Intellectual Property Exchange Between Two Partner Companies – Application of the Theory of Constraints Thinking Processes

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The problem of implementing a database for intellectual property sharing in a two company alliance is examined utilizing the Theory of Constraints Thinking Processes. The implementation of this database is required for new product development. Database implementation is hampered by internal policies, cost considerations, and strategic misalignment. A cause-effect analysis employing the Current Reality, Evaporating Cloud, Future Reality and Prerequisite techniques allows resolution of the conflict, resulting in a win-win solution and feasible implementation plan. This application of the Theory of Constraints Thinking Processes provides an excellent example for practitioners, academics and educators to examine the methodology and analyze its strengths.

The Theory of Constraints (TOC) began development with the introduction of Optimal Production Technology (OPT) scheduling and control computer software in the late 1970s (Lockamy & Spencer, 1998). Although TOC began as a production philosophy, it has evolved into three interrelated areas: logistics, problem solving, and performance measurement (Spencer & Cox, 1995). The problem solving techniques utilized in TOC, the Thinking Processes (TP), were introduced by Goldratt in 1990 and expanded in 1994 (Goldratt, 1990, 1994). The purpose of these techniques is to answer three simple, yet powerful, questions: (1) what to change; (2) what to change to; and (3) how to cause this change (Scheinkopf, 1999).

To answer the question of what to change, the TP use an effect-cause-effect diagram called the Current Reality Tree (CRT) to identify core problems that result in the current undesirable system outcomes. To address the question of what to change to, the TP utilize two techniques: the Evaporating Cloud and the Future Reality Tree. The Evaporating Cloud (EC) identifies prerequisite relationships between objectives and actions to expose what Senge (1990) calls mental models; the assumptions that underlie our perceptions and actions, to expose faulty logic allowing conflicts to be resolved in a win-win manner. The Future Reality Tree (FRT) is an effect-cause-effect diagram used to analyze the solution determined by use of the EC to test this solution and to predict potential problems within the system that may occur from its implementation. The Prerequisite Tree (PRT) and Transition Tree (TT) are then utilized to plan for and control the implementation of the solution.

The Thinking Processes have been successfully utilized and expanded over the last decade to address general managerial problems (Hsu & Sun, 2005; Schragenheim & Pascal, 2005; Shoemaker & Reid, 2006; Walker & Cox, 2006), as well as to solve very specific issues in business strategy and competitiveness (Gupta et al., 2004; Polito et al., 2006; Taylor & Ortega, 2004;), improvements in manufacturing and supply chain (Cox et al., 1998; Ehie & Sheu, 2005; Gattiker & Boyd, 1990; Rahman 2002; Umble et al., 2006), business finance (Taylor & Churchwell, 2003, 2004; Taylor & Thomas, 2008), government (Schoemaker & Reid, 2005), human resource development (Cox et al., 2005) and service management (Breen et al., 2002; Reid & Cornier, 2003). They were also applied to education (Cooper & Loe, 2000; Musa et al., 2005; Sirias, 2002). The variety of applications shows that the methodology is embraced by both academics and practitioners across many fields. A comprehensive review of the literature is provided by Kim et al. (2008), which also encourages further research work and publication of practical implementation cases to further solidify the available know-how about this methodology in academic and practitioner literatures.

Encouraged by Kim's work (2008), the present study utilizes the TP as originally discussed by Scheinkopf (1999) to identify and address policy constraints encountered during the development of a shared information database for the dissemination of intellectual property between two technology companies. This business situation clearly showcases the strengths of the TP, as they allow a step-wise detangling of core problem drivers, perceived positions, and underlying assumptions, resulting in a simple and practical solution to a problem that otherwise would have been moved to a critical top management escalation level.

As practitioners in all fields of business constantly face problem scenarios that involve facts, opinions, perceptions and other mental models, this paper hopes to further encourage the use of the Thinking Processes by exemplifying their logic and effectiveness, and to add another example to the academic literature. Additionally, educators may find this case to be a useful tool for teaching the TOC TP.

