition constructs include sufficient information to permit determination that the current state of the world is the desired state of the world, or not. The naming differences between Intent and Outcome, Observer and Agent, and Object and Resource are intended to highlight these differences. It is important to note that the Rationale Outcome provides the environment within which the Intent Outcome's occurrence will be judged (Simon 1996).

An example of the Definitional quadrants (right side) of the Scope Model extends the conceptual example in Figure 3 and is shown in Figure 4. The Rationale, "be good corporate citizen", has an alternative means (there could be many alternatives) of achievement defined for it, which is the Rationale Outcome "Receive National Service Award". One step in achieving that award is to demonstrate support of local charities through funding. Thus, an Intent Outcome is defined that will fund local charities; this will be further detailed in later models. Additionally, this Intent Outcome is in alignment with the Intent "Support Local Charities" such that occurrence of the Fund Local Charities is considered an alternative means of achieving the Support Local Charities Intent.

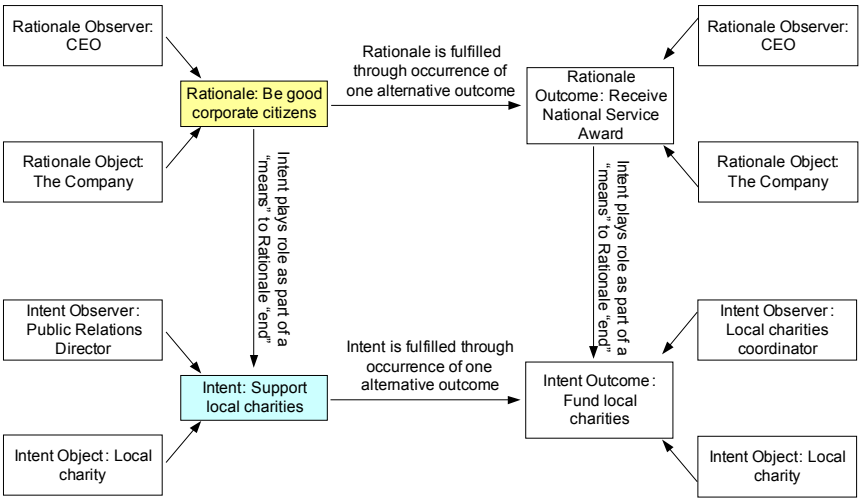

Figure 4: Definitional Example

The Scope Model defines the environment within which the Intent Outcome (highlighted in Figure 1) model is expected to apply. The proposed Intent Outcome models begin definition of a reference architecture of organizational Intent to provide the needed vocabulary, rules, and structure for development of strategically aligned enterprise architectures.

CONSTRUCTS

The constructs of the artifact identify and define the entities of interest, whether they are physical phenomena or abstract theoretical terms (Gregor and Jones 2007). There are a number of constructs used in the two proposed models of Intent Outcome. The first model of Intent Outcome, as shown in Figure 5, will describe the general case of any Condition of Satisfaction (COS).

The second model describes one special case of a COS, an Intent Outcome; when an Intent Outcome occurs then an Intent has been fulfilled. More specifically, an Intent Outcome is a fully attributed definition of a desired state of the world that provides enough information to enable the decision that the current state of the world is the desired state of the world.

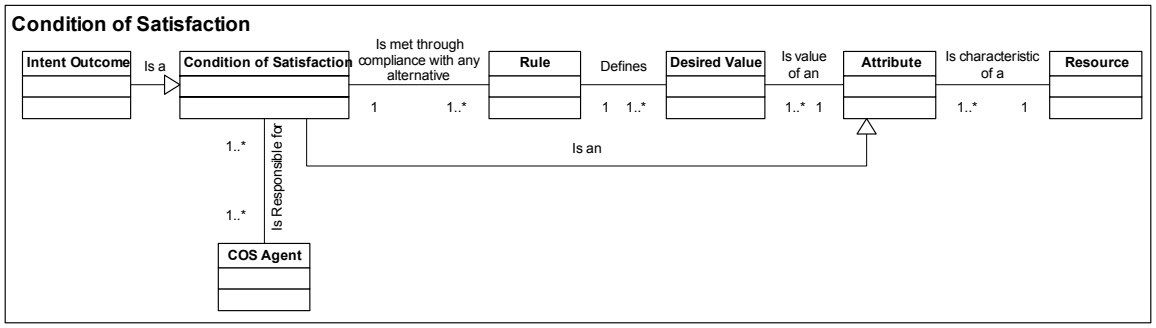

Figure 5: Condition of Satisfaction (COS) Model

A general model for a Condition of Satisfaction includes six constructs.

