COLLABORATIVE COMMERCE: THE ROLE OF INTERMEDIARIES IN E-COLLABORATION

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ABSTRACT

We propose a model for implementing collaborative commerce in which independent companies form temporary alliances by combining their capabilities and capacity to meet market needs. Lessons from a case study of one of the earliest tests of agile collaboration among small firms, the Agile Web, Inc. guides implementation. The study illustrates that small firm owners may not have the expertise, time, or inclination to initiate new opportunities outside their existing markets, nor can they effectively manage across unfamiliar enterprises. An intermediary or a domain expert is required whose major responsibilities include: the identification of market opportunities, forming collaborative teams, and project managing the resulting virtual enterprise. Internet enabled information systems enhance the intermediaries' productivity, enabling speedy formation, design, and operation of these alliances.

1. Introduction

E-marketplaces today facilitate the trading of products and services, while electronic hierarchies support collaborative relationships among supply chain partners. Tapping excess capacity and forming temporary alliances of companies to meet new market demands can further enhance e-commerce, extending e-marketplaces through temporary collaborations. This requires agile companies to form and dissolve virtual organizations quickly. While the concept of agility has received much attention [11, 13] , its implementation has not.

An agile company is capable of operating profitably in a competitive environment of continually and unpredictably changing customer requirements [13] . Agility can be achieved in virtual organizations, opportunistic alliances of capabilities and available capacity distributed among a group of independent companies to provide a product/service to a customer. In a virtual organization, complementary resources existing in a number of cooperating companies are integrated to support a particular product effort for as long as it is financially justifiable. Resources are selectively allocated to the virtual organization if they are underutilized, or if they can be more profitably utilized. This minimizes not only the investment in personnel and facilities dedicated to the new project, but also the disruptive impact of new projects on existing operations. Since overhead is absorbed by current operations, the lower total cost basis provides additional opportunity for revenues.

The ability to work intensively with other organizations is enhanced by pre-qualification agreements based upon company attributes and contractual commitments. A more dynamic means of facilitating virtual organization formation than pre-qualification agreements are webs, open-ended collections of pre-qualified partners that agree to form a pool of potential capability and capacity for virtual organizations. The web is a virtual organization-enabling mechanism [13] .

While the concept of agile, virtual manufacturing may appear sound from a strategic business perspective, there has been little research on how to implement successfully agile webs, particularly among small firms. The concept assumes suppliers are knowledgeable about and trust others in the collaboration. Small firms may find the implementation of these webs to be especially challenging because their individualistic culture does not lend itself to collaborative efforts. Whereas conventional management makes no clear distinction between requirements and ways of satisfying them, management of a virtual organization separates abstract requirements from concrete satisfiers [30] . Traditional managers may have difficulty separating production competencies from core capabilities. In the current culture of small manufacturing firms, collaboration may best be achieved with an

external party that identifies opportunities and brings partners together. "Competitors will not come together unless they have an intermediary they can trust" according to Stuart Rosenfeld, founder of Regional Technology Strategies, Inc. [6] . There has been little research on the roles of the intermediary in an agile web.

There are also significant information management challenges for these webs [8] . Jarvenpaa & Ives predicted that without the technology platform to provide all the information needed, the emergence of agile enterprises would be unlikely [17] . Information technology enhances the productivity of a web. Specialized communication systems and databases, robust groupware with universal data standards, and availability of broadband communications have all been recognized as enablers of agile virtual enterprises [8, 18] . There has been little research on the types of systems that will be needed and exactly how these tools will support webs.

This paper introduces a model for collaborative commerce that effectively implements the concept of agile webs using external intermediaries supported by information systems. The major responsibilities of the intermediary are: the identification of market opportunities, forming collaborative teams, and project managing the resulting virtual enterprise. Productivity of the enterprise is increased by information systems support. This approach allows a supplier to remain passive in collaboration while moving the agility and integration process to the web management. The model is based upon a review of the literature on web management requirements and success factors in alliances as well as from lessons learned from a case study of one of the earliest implementations of an agile web.

The paper begins with a review of the literature on virtual organization management and success factors of alliances. We then describe the implementation of agility in the Agile Web, Inc., a U.S. government funded project begun in 1993 to define and test implementation strategy and operating procedures for an agile web of small manufacturers in northeastern Pennsylvania. The lessons learned from this project are discussed. A model for implementing collaborative commerce is introduced, focusing on how an external intermediary and information systems support the life cycle of an agile web.