The Case

Companies A and B are technology manufacturing companies, with headquarters in Europe and Asia. These companies have formed a joint technology development alliance (JTDA) with the physical location of the alliance engineering team at Company B in Asia. The objective of the team is the development of a certain technology from which a range of new products will be developed, manufactured, and marketed by both. Company B is also contracted by company A as an outsourced manufacturer and serves additional companies in a similar capacity. The technology developed by the JTDA will be utilized in production by both Company B to serve Company A and others. However, Company A also keeps some in-house manufacturing facilities located in Europe where it will also implement this new technology.

During the development, a significant amount of intellectual property (IP) is generated, describing the technology and its underlying features. This IP is the prerequisite for developing new products and implementing manufacturing processes. With the recent joint development agreement, it is necessary to provide an IP management system to collect and exchange IP within the engineering team and to distribute to both companies' manufacturing facilities (the technology development does not take place within a productive plant). Additionally, there is a constant feedback loop between technology, product and manufacturing development of both companies to ensure that the underlying technology supports planned products and is manufacturable. Access to the development information by the respective departments of companies A and B and the ability to provide feedback is therefore crucial for a successful development.

Some of the IP is well-documented (i.e. available as *explicit knowledge*). However, a large part is the knowledge and experience of the individual engineers that are employed by either of the two companies (tacit knowledge). Explicit knowledge captured in official documents can be exchanged through contractual documentation procedures. To tap into the *tacit knowledge*, it is common practice to utilize databases of varying sophistication that allow functions from simple information sharing to discussion between team members and specialists.

As the JTDA operates in the facilities of Company B, such a database must be consistent with Company B's information technology infrastructure. Both companies have already adopted separate commercial software systems with database and communication solutions, and these are the only packages supported by each company's internal Information Technology (IT) groups. Therefore, the IT policies of both companies limit the possibilities to identify and adopt a software system for knowledge sharing that is supported by both firms.

With the two companies working on the implementation of a joint technology development team, a significant effort in analyzing and understanding each other's work environments, procedures, and attitudes is required. Both companies view the JTDA as key to future success so there is great interest to make all steps of the team build-up smooth. However, the competition that exists between both companies with regards to manufacturing capabilities and products makes integration complex. Although Company A contractually secured usage of the jointly developed technology to manufacture in its own facilities, Company B wants to keep the outsourced manufacturing of future products of Company A. Hence, Company B has a weak incentive to support a software system which can easily be used by Company A to transfer IP back into its own environment. Company A, on the other hand, views the timing of the database implementation as critical, as the development work started without having the appropriate IP management infrastructure in place, thereby inhibiting communication, knowledge exchange and feedback loops between the JTDA and the parent company. Figures 1 and 2 provide schematics of this situation, from the viewpoint of Company A and Company B.

Although it seems from the onset of the alliance that implementation of a database should be a minor issue to start IP sharing, the complexity of the decision-making environment warrants a careful analysis of all details within both companies, as well as of their mutual interfacings.

The Thinking Processes of the Theory of Constraints were found to provide an excellent tool set to accomplish this challenging task. The following sections describe the successful application of the Current Reality Tree, Evaporating Cloud, Future Reality Tree and Prerequisite Tree to this problem. The results of this analysis make it possible to establish a clear implementation path for a mutually agreed-upon knowledge management system. The analysis is performed by a member of Company A's project management team working on tactical aspects of JTDA implementation and takes on the perspective of Company A during the implementation phase. The objective is to overcome the lack of an IP sharing mechanism on a tactical level while still being within the strategic environment of both companies.