- Condition of Satisfaction (COS)
    - COS is defined by Searle within the context of intention. "Intentionality is not an ontological problem (what is a belief really?); the answer has to be given, at least in part, in terms of the logical properties of belief: a belief is a propositional content in a certain psychological model, its mode determines a mind to world direction of fit, and its propositional content determines a set of conditions of satisfaction" (Searle 1983). More specifically in this model a COS can be conceptualized as a pre-condition to achievement of some Intent that is represented as a Boolean field that is set to "Y" when the COS is satisfied.
- COS Agent
    - COS Agent is analogous to the Intent Agent (Figure 1) concept in that the COS Agent has been delegated responsibility for the COS. While the delegation of responsibility implies an individual or organizational responsibility, it also includes the infrastructure support needed to achieve the Outcome. Under this expanded definition, software (including applications, components, and other services) and technology infrastructure (including networks and other technology used in communication) are COS Agents.
- Rule
    - Rule is a single alternative string of logic that defines a desired state of the world. Rules within this model do not contain "OR" as this expression suggests another alternative and thus another Rule. Rules identify Desired Values of one or more Attributes.
- Desired Value
    - Desired Value identifies the value for an Attribute as it is required to comply with a Rule.
- Attribute
    - Attributes are Resource characteristics whose current values will be compared to the Desired Values.
- Resource
    - Resources are Objects that the firm uses or manipulates to achieve intents. Information is a Resource and is represented under this construct.

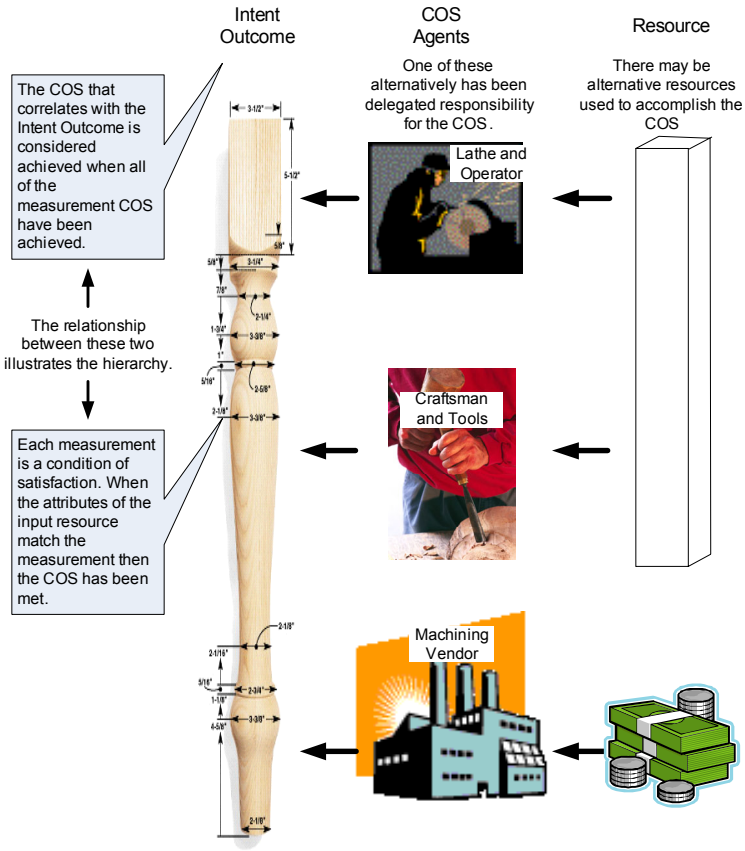

Figure 6: COS Example

An example in Figure 6 illustrates the COS model, but the use of the model is not limited to manufacturing of a product part. The COS model can be used at the strategic-level as shown by extending the example in Figure 4 using the "Fund Local Charities" Intent Outcome. The COS associated with this Intent Outcome would be represented as net profit (Resource) that has been donated (Attribute) with a Desired Value of 1% by the Local Charities Coordinator (COS Agent). This definition results in one alternative means of achieving the Outcome (Rule) being satisfied for the charity (Intent Resource) being funded (Intent Outcome) by the Public Relations Director (Intent Agent). Other funding schemes could be defined as alternative means.

