Chapter 5

ORGANIZATIONAL INNOVATION

Global Workflow and Institutional e-Networking

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Introduction

To date, much of the attention on the role of e-technologies for facilitating development has focused on increased knowledge intensity of economic activity. By the same token, much of the attention to knowledge e-networking has addressed matters related to infrastructure, the nature of the Internet, or situational impediments facing users in various parts of the world. Less appreciated, however, are the organizational and institutional barriers to knowledge e-networking worldwide.

This chapter indicates how human-centered factors impede technological developments and how such impediments can delay the deployment of new applications in response to new demands shaped by new realities. In this connection, the GSSD experience is probably not idiosyncratic. It highlights classes of human-centered features as well as organizational issues that are increasingly important in the domain of knowledge e-networking, especially in the context of distributed global collaboration.[1] More specifically, this chapter focuses on three sets of institutional challenges that are a generic nature, and thus relevant to different contexts, locations, and domains.

The first set of challenges pertains to the nature of the *initiating institution* that serves as the focal point for framing and generating a global e-network. In this case, the institution is GSSD at MIT. The challenge consists

[1] This chapter should be considered in the context of the issues addressed in Chapter 7 focusing on GSSD-Arabic. The discussion of multiple challenges, problems trials and errors associated with the implementation of GSSD-Arabic reflect the organizational disconnects between the initiating GSSD institution (MIT) and the collaborating technical partner (Lotus-IBM). It also shows the ways in which all partners have contributed to the development and implantation of the overall global system – each operating within attendant and immediate institutional constraints, and each seeking to create the best uses and best leverages of their own capacities.

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of the nature of its research personnel. The GSSD project continues to be managed on a day-to-day basis by MIT undergraduate and graduate students. Motivated by of the opportunity to participate in an innovative venture, these students consider the GSSD project as part of their educational experience. GSSD does not employ a permanent staff, and relies almost entirely on the participation of students. This situation is typical at MIT, a major research university, where groundbreaking initiatives are closely connected to the students' educational experience. As always, the research directors give priority to student schedules and educational requirements. This situation inevitably introduces delays in a research problem that often coincide with the academic calendar.

The second set of challenges are those central to the collaboration with Lotus-IBM around e-product development and the technological obstacles that impede the deployment of an emerging technology. In addition, the multilingual aspects of the GSSD mission, buttressed by the nature of its overall vision, confronted Lotus-IBM with a new situation, one that had not been encountered earlier by the product developers assigned to this project.[2]

The third, and most important set of challenges, pertains to the organizational and technological capabilities that had to be established in order to render distributed knowledge e-management possible. Given the realities of the Lotus-IBM personnel issues and vision of the GSSD team at MIT, this third challenge called for large-scale and system-wide strategy in order to realize the very basics of distributed knowledge e-networking and to engage each of the partners around the world effectively in the pursuit of this goal.

In the absence of a more viable alternative, the GSSD team reframed the approach proposed by Lotus, and designed an entire distributed networking system. This technical challenge was undertaken while protecting the basic vision for the project as a whole.

In the last analysis, the successful re-design of GSSD and the development of a new institutional framework enabled the establishment of the knowledge e-network, the operation of the mirror sites, and the collaboration of the various participants in the management of an evolving e-knowledge-base.

Since all of the organizational challenges encountered in the course of product revolved around e-development, reutilization, evolution and management of the knowledge-base, this chapter draws upon this experience as the focal point for discussing each of the three sets of challenges noted above. Together, they highlight almost all of the critical institutional problems

[2] While the developers sought to derive a high degree of reliability for their product, internal personnel issues provided obstacles that were difficult to overlook. As an example, during the course of this collaboration, the Lotus-IBM technical liaison personnel to the project have changed six times over the last two years.

encountered and the innovations generated in the effort to reduce the resulting impacts.

5.1 The GSSD Knowledge-Base

Given the complexity of the institutional issues in any distributed system we begin with the basics, namely the distinction between the essential technical and physical supports, on the one hand, and the critical interactions among the partners, on the other. The system as a whole is contingent on their effective operation.

5.1.1 Technical and Physical Supports

As noted earlier, the GSSD system is supported by a physical infrastructure composed of four basic elements. The most basic component is the *server*, which relies on Lotus-IBM Domino software for operation. The server hosts a set of Lotus-IBM Notes called *databases*, which contain GSSD content in various languages. Each database is comprised of *documents*. There are two basic types of documents, static and dynamic. Static documents include content that rarely changes once it is incorporated into the system, such as reports. Dynamic documents include content that require periodic updating and/or maintenance, such as abstracts.