Analysis of the Theory of Constraint Thinking Processes

Current Reality Tree

The Current Reality Tree (CRT) is used to describe and define the momentary situation of the system in a cause-effect relationship. The objective of the tool is to find an answer to the question: "What to change?" in order to determine the core problem and core drivers of the system. The purpose here is to identify why IP sharing within JTDA, as well as between JTDA and companies A and B, is not immediately taking place. The system of each company's product development and manufacturing environments includes the available IT infrastructure, technical requirements as well as policies. As explained above, both Company A and B have legacy database systems in place. Figure 1 shows that Company A wishes unhindered IP flow between all entities, whereas Figure 2 depicts the reluctance of Company B to enable free IP flow to Company A.

Figure 1: *Schematic View of the System, Viewpoint of Company A*

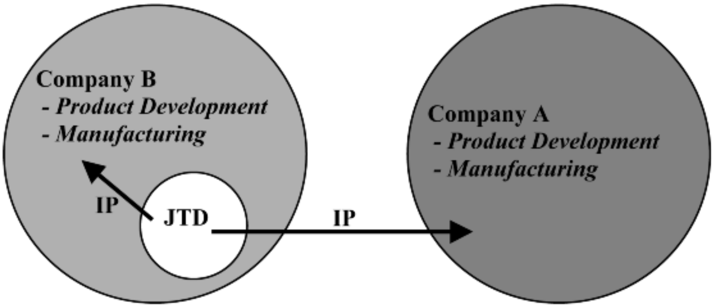


Figure 2: *Schematic View of the System, Viewpoint Company B*

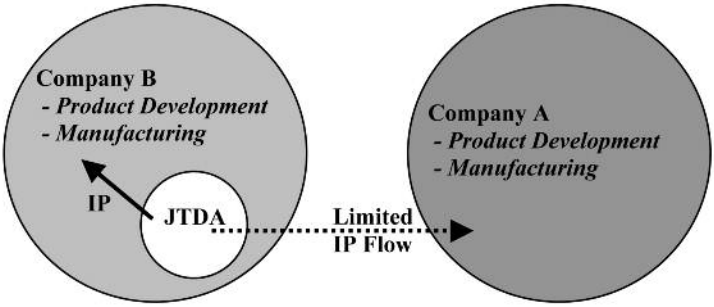
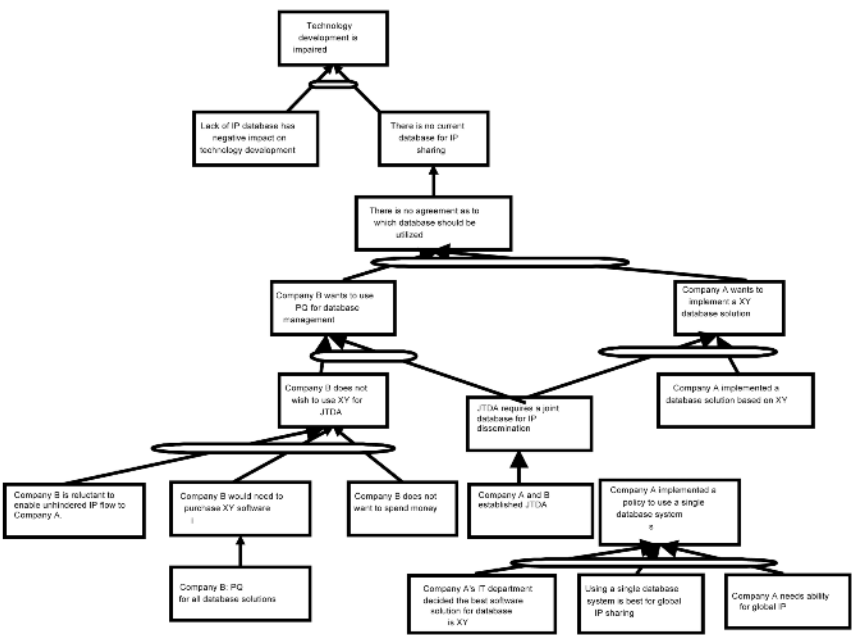