2. Background

The virtual organization literature describes the advantages and characteristics of this form of organization [11, 13] . Since these are temporary alliances, they often have short life cycles and require specific management skills to form, operate, and dissolve. However, the literature does not address what factors are critical to the success of these temporary alliances. Thus, we draw upon the literature on success factors for strategic alliances, particularly among small firms. In a strategic alliance, the same partners work together over time, whereas in a virtual organization different combinations of organizations work together on specific projects for a limited time period. The temporary nature of virtual organizations introduces more challenges than the traditional strategic alliance, especially surrounding the issue of trust. Research has indicated the importance of having an intermediary with the proper technology to facilitate communication in strategic alliances.

3. Requirements and Life Cycle of the Virtual Organization

The virtual organization makes explicit the need for certain dedicated management activities called metamanagement tasks, which include: determining and analyzing customer requirements; tracking possibilities for satisfying these requirements; developing and allocating production tasks among members of the virtual organization; and assessing and adjusting tasks and allocation procedures [31] . These activities support the steps in the life cycle for agile virtual enterprises. The life cycle stages of an agile virtual enterprise are as follows [18] :

· Identification: Search for recognition of market opportunities

· Formation: Find potential partners

· Design: Develop specific detailed rules for executing the mission (material and information flows, controlling systems, legal framework, database, business rules, financial arrangements)

· Operation: Carry out the mission

· Dissolution: Archive mission information and distribute residual interests and obligations

4. Critical Success Factors for Strategic Alliances

While the literature on virtual organizations describes the characteristics of these organizations and their life cycle, it does not address critical success factors to carry out the activities required in these different stages. Critical success factors for strategic alliances, shown in Table 1, include trust, commitment, social embeddedness, and communication quality. The transitory nature of virtual organizations limits opportunities for social networks and hinders the development of trust and commitment. Other challenges include those associated with formation and dissolution as well as those associated with information management, which include security conflicts, project

management difficulties, incompatible organizational application systems, and information semantics [8] .

Table 1. Critical Success Factors in Strategic Alliances

Success factors	**Reference**
Commitment; Coordination; Trust; Communication quality and participation; Conflict resolution technique of joint problem solving	[27]
Trust and coordination; Interdependence; Information quality and participation; Information sharing; Joint problem solving; Avoiding the use of severe conflict resolution tactics; Existence of formal supplier/commodity alliance selection process	[28]
Social control mechanisms	[19]
Confidence resulting from trust and control	[10]
Positive reputation of partners; Shared decision making; Strategic similarity	[35]
Partner evaluation; Partner dominance; Government policies; Human resource management	[33]
Trust; Cooperation	[7]
Trust; Gatekeepers	[22]
Trust; Commitment	[29]
Trust	[40]
Social embeddedness	[14]

The development of trust among participants is crucial to the success of strategic alliances. While most strategic alliance research has focused on larger firms [16] , trust has been recognized as an important factor in small firm networks as well [21, 22, 32] . However, the development of trust among small firm competitors may be especially difficult to achieve, as individualistic forces in the U.S. manufacturing industry have worked against networking [5] . Companies have traditionally competed by maintaining proprietary procedures, products, or services; providing access to these "secrets" is tantamount to competitive suicide [26] . Additionally, smaller firms may lack both the time and resources to build trust [22] .

The transitory nature of the virtual organization exacerbates this problem particularly among small firms. Trust involves both cognition, individual beliefs about peer reliability, competence, honesty, and reputation; and affect, grounded in reciprocated interpersonal care and concern [9, 25] . Since the partners in a virtual organization work together on a transitory basis, there may be little opportunity to develop affect-based trust. Pre-qualification of webs helps establish cognition-based trust. Perceived ability and integrity standards should be established especially if no prior benevolence data is available [24] .

Since networks of small firms frequently lack the time or resources to build trust, they can use intermediaries, often called brokers. A major goal of alliance intermediaries is provision of a coordinating structure to facilitate interaction among network member firms [16] . Suarez-Villa [38] suggests that the development of nodal functions that coordinate, allocate resources for shared projects, gate keep, and arbitrate, may be inevitable in small firm alliances. Administrative and interactive structures established by intermediaries can intervene to facilitate the process of network involvement in ways that can lead to favorable outcomes for member firms [16] . Intermediaries ensure the continuing exchange of information, experience, and technology across industry boundaries and between firms of all sizes [34] . They can use their extensive personal contacts to communicate across sectors, providing the necessary sorting and evaluation that small firm owners and managers are less able to provide [22] . Intermediaries are expected to be especially important in agile webs since members may lack the time to not only build trust, but also to form, organize, and dissolve.