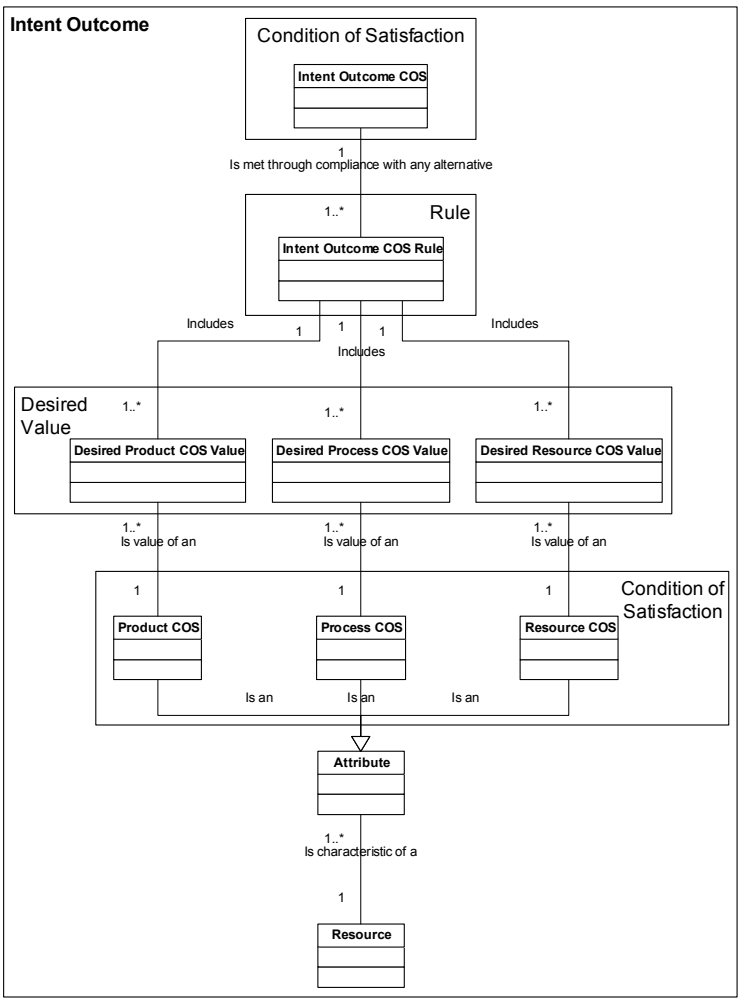

Figure 7: Intent Outcome Model

An Intent Outcome is a special case of the COS model (Figure 7) whose composition contains some specific sub-types of COS necessary to state that the Intent Outcome has occurred. It is proposed that the specific COS sub-types of an Intent Outcome are required because an Outcome must meet Conditions of Satisfaction in three areas: product, process, and resource. Support for this proposition comes from Lederer and Sethi (1988) who categorized IS planning problems into these three categories. As "problems" suggest not achieving the desired Outcome, then these "problems" should be considered a component of achieving the desired Outcome. Adding the special sub-types refines the model for Intent Outcome as shown in Figure 7. While the definitions for the constructs Condition of Satisfaction, Rule, Desired Value, Attribute, and Resource remain the same, there are eight additional constructs which require definition:

- Intent Outcome COS
    - Intent Outcome COS has been previously defined through the definition in Figure 5 that an Intent Outcome is a COS. It is made explicit here to show that this model only applies to Intent Outcome COS's.
- Intent Outcome Rule
    - Intent Outcome Rule identifies a special type of Rule where Intent Outcome occurrence requires the simultaneous compliance with a Product, Process, and Resource COS.
- Product COS
    - Product COS identifies Rules by which the appropriate deliverable (state of a Resource) with all required characteristics was delivered by the Outcome.
- Process COS

- Process COS identifies Rules by which a satisfactory set of methods were used to achieve the Outcome.