Figure 3 depicts the CRT. Arrows connect causes to effects, with ovals symbolizing where more than one cause comes together resulting in one effect. The right side of the diagram focuses on Company A, beginning at the bottom. Company A is currently engaged in operations on a global basis, requiring equally global IP exchange. IT management considered it most efficient to use one database system across the company and determined that software solution XY fulfills all requirements best. Therefore, a policy was implemented; defining that software XY is to be used at all locations to facilitate and standardize information and IP flow. Although the JTDA is not operating at a location of Company A, the dissemination of IP from the JTDA to various departments within Company A is considered to fall under this policy. Therefore, Company A wants the JTDA to utilize XY software for the needed IP transfer database.

Figure 3: *Current Reality Tree*



The other side of the diagram depicts the situation of Company B, who utilizes a different software solution (PQ) for database management and would have to acquire software XY. As Company B does not wish to incur additional expenses for software and support of XY based databases, and as it has fewer incentives than Company A to implement an easily exchangeable database, Company B would like the JTDA to implement PQ for database management. Thus, there is no agreement between the companies pertaining to the type of database that will be established. The absence of IP sharing, however, impairs the successful development work of the JTDA, as critical feedback loops to manufacturing and product development are missing.

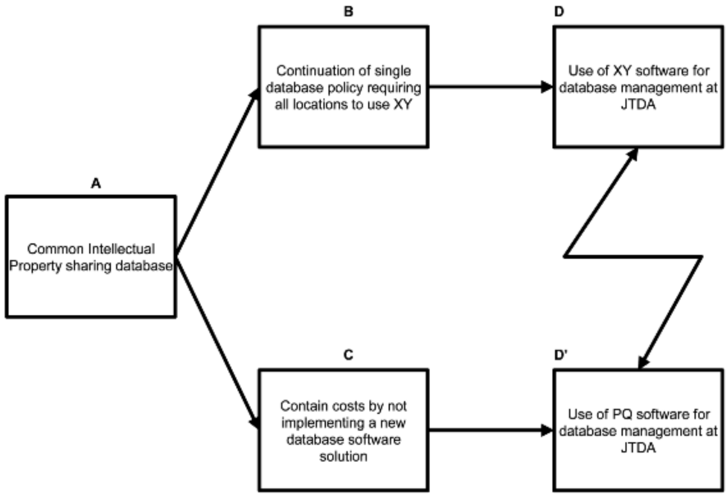
Analyzing this situation with the CRT, therefore allowed for a clear determination of the core problem for the lack of IP sharing between JTDA and Companies A and B: the inability to agree to a common database solution. The strength of the CRT tool lies in its capability to determine the core drivers that result in the entrenched positions taken by both companies. Company A is constrained by its internal policy to use the XY software package. Company B is constrained by cost containment considerations and strategic motivations. In the next step, the Evaporating Cloud technique is utilized to uncover potential solutions to these (perceivably mutually exclusive) positions that could result in a win-win outcome for both companies.

Evaporating Cloud

The Evaporating Cloud (EC) is constructed using the following logical connections: A common objective is defined, which is derived as being the opposite of the core problem (as identified by the CRT). Then the prerequisites required by both parties to accomplish the common goal are listed. Lastly, these prerequisites are connected to the underlying "wants" of each party.

First, the opposite of the core problem is defined: "lack of IP sharing database" thus becomes "common intellectual property sharing database" and is placed in box A in Figure 4. Once this common objective is established, each company's prerequisites for achieving it are placed in boxes B and C, respectively. In this case, the prerequisite for Company A (box B in Figure 4) is the continuation of a single database policy requiring all locations to use XY. The prerequisite for Company B (box C in Figure 4) is to contain costs by not implementing new database software. The strategic motivation of Company B to gain future manufacturing contracts from Company A - realized through the reluctance to support easy IP flow (see Figure 2) is considered to be an element of the strategic environment in which this analysis was performed. This allows identification of the causes (wants) for the present positions for both companies: Company A wishes to use XY software (box D in Figure 4) while Company B wishes to use PQ software (box D' in figure 4). The EQ now clearly represents the reasons why the common goal cannot be accomplished. It also structures complex situations in three simple categories: namely the common goal, the parties' prerequisites, and how each plans to accomplish these and the common goal. A pair of mutually exclusive positions, at first site, is now stated, denuded of all overlying arguments.