Recently new forms of information technology have enabled unprecedented collaborative structures. While researchers have suggested that IT plays an important role in enabling alliances [1, 4, 12, 39] , small firm alliances use IT infrequently to collaborate [37] . Facilitation, rather than collaboration, may be the key requirement for IT to support a virtual web of small companies. The coordination intensity of the virtual corporation drives the need for communication and information technology [12, 23] . Dynamism in the choice of actors in the supply chain results in increased coordination costs for actor selection, contract negotiation and specification, and increased monitoring. Information technology supports and/or enables these activities [20] . Virtual organization is practical because computers minimize the cost of switching the assignment of satisfiers to requirements, which must be logically separated [31] . Although conceivable without computer communications, agile webs would not be practicable without the technology that enables dynamic switching between satisfiers for the same requirement [30] .

5. The Agile Web, Inc.: A Case Study

In addition to the literature on critical success factors in strategic alliances, we can learn about the critical success factors for agility from a case study of one of the earliest implementations of this concept. We describe the concept for this web, the pilot program, and the practices of the formal entity, Agile Web, Inc. that was established because of the pilot.

Phase 1: Concept Development

The concept for this web was an outgrowth of the (1) emergence of the concept of agility in manufacturing; (2) trend toward consolidation of supplier chains in fabricated products; (3) and needs of the American defense sector's lower tier suppliers. The Agility Forum, organized by the Iaccoca Institute at Lehigh University, defined the concept of agility, which was then applied in several large corporations. Meanwhile the Northeast Tier Ben Franklin technology center, also at Lehigh University, was increasingly wary of the trend toward supplier consolidation, particularly since northeastern Pennsylvania's industrial base was overwhelmingly populated with small to medium sized manufacturers. At the federal level, government officials concerned about the ability of American industry to compete globally, coupled with their desire to reuse defense technology as a peace dividend at the end of the cold war, developed the Technology Reinvestment Project to fund proposals to strengthen the nation's small company industrial base [36] .

The concept of an agile web emerged in early 1993. The goal was to combine the resources of small to medium-sized manufacturing companies to provide a resource pool of diverse capabilities for the development of new business opportunities for the member companies. During the spring and summer of 1993, executives of the Northeast Pennsylvania Ben Franklin partnership screened over 700 companies and met with candidates for inclusion in the web. By August 1993, 19 companies agreed to participate in site visits from the federal government's Technology Reinvestment Project, which was in the process of evaluating grant proposals. These companies represented a wide range of capabilities, including product development and design, CNC machining, metal fabrication, die casting, plastic-injection molding, finishing and coating, and design and manufacture of electronic sub-systems. In October 1993, the Northeast Pennsylvania Ben Franklin Technology Corporation was awarded a $2 million, 2-year matching grant from ARPA Technology Reinvestment project, which was eventually extended one additional year through 1996. The goal of this project was to test the theory and implementation of agility concepts in and between small businesses.

Phase 2: Agile Web Pilot Program

The Agile Web pilot program was established January 1, 1994 under the directorship of Dwayne L. Hansen of the Ben Franklin partnership. The program's objective was to create an infrastructure for collaboration to enable small to midsize manufacturers to transition into agility by defining concepts for agility, an implementation strategy, and operating procedures. Major activities during the pilot program included assessment of the capabilities of the member companies, establishment of collaborative business practices, and business development.

Before marketing the web, it was necessary to identify its core competencies and insure that all members achieved minimum standards of quality for participation in web activities. Many of the small businesses defined themselves by their output, their products and services. The notion of core competencies, in terms of unique capabilities, design and process capabilities, knowledge, equipment, and business practices were unfamiliar concepts. The Ben Franklin partnership arranged external expertise to guide discussions regarding the definition and identification of core competencies. Each of the web members was subject to review of their business practices; a quality assessment of each company was completed and action steps were identified to enable all companies to achieve a minimum acceptable quality standard. By the end of the pilot project, a core competencies database had been created, and each participant was provided with sales force training.