Abstracts, which are the main building blocks of the GSSD knowledge-base, contain information on sustainability-related e-resources. These documents are created and maintained by *users*. As shown in Chapter 2 earlier, users themselves develop and maintain the GSSD knowledge-base.

5.1.2 Organization and Partners

GSSD relies fundamentally on its partners, who are distributed all over the world, to develop and organize localized content related to sustainable development in their local languages. Partners are also crucial in providing translation of localized content. The partners are responsible for the oversight of the entire system as illustrated in Figure 5.1. Each of the circular diagrams represents a mirror site location and each location houses an entire GSSD system.

In institutional terms, the GSSD network is much more than just a physical network of servers distributed across the world, as it is also an operational and interactive knowledge network. Once GSSD partners develop localized content and submit the materials to any of the mirror sites – or via the Web – these can then be transmitted through the system, translated into other languages, and distributed to other mirror sites.

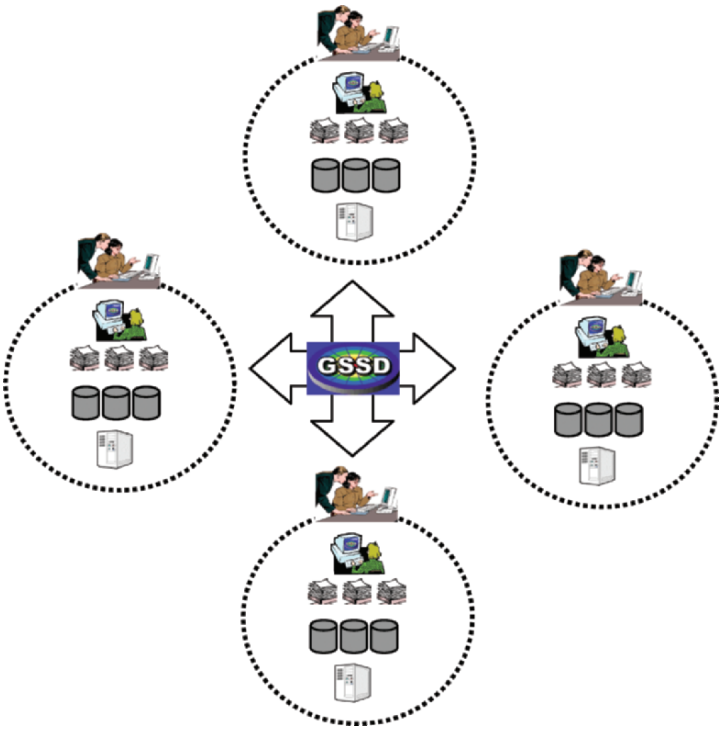

Figure 5.1 **Overall structure of the GSSD knowledge network.**

This entire system consists of a *network of network.* It allows for the effective development of localized knowledge, which can also be shared with the rest of the global knowledge network, leading to utilization, modification, and creation of an integrated knowledge-base.

5.2 Organizational Challenges

5.2.1 Diverse International Partners

The diversity and institutional nature of our partners present considerable challenges for GSSD administration. Cross-institutional management in itself is particularly challenging since each institution has its own policies and goals. GSSD partners are also distributed across countries. Differing cultural norms present an additional layer of complexity to GSSD management.

The institutional imperatives of GSSD partners translated into a series of technical requirements for GSSD. For example, it is important for partners to maintain control and ownership while asserting a certain level of

independence from the main GSSD administrators and developers at MIT. As a result, the design has been configured as a "hub and spoke" system, where the "hub" represents the main administrative and development activities which take place on the Stage server, and the "spokes" represent the mirror sites which are essentially independent from each other, yet still maintain a direct line to the hub for necessary updates and upgrades.

5.2.2 Institutional Impediments

The requirements of a hub and spoke conception, in conjunction with the need for a distributed network characterized by the autonomy of the collaborators, resulted in a significantly more complicated technical design of the system than initially expected. Consequently it was resisted by Lotus-IBM, who believed that the system worked fine "as is." In fact, the Lotus technical staff did not grasp the complexity of their own product in a large-scale distributed application with different non-western languages.

This situation led to a set of significant disconnects between the GSSD team and the product developers at Lotus-IBM. In addition, the technical staff assigned to GSSD-MIT experienced considerable turnover, which resulted unavoidable delays. All of this was taking place as the new Lotus relationship with IBM was being realized.