Figure 4: *Evaporating Cloud Diagram*



Depicting the problem in such a precise manner now allows the builder to uncover assumptions and to validate the truth and applicability of the underlying arguments. Such assumptions are discovered by stating the argument in the following manner: "In order to achieve (prerequisite), I must have (want) because…(assumption)." For example, for Company A, the sentence reads: "In order to achieve a single database policy, we want the JTDA to use XY software, because…."

As box D and D' create the conflict, the assumption underlying the conflict is that they are mutually exclusive. Once the assumptions underlying the conflict are surfaced, flaws in the logic are determined to overcome the faulty assumptions by using so-called injections (solutions) that "break" the assumption. The injections are then analyzed to determine the one with highest potential for implementation.

Among the assumptions identified within the argument, four were flagged for further evaluation and are summarized in Table 1, together with injections and their evaluation of potential for implementation. Figure 5 depicts the revised EQ including the assumptions and which connectors they appear to support.

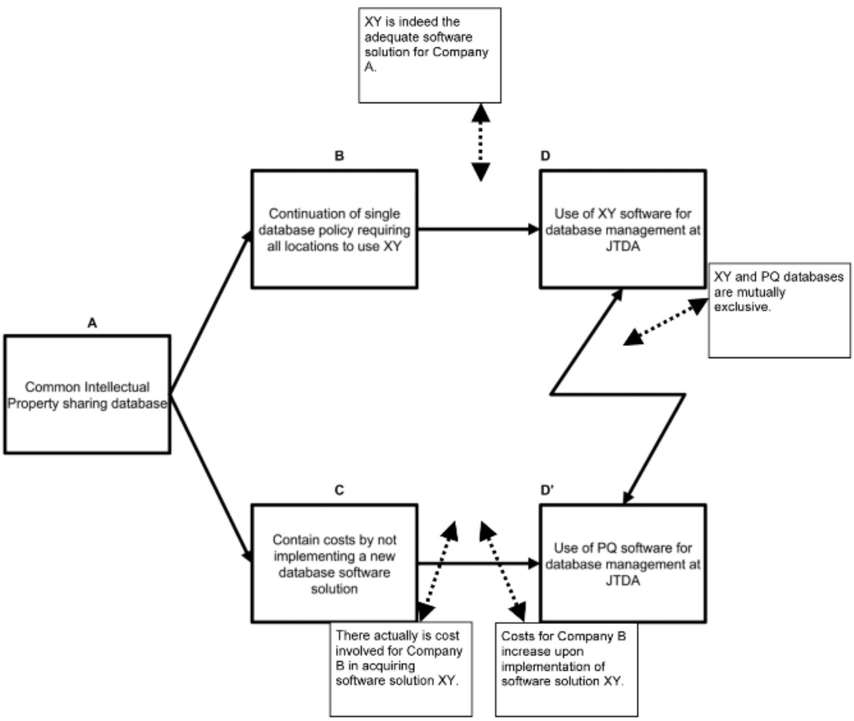
The first assumption, identified between C and D', is that there are actual costs associated with the implementation of new database software by Company B. The injection that breaks this assumption is the development of a cost sharing model between the two companies. This is a practical injection, and Company A's management indicated agreement.

The second assumption identified is also along the C-D' axis: the cost of purchasing and maintaining the XY software package increases costs for Company B. However, if it is possible to find efficiency benefits for B to use the software proposed by A, a win-win situation can be created. There is, however, the risk that a lot of time is spent without convincing Company B. Hence, while this injection is possible, it has some uncertainty.