A great deal of effort focused on the development of collaborative business practices, as it was recognized early in the project that substantial cultural change would be required. To develop trust and familiarity among web members, the Ben Franklin partnership provided opportunities for them to work together to develop a shared vision through simulations and team-building activities. Ben Franklin worked with members to develop a business plan that outlined the shared philosophy, desired practices, and business goals. They ran workshops and used small group breakout sessions and breakfast meetings to provide opportunities for owner networking. A simulation exercise of a real-world bid situation demonstrated to participants the level of proprietary information they needed to share and the amount of communication required to manage an order. This was followed by a pilot project to develop an RFQ for a real customer, providing an opportunity for participants to gain familiarity with fellow members' business approaches [3] . As bid opportunities were encountered, members had additional opportunities to work together. In addition, they worked together on committees to develop recommendations in three areas: marketing plans and implementation, legal concerns, and the operation of the web.

As long as the web members were dealing with theoretical documents and practices, there was good cooperation in developing the processes. Each member was careful to contribute a piece of the process that was not strategic to their operation and since they could not recognize the resulting integrated document, it was of no practical threat. Throughout this process of workshops, mistrust was building, and each company was positioning to protect its interests. They were learning from both each other and the relationship with the project, but they were not advancing the concept of collaboration in a virtual enterprise.

The web developed an ethics statement that detailed the ethical practices that web members were expected to use in their dealings with each other. Members believed that a legally binding document was inconsistent with the model of agility. The director saw the movement away from having everything in a contract as an indication that a cooperative environment was developing; in reality, it demonstrated the inherent mistrust that existed between the companies, as well as their desire to remain free and autonomous as small business owners. Creating a legally binding document was exactly the commitment they were careful to avoid. As long as the documents were non-binding, they did not represent a threat to their respective businesses and processes.

Web members received computer hardware and software providing them with EDI and email capabilities. Videoconferencing technology was installed to encourage interaction among members. This equipment went largely unused since it created a framework for communication instead of collaboration. The introduction of communication technology exacerbated the mistrust, further inhibiting collaboration, as users believed that electronic information was uncontrolled and could be sent to places unknown.

The web advertised its capabilities through local contacts, articles published in magazines and regional newspapers, and brochures explaining capabilities of the web and sales departments of individual companies. Ben Franklin urged the participants to help market the capabilities of the web as an entity, but they found that the individual companies were reluctant to sell the services of the web to their existing customer base. Companies kept their web activities separate from their core business activities [2] , a further indicator of the rapidly developing mistrust. Companies were concerned that making their customer lists and contacts available to the Web could open a door to competitors. In addition, they did not want to endorse another company whose performance they could not control.

By July 1995 the Web had presented proposals worth nearly $7 million. For each business opportunity a subset of the members were selected, based upon the characteristics of the opportunity and the capabilities of the firms, to form a virtual firm to respond to the requests. They found that they were able to demonstrate value with enhanced design ideas but they were unsuccessful in winning business. In fact, they were unsuccessful in closing any orders until the 3rd quarter of 1995 and this first production order involved only one supplier with a total order value less than $36,000.

Phase III: Agile Web Inc.

During the pilot project, new business practices emerged, including processes to qualify web opportunities, methods to create quickly a virtual firm and the obligations and rights of its participants, and the methodology to present a unified response to the customer. The need for a separate business entity arose primarily because the smaller firms could not market strategically. Also, web members found it difficult and time consuming to know and keep up with the core competencies of the others. A separate entity could seek and suggest new business practices and creative ways of combining core competencies. The CEO of the entity could screen and pursue business opportunities, be knowledgeable about all core competencies, creatively package these competencies for specific customer opportunities, make day to day decisions on which firms should be teamed, look for and suggest new business practices, identify lacking core competencies, and look for new members. In addition, customers wanted a single point of contact for contracting and accountability. A single decision maker enabled more rapid customer response. Furthermore, creating a separate legal entity provided certain legal protections, including limiting joint and severable liability to companies participating on an opportunity, without losing flexibility.

In June 1995, Agile Web, Inc. was launched as a for profit Class C corporation with each member company holding one share of voting stock costing $1 each. Any company participating on a project would earn profit through a competitive bid process as they would with any customer opportunity. Agile Web would add program management fees to the integrated bid to a customer to generate revenues for corporate expenses. Any residual profit generated by project fees would flow back to all shareholder companies on a per share basis as an annual dividend. A five-member board governed the entity: four members from the Web companies and one from Ben Franklin. Ted Nickel of the Ben Franklin partnership, who was part of the original team that developed the concept of agility in manufacturing, was named interim President.