- Resource COS
  - Resource COS identifies Rules by which a satisfactory application and quantity of schedule, budget, and other Resources were used to achieve the Outcome.

- Desired Product COS Value, Desired Process COS Value, and Desired Resource COS Value
  - All of the Desired Values must be "Y," as a COS is represented as a Boolean field. The alternative levels of each are defined by their Rules, and the Intent Outcome COS Rule identifies the alternative sets via different Product, Process, and Resource COS's.

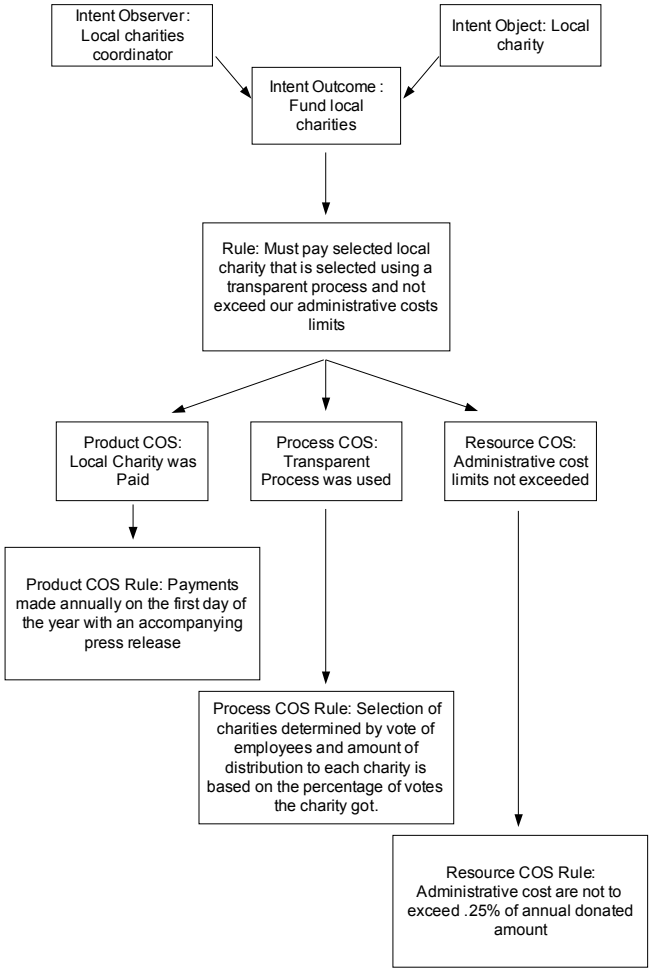

Figure 8: Intent Outcome Model

An example of this Intent Outcome special case can be found in Figure 8, and the example extends the Fund Local Charities example introduced in Figure 4. For the Fund Local Charities Intent Outcome to be considered successfully occurred, each of the three COS (Product, Process, and Resource) must be met. Each of the COS's shown in this example follow the same structure described in Figure 5 but the structure has been abbreviated in this illustration. If any of the Rules are not met then the Outcome has not occurred under this Rule. Other Rules can be defined to create other scenarios which may be met.

PRINCIPLES OF FORM AND FUNCTION

The principles of form and function describe the structure and functioning of the artifact (Gregor and Jones 2007). The approach presented enables the firm to identify their Intents, model the Conditions of Satisfaction that define Intent achievement, identify the Agents responsible for those Intents, and identify the Resources necessary to achieve those Intents. Additionally, the models permit viewing the alignment structure from perspectives of Product, Process, and Resources as an Intent Outcome cannot be seen as successfully occurred if all three perspectives are not in compliance. These models show an

integration of multiple hierarchies including responsibility (Agents include the notion of a software system and the organizational structure), Intent (what lower-level Outcomes must be achieved in order to achieve higher-level Outcomes), and Resources (including the role structure of Resources used to achieve the Intent and the organizations classification schemes for Resources i.e. facilities and equipment, consumables, capital, etc.). These models provide the underlying information that may best be viewed using a network science approach in which the strength of relationships can be identified from the interaction of the hierarchies. The clustering of Resources, Agents, and Intents can show the organization that best supports the Intent of the firm.