Table 1: *Assumptions identified using the EC tool, injections and assessment of feasibility*

Entities connected by Assumption	Assumption	Injection	Feasibility
C and D'	There actually is cost involved for Company B in acquiring software solution XY.	Cost sharing Model between both companies.	Management of company A is willing to consider this solution.
C and D'	Costs for Company B increase upon implementation of software solution XY.	Find efficiencies for Company B when implementing software solution XY.	Uncertainty that Company B can be convinced.
B and D	XY is indeed the adequate software solution for Company A.	Evaluate if software solution PQ fits requirements and provides additional benefits for Company A.	Time-consuming review process might not result in actual adoption of PQ. Possible internal resistance.
D and D'	XY and PQ databases are mutually exclusive.	Ability to replicate PQ database into XY database.	Fulfills prerequisites of both companies. IT resources need to be confirmed.

Figure 5: *Revised Evaporating Cloud including uncovered underlying assumptions*



The third assumption along the B-D axis is that XY software is the correct database solution for Company A. The injection that may cause this assumption to be invalidated is to review A's database requirements (features, functions) and compare with B's solution. If PQ software offers greater benefits than XY, adoption of PQ by Company A renders the conflict moot. Again, this injection may result in a loss of time for implementing a common database at JTDA, as a review of the software packages may not identify benefits to Company A. Furthermore, it is complicated by political resistance against a change of a recently implemented global IT policy within Company A.

The fourth and final assumption is that the PQ and XY software are mutually exclusive. This assumption can be invalidated if the software packages are not mutually exclusive. It seems surprising that this aspect was not investigated from the beginning. However, as JTDA negotiations took place at a managerial level, IT personal was not involved. Once IT specialists were included in the discussion, it was quickly discovered that a replication agent can be programmed to function as an interface between PQ and XY. This injection is obviously the most practical as it addresses Company B's preference, while keeping Company A's internal policy in place.

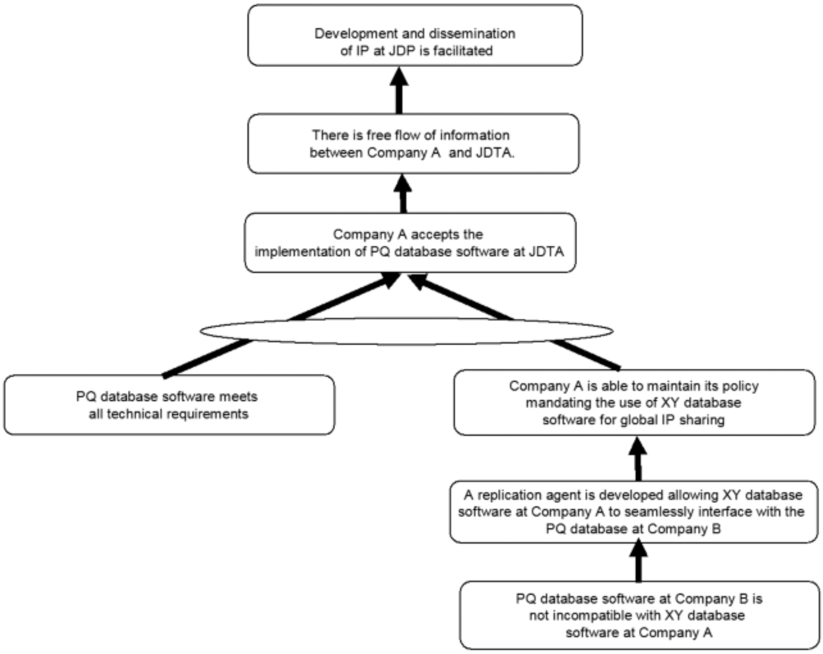
To summarize, the EC provides a feasible and practical injection to overcome the disagreement on which database software packages to utilize for IP sharing between the two companies and JTDA. This conflict initially resulted from the core drivers of an internal IT policy constraint (Company A) and cost considerations (Company B), and the perception that these drivers create a problem that cannot be overcome without significant compromise on either one of the sides. The injection chosen allows both companies' prerequisites to be achieved, and the presumably unsolvable core problem and mutually exclusive positions are "evaporated"!