In the 4th Quarter of 1995, Bill Adams was hired as President of Agile Web, Inc. His business development strategy focused on long-term relationships with large customers desiring supply chain management and the value added capabilities of the web. The strategy to develop opportunities was to provide a process map, determine needed

technologies, organize brainstorming sessions among shareholder presidents and/or chief engineers, facilitate meetings, and integrate core competencies. Adams' efforts, along with these new business practices, enabled the web to bring in $3.5M in revenue, and in 1999 it earned $75,000 in after tax profits. Today the web has a $50M backlog that is expected to return $1.8 million in shareholder dividends.

6. Lessons Learned

The Agile Web project demonstrates that the theory of agility is sound but the implementation is not intuitive. Small firms will not come together naturally and collaborate at the level necessary to make this business model effective. An external intermediary can facilitate collaboration, achieving it from the outside, not attempting to drive it into the supply chain. The intermediary can also help define core competencies, market capabilities to outsiders, and establish a trusted entity for customer contact. Additionally, program management can take place using traditional supplier relationships rather than the more collaborative model.

6.1 Theory of Agility is Sound

The Agile Web demonstrated that the theory of agility is viable. It taps intellectual property and uses excess capacity to smooth out enterprise loads, provides entry into new markets, and makes small companies appear large. It also has the potential to make large companies appear small and flexible by splitting them into their core competencies and identifying over-capacity in each micro business. Agile Web was able to attract business that none of the companies could have pursued on their own. Customers found that working with the web was cost-effective because overheads were not added at each level of the value chain. In fact, the customer transacted with a single company that had no physical assets, providing access to best in class expertise with lower risk.

6.2 Looks like Collaboration: Collaborate from the Outside Rather than Internally

Independent companies often encounter difficulty collaborating. Small companies are often run by independent entrepreneurs who perceive their intellectual process capability to be unique. There are three roadblocks to collaboration in this environment:

1. Small firm owners most often do business based upon relationships. They often do not understand industries outside their own, nor do they know how to break into those industries.

2. Small business owners often do not collaborate with each other, as they are afraid of both losing relationships with their customers, and that competitors will steal these relationships.

3. Small business owners are often resistant to change.

Collaboration can be achieved despite these obstacles, however, from the outside; a neutral, external party can facilitate the interaction, supporting the premise of [16, 22, 34] . Trust, demonstrated to be a critical success factor in small firm alliances [21, 22, 33] , can be established in the web between the intermediary and the participating members of a virtual enterprise more readily than between partners. The form of trust that develops is one that is classically prevalent in customer-supplier relationships. The customer provides the opportunity and payment while the supplier contributes the services. Successful execution of this cycle over time builds trust. Communication and collaboration in the Agile Web occurred primarily through the web president, not among members. The president defined the business opportunities and the interfaces required between participating companies, and apportioned each opportunity into individual "safe" pieces that were divided up among participating companies. Companies worked with each other using traditional buyer-seller arrangements, subcontracting from a programmatic standpoint with each other. Thus, it looked like collaboration, but was in reality, collaboration from the outside rather than internally. Since collaboration was not occurring internally among members, IT tools to support this type of collaboration were not necessary.

6.3 Redefining Core Competencies is Critical

In the new model of the web, companies evaluate their core competencies in different ways. Core competencies in terms of equipment, people resources, and competencies are defined in terms of capabilities and capacity, such as design and engineering capabilities, compliance with military specs, quality control and testing procedures, software programming, prototyping, supplier sourcing, and financial systems. These capabilities differ from competencies in producing existing products. As small firms might not recognize their own true capabilities, the Agile Web president was helpful in reviewing the capabilities of the firms.

6.4 Need for External Market Development Intermediary: the Domain Expert

Figure 1 compares the web enabled value chain to the traditional value chain. A new layer of knowledge management is required to develop market opportunities. A domain expert can identify and qualify opportunities for a specific market or technology. Knowledge is needed to determine if (1) the customer is one the web wants to work with, (2) the opportunity is reasonable from the perspective of projected revenues, and (3) the web has the capabilities required to carry out the work competitively.