The proposed approach is consistent with leading IT-Strategy Alignment models such as the Strategic Alignment Model (SAM) (Henderson and Venkatraman 1991). Each of the choices referenced in SAM can be modeled as an Intent. For example, Business Scope decisions about where the firm will compete with regard to product type, market, geography, and customers can be modeled as Intents, as can the IT Infrastructure decisions about the rules, priorities, and policies concerning the data, application, and hardware architectures.

Determining the gaps in the enterprise architecture with regard to strategic alignment is attributable to viewing the Intent structure for Agent and Resource coverage. Since Agents include IS applications and components, the gaps are found where there are no, or few, IS Agents (the applications and components of the Enterprise Architecture). Since information is a Resource and supplied by IS databases, the gaps are found where the information cannot be supplied by IS databases. The gaps are filled through a process of review, definition, prioritization, and selection of projects to fill those gaps.

IMPLICATIONS AND LIMITATIONS

Implications for Research

The implication of the proposed approach is the potential to begin to view the actual interactions between the Resources, Agents, and Intents of the organization independent of process. This independent view based on the interactions of hierarchies opens up new avenues of approach for research with regard to enterprise architecture. Specifically, the interacting hierarchies in the fashion described by the approach may permit the use of network science to understand the strength of the relationships that may permit innovative views of how enterprise architectures could work.

Implications for Practice

The view of Resources, Agents, and Intents which is orthogonal to the process and software centric views may permit a refactoring of component boundaries. This refactoring may enable reduced redundancies and rigidity and permit a more adaptive approach to software development than has been possible in the past. This refactoring would be possible due to the network science view of the organizations possible with the approach.

Limitations

The proposed approach is at an early stage of development. The proposed approach does not cover all of the domains necessary for strategic alignment, and these additional models will move towards filling the gap. Additional models that are known and still need to be integrated into the intent-based approach are:

- A model of Product lifecycle must be added as it seems obvious that the planning for a Product is significantly different than performing routine Product production on an established line from each of the Intent, Agent, and Resource perspectives.
- A model of Process that to permit the transformation of Intent into a Process for achieving the Intent must be developed.
- Models that isolate the “concrete” Products (as in the ontological use of the word concrete) and information Products, such as decisions that control the production of concrete Products, must be developed.

Artifact Mutability

Artifact mutability describes the evolving nature of the artifact (Gregor and Jones 2007). The evolution of the artifacts is not detailed in this paper as a function of maturity and paper length limitations; however, some of the fundamentals of the changes in the artifact are apparent in the models presented. The models evolve from the minimal attribution of the conceptual views toward the definitional views as the Intent structure matures. Additionally, the limited binding to Process permits the more rapid adaptation of the Intent structure over time as the organization’s Intents change.

Testable Propositions

Testable propositions in the case of this design artifact at its level of maturity test whether the proposed approach is consistent when developed in an implementation (Gregor and Jones 2007). A significant amount of testing for validity must be performed for each model. The testable propositions of the proposed approach center on how these hypothesized relationships match with relationships found in practice. Gaps not covered by the approach must be explained and the models extended to cover the gaps.

CONCLUSION

Strategic alignment involves positioning the organization in the external environment and then organizing the internal arrangements to meet the needs of that external positioning. One of the internal arrangements that must be positioned is software and other information technology. Enterprise architecture enables strategic alignment through creation of a unified business and IS view of the target state of the business. This paper proposes such an approach for achieving alignment of the Enterprise Architecture that is based on the Intent structure of the organization. These models are grounded in Sciences of the Artificial (Simon 1996) and Aristotle's four causes as illustrated by Heidegger (Heidegger 1977).

The proposed approach fits the often cited Strategic Alignment Model (SAM) (Henderson and Venkatraman 1991). The choices referenced in SAM can be modeled as an Intent. Gaps in the enterprise are views of Agent and Resource coverage in the Intent structure. Where there are no, or few, IS Agents (the applications and components of the Enterprise Architecture) or no, or few, IS databases providing information Resources in the Intent structure there may be a lack of coverage (assuming coverage is required). The Enterprise Architecture may be brought into alignment by reviewing, defining, prioritizing, and selecting projects to fill those gaps.

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