Future Reality Tree

The FRT, as shown in Figure 6, is constructed next to depict the cause-and-effect relationships of the solution found in the previous step and also to answer the question "What to change to?", as well as to identify possible unwanted consequences. The base of this tree is the injection (solution) from the EC – namely, that the software packages are not mutually exclusive. A replication agent is developed at Company A, which allows the firm to replicate databases from PQ to XY and to maintain its IT policy. As Company B's PQ database system fulfills all requirements, Company A accepts the use of this system at the JTDA, and the free flow of IP can finally start. The initial problem statement from the CRT is thereby solved. Now each step of the FRT is tested to identify any potential negative consequences. Two are discovered: First, the injection, (i.e. development of a replication agent), requires resources from Company A's IT group that are not planned for. Second, keeping Company B's strategic reluctance for information sharing in mind, other obstacles to hinder information flow should be anticipated. The latter requires management of Company A to review the relationship-building process, a question that is outside the scope of this paper.

The Prerequisite Tree (PRT) is used next to address the uncovered consequence of IT resources at Company A.

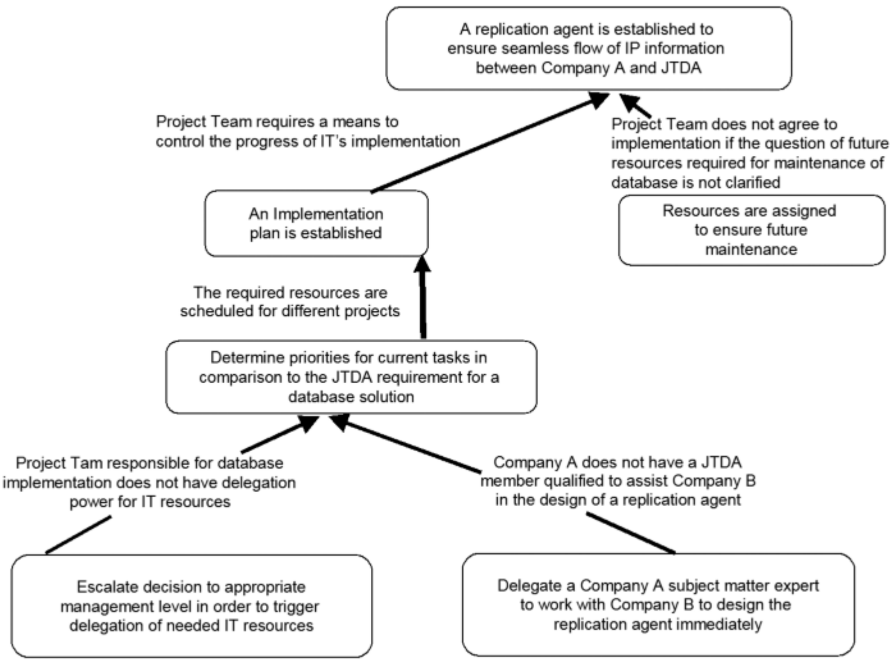
Figure 6: *Future Reality Tree*



Prerequisite Tree

This tool finally allows for the clarification of the detailed actions required at Company A to reach the objective of the FRT, hence answering the question of "How to cause the change?" The result is depicted in Figure 7. This step is particularly crucial as it also allows uncovering potential further consequences of the attempted solution. The graph needs to be read in the following manner, starting at the bottom left: As the project team that decided on the implementation of the replication agent does not have power over IT resources, an escalation to a higher management level is needed. Also, as none of the JTDA members are qualified to support the programming effort, Company A needs to delegate a subject matter expert to this task. Together, these two actions result in determining resource priorities. As all resources are currently scheduled for other projects, an implementation plan is created that re-assigns project priorities, tasks, and experts. The project team requires control over the implementation as well as assurance of future resources, and the implementation plan together with future resource assignments results in the successful implementation of the replication agent. The last tool of the TP is the Transition Tree, that spells out more details of the change process. The tool was not used, as the project team handed over responsibilities to IT.