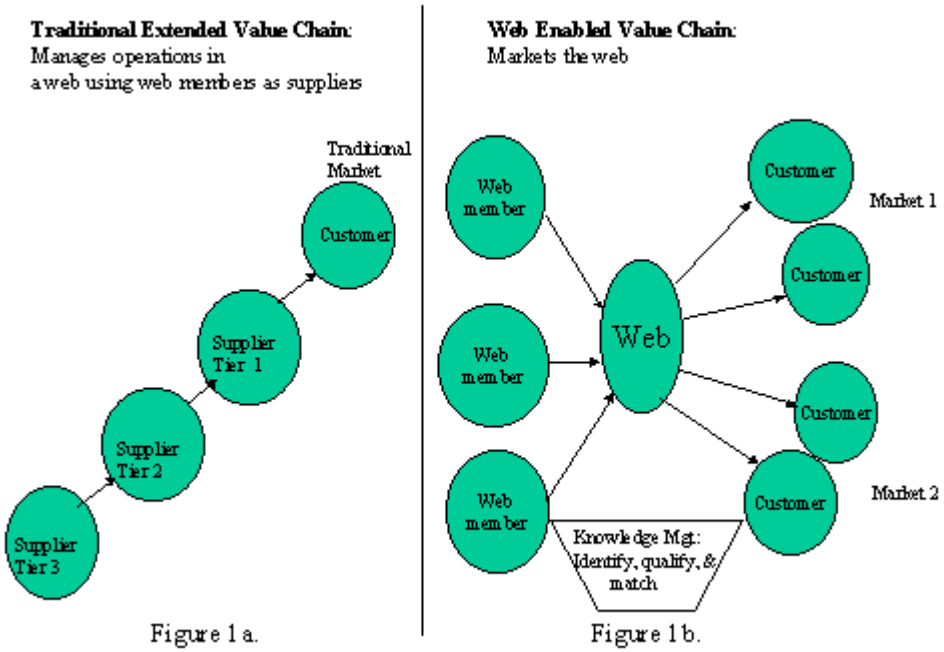

Figure 1. Comparison of Traditional and Web Enabled value Chains

6.5 Establishing Trust: Need for Separate Entity

While we have focused on the difficulty of establishing interorganizational trust in the web, there is another dimension of trust that is important: trust between the customer and the web. Customers may be particularly concerned about doing business with a temporary entity. Not only is there a lack of history on the web's past performance, but also there may be concern about future liability. For example, who is responsible if there are quality problems once the web is dissolved? One of the reasons for the formation of Agile Web, Inc. was the need for a separate entity that enabled management of legal and insurance issues. The external entity provides assurance not only for participating companies, but for customers as well.

6.6 Program Management

To operate the web, the president of the web set up a self-managing system where the proposal became the project management plan and companies used the traditional value chain shown in Figure 1a. The proposal detailed the individual specific responsibilities of each web member. Relationships among member companies were managed vertically, using the traditional value chain model in Figure 1a. However, from the standpoint of the customer, it appeared as though there was a horizontal relationship, as if the web-enabled value chain was in place, shown in Figure 1b.

7. A New Model for Collaborative Commerce

We draw upon the literature on webs and critical success factors in alliances and the lessons learned from the Agile Web to propose a new model for collaborative commerce. Instead of direct collaboration among members, a domain expert supported by information systems facilitates management of a web in which a market demand is aligned with a temporary supply chain's capabilities and available capacity.

7.1 Evolution of Collaborative Commerce

Figure 2 shows the evolution of e-commerce. Today, e-marketplaces which incorporate both buy side and sell side solutions are at the apex of the e-commerce framework [41] . In the e-marketplace, customer demand is matched to existing products and services that are typically provided by a single source or coordinated through the traditional supply chain. The next evolution of e-commerce is e-collaboration, which combines the collaborative nature of electronic hierarchies with electronic marketplaces enabling truly collaborative commerce. In e-collaboration, several vendors' capabilities are matched with customer opportunities to create new products and services. The agile web is a mechanism for achieving this match. Its implementation requires an external intermediary and is supported with information systems.

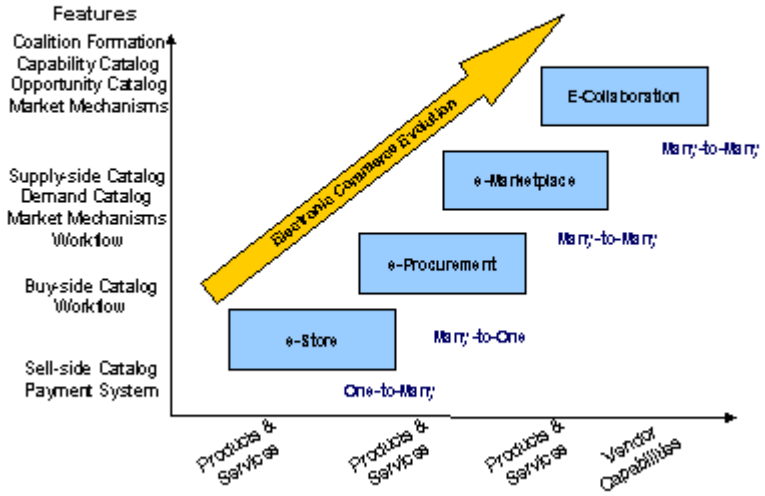

Figure 2. Evolution of E-Commerce

Figure 3 presents a new model for e-collaboration based upon the Agile Web experience and supported by the literature on critical success factors. Communities called Collaborative Business Networks (CBNs) form the basis of collaboration. A CBN is a virtual industrial park, or agile web, that brings together a group of pre-qualified companies. Each CBN has a domain expert, the intermediary. For each opportunity, several different temporary groups of companies that could satisfy the opportunity are evaluated. These are called Agile Virtual Enterprise (AVE) solutions. The customer, aided by the domain expert and an information system (called the Virtual Corporation Management System (VCMS™)), evaluates these solutions and selects an appropriate AVE solution. The AVE is registered as a limited liability company. .

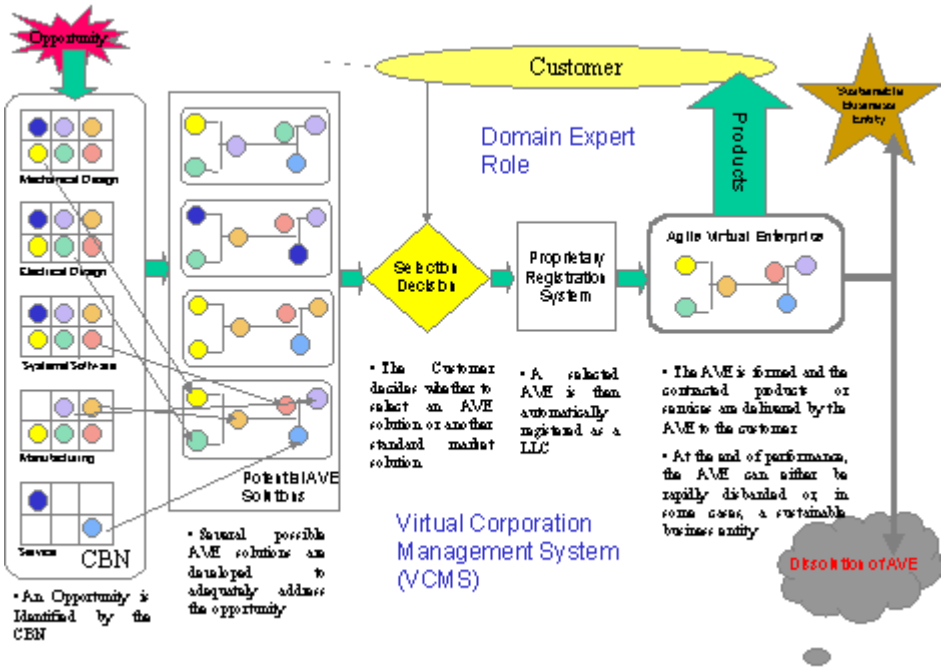

Figure 3. E-Collaboration Model

This model incorporates the lessons learned from the Agile Web experience as well as the literature. Collaboration occurs from the outside rather than internally. The domain expert performs the metamanagement tasks [31] , aided by the VCMS. The domain expert also establishes trust with the participating members of the AVE. Information systems support the formation of the AVEs as well as program management. Table 2 describes the role of the domain expert and the role of the VCMS in supporting each stage of the life cycle of the web.

Table 2. Life Cycle of an Agile Web

Life Cycle Stage	Role of Domain Expert	Role of VCMS
Identification	Manage and transmit competitive information; Identify, characterize, and qualify opportunities	Requirements templates
Formation	Develop competency databases	Databases of core competencies, opportunities; Match supply/demand using different objectives; Build proposals
Design	Evaluate designs	Create AVEs; Assign tasks to partners; Create contracts, documents
Operation	Oversee	Project management
Dissolution	Assess project/participants	Archive performance information

To overcome the obstacles to market identification by web members themselves, the domain expert who has expertise in broad market areas acts as a trusted party to manage and transmit competitive information. Thus, the critical success factor of trust, difficult to achieve in a transitory organization, is established through the domain expert. The domain expert identifies, characterizes, and qualifies business opportunities using templates and business processes designed generically for an industry of interest.