Figure 7: *Prerequisite Tree*



Coda

Looking at the successful application of the TP, the question remains whether at the end, IP flow between the JTDA and Company A is taking place at a satisfactory level.

The story evolved as follows: The technical obstacles were indeed overcome, enabling database replications into Company A's XY systems. However, and as suspected, this did not guarantee the attempted information flow, as Company B inhibited it by other means. For example, by not adding the required information to the database, by using native language not understood by the majority of Company A's JTDA members, and by significantly restricting the access of the latter to critical technology know-how within the alliance. The lesson learned is that the TOC TP enabled the project team to solve the issue of hindered IP flow on the tactical level. However, it was outside of the scope of this team to address the underlying strategic misalignment of the two firms. Forming successful alliances requires managerial effort in trust and relationship building, which may not have taken place sufficiently. The respective management levels probably would have been well-served conducting their own analysis of why the approach to the alliance was different between Company A and B, and using the TP tools would have allowed uncovering underlying assumptions and strategic misfits. Without this being done, it is no surprise that the development alliance was dissolved ahead of contractual agreements.

Conclusions

The objective of the presented analysis is to describe how two firms, A and B, can agree on the implementation of a database for a common JTDA team. Company A's specific requirement is that the information stored in the JTDA database can be utilized within A though JTDA is physically located at Company B. Company A is additionally constraint by an internal policy to use a single database software solution (XY). Company B, which does not have XY software, is driven by factors of cost and practicability and therefore wants to use PQ database software. At first, the situation looks like a conflict of mutually exclusive positions without promising solutions.

The Thinking Processes of TOC allow a detailed analysis of the system and provide a practical solution to the perceived dilemma. The development of a Current Reality Tree, which determines what in the system needs to be changed, determines a core driver to the conflict. Using the tool Evaporating Cloud, the core driver is subjected to a conflict resolution process. This process provides a solution to the problem, eliminating the core driver, and making the conflict moot.

The benefit of the EC is that it allows the complexity of the system, in which an agreement must be reached to be simplified and broken down into discrete units for investigation. This allows the Thinking Process techniques to disclose assumptions of varying credibility. As such, it is a very efficient way to establish perceived cause-effect relationships, to unveil political issues or to stop hidden personal agendas, which are all common in any type of organization. To give an example: in the case presented in this paper, the discussions leading to the construction of the Evaporating Cloud brought to the surface that the two software solutions currently used by Company A and B, respectively, are actually compatible, and not mutually exclusive as initially assumed. Therefore, the responsible specialists at Company A determined that a database programmed in B's software can be replicated into the existing database at Company A. In the following, the use of the Future Reality and Prerequisite Tree allows a clear implementation plan to be developed that also uncovers and addresses the obstacle of IT resource constraints resulting at Company A.

Starting from a conflict situation with no visible solution or compromise, the analysis is able to untangle arguments and opinions, point to a route cause and from there, on to a practical solution. Application of the Thinking Processes of TOC proves to be an immensely effective way to overcome one of the many problems companies A and B are facing during the build-up of the JTDA.

This paper showcases the effectiveness and straight forward analytical strength of the TPs for change management. Although the methodology is purely qualitative, it allows decomposition of a complex situation through the logic of cause-effect analysis. Many other decision-making methods call for a quantitative approach. Examples of combinations of the TPs with such models are reported in the academic literature (Kim et al., 2008). However, as an important advantage, the qualitative nature of the TPs allows their use without major training or potentially time-consuming development of metrics. The case presented in this paper hopes to encourage practitioners to use TOC TPs', academics to further explore their use, and educators to include them in courses on change management or decision-making theory.

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