In the formation stage, the key metamanagement activities include determining possibilities for satisfying requirements and developing the best combination of partners. Information systems support this phase. Databases of core competencies or satisfier capabilities will be matched against requirements. We believe that a domain expert will initially develop these databases since members may require help identifying core capabilities beyond those used to satisfy existing product needs. Factors that will determine optimum combinations of partners will be reviewed to determine which ones should be included in these databases. In addition, different AVE solutions will be evaluated based upon different objectives. For example, low cost, minimum time, least risk objectives can lead to different network designs. Modular network design illustrates how different designs of the fulfillment process affect cost and time objectives [15] .

The domain expert's productivity can be enhanced if the matching of supply and demand is accomplished with the use of information technology tools such as the VCMS™. Opportunity and capability databases in the VCMS™ will take into account key criteria to configure potential AVEs. Key criteria include capabilities; core competencies; and participant information such as performance history, liability and financial information to establish cognition based trust. The VCMS™ will match opportunities with available supply among the members of the CBN. Finally, the VCMS™ will build proposals automatically, using different objectives such as lowest cost, best past performance, etc. Information systems, suggested as a key enabler for collaboration, will be used primarily to facilitate the formation of the AVE rather than to support direct communication among potential participants.

In the design stage, production tasks will be allocated to specific partners and an Agile Virtual Enterprise (AVE) will be created. This enterprise will have insurance, financial, and legal status. A contract for the virtual enterprise will be developed and registered with the appropriate authorities. A Digital Business Certificate will detail the contract, which will be electronically notarized and registered as a Limited Liability Company. The VCMS ™ will prepare the documents using the information in the databases. Again, information systems act as a facilitator of the collaborative process.

To operate the web effectively, project management responsibilities will be assigned. While the domain expert can manage each project, it is expected that a more productive model would use a lead company to manage each project. The VCMS™ would provide project management capabilities to track milestones and note deviations from plan.

During the final stage, dissolution, the domain expert will assess the project and the participants. In addition, the dissolution of the legal contract may require assignment of responsibility for after sales service. Performance

information will be archived in databases used for future formation decisions. The VCMS™ will capture performance information in the databases. This information will then be used to evaluate future possible AVEs.

The model that we present here is currently being tested in the state of Pennsylvania. The "Lightning Manufacturing Project" announced by the state on October 29, 1999 supports the creation of the Virtual Corporation Management System (VCMS™) and will push web collaboration among industrial and technology companies in Pennsylvania. The project is backed by Agile Web, Ingersoll-Rand, Lockheed Martin, Cadence Design Systems and IBM.

8. Conclusions and Implications for Future Research

Using both the literature and a case study of one of the earliest implementations of the concept of agility, we have demonstrated the importance of intermediaries and information systems in implementing agility in a web. Their role in supporting the life cycle of the web is embedded in the evolution of e-commerce currently under development in the Lightning Manufacturing project. From the external standpoint horizontal collaboration appears to be occurring as a result of the intermediary. The VCMS™, or IT tools that will support these webs, primarily facilitate web management rather than collaboration among members.

Our exploratory research indicates that intermediaries are particularly important in the identification of new market opportunities, helping member companies identify core competencies, and providing project management services. Information technology will play a key role in supporting the domain expert. The VCMS™ will include infrastructure and agent tools that match supply and demand at the capability level to aid in the formation of the webs. Knowledge based configurator tools will develop contracts based upon project requirements, allocating tasks based upon goals and capabilities and project management tools will support the operation of the AVE formed. Finally, performance will be recorded in databases for future reference and reuse.

Several research questions are raised:

· What performance information should be maintained in these databases to establish cognition based trust among members and with customers?

· How can core competencies best be defined and incorporated into databases?

· Is an external entity essential for determining market opportunities? Are there situations where one or more internal partners could perform this task? Can members be trained to perform this task effectively?

· Are there conditions where collaborative tools can promote trust, especially affect-based trust?

· Is the vertical model for project management the most effective model or are there alternative models?

· As information systems tools evolve, what changes will be necessary to internal systems to insure interoperability of these tools with legacy systems?

Future research will study the evolution of the VCMS™ model and will also review other models for implementing agility. In order to implement the VCMS™ concept, research will be needed to characterize opportunities and capabilities, develop algorithms for matching supply and demand, and creating supporting intelligent agents and IT tools. New business processes must be developed. Other webs will be investigated to validate the necessity of intermediaries and IT tools.

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