5.3 Organizational Disconnects

A significant body of literature devoted to the impact of technical factors on organizational structure and processes addresses on the role of information technologies in redefining organizations. Several studies have focused explicitly on Lotus-IBM tools, including the IT application that we used to develop and enable GSSD.[3] An important empirical finding is that an entity initiating collaborative computing technologies, such as Lotus-IBM Notes, is unable to enact organizational changes on its own and that its responses are reactive rather than anticipatory. This finding is significant, as it points to constraints on corporate flexibility especially when confronting new operation conditions or applications defined by situational factors.

A number of organizational characteristics, such as cultural factors (such as how people understand and appreciate technology), and institutional properties (such as incentive systems or personnel-related norms) significantly influence how advances in information technology are implemented and used in organizations. In IT-producing firms, organizational constraints

[3] For example, see Orlikowski (1992, 1995).

of the sort we described above generate multiplier effects. This means that the usual factors that impede the effective use of IT in large corporations provide further constrain the development of new IT products. The GSSD experience appears to confirm these findings. More important, it illustrates the very real challenges involved in cross-organization collaboration.

In short, the organizational and institutional constraints noted above seriously impaired our ability (and that of our development partners) to utilize the new Lotus-IBM technology for distributed multilingual e-networking (i.e. our development partners' own technology) to its greatest potential. This situation shaped the vision for a new e-product, one that would have to be developed without the leadership of the IT product-developer itself.

Paradoxically, it is these organizational failures and the powerful impediments that they created actually enabled a valuable transformation of the GSSD system – from the Lotus-IBM application, then new, into an improved and more effective tool. The core of the new tool consists of the formalization and customization of the global workflow processes, on the one hand, and the consolidation of groupware technology, on the other.

To be fair, Lotus-IBM had not yet encountered e-networking applications in two non-western languages at the same time, and neither was represented in the usual Latin alphabet. The GSSD vision was simply too novel as an envisaged application.

More important, however, is the fact that the development and implementation of the new GSSD groupware technology is due to the belief among the GSSD partners that the management of diversity was essential to effective cooperation, that collaboration is a key to the project's success, and that this success is contingent of innovations in the management of distributed knowledge e-networking. Interestingly, this cooperative cultural feature of the GSSD networking vision entirely consistent with and enabled by the Lotus-IBM architecture and e-products, but it was considerably less consistent with the technical developer's operational norms-in-practice.

5.4 New GSSD Design

The organizational issues and institutional imperatives of GSSD partners translate into a series of technical features. For the knowledge-base itself, the abstracts of individual documents, constitutes the basic content. To ensure that the system operates in its intended manner, the set of technical requirements were formulated by the GSSD team, and then directed to the Lotus-IBM developers to be incorporated into the new system design. The technical requirements consist of the following elements:

- *Submission*: When an abstract is submitted at one mirror site, it is transmitted to all other mirror sites. When an abstract is submitted in one language, it is eventually available in all other GSSD-supported languages.
- *Translation*: Abstracts are translated once the English-Stage version of the abstract is completed. Abstracts are published once the English version of the abstract is published.
- *Changes*: When a change is made to an abstract, that change is propagated to all language versions of the abstract. A change made to an abstract is propagated to all other mirror sites.
- *Imperatives*: Simultaneous changes to an abstract are not allowed; these are typically referred to as "locks" in database terms. The user interface needs is user-friendly to ensure that the complexity of the backend operations is transparent to the users. The design takes the least amount of disk space and requires minimum bandwidth, to encourage maximum utilization of the system.

These requirements are essential for the distributed nature of the global e-networking system. In retrospect, most of the technical problems confronting GSSD in its development phase stemmed from the inability to address the above requirements adequately.

In the course of product development, GSSD confronted two choices: either to compromise its project goals and priorities by adapting to the limitations suggested by the Lotus developers and accept their system as is, or to pursue the initial vision and its design and implement the requirements with the GSSD team that consist of graduate and undergraduate students – rather than with the professional developers of Lotus-IBM.[4] Only the first of these options seemed viable to GSSD-MIT. Eventually, the GSSD team created the new design and resolved the technical problems noted above.

Once the design and its technological features were undertaken, the challenge was to ensure implementation on all mirror sites and involving all of the participating partners worldwide. At this point in this story of organizational challenges, the focus of activity shifted away from Lotus-IBM and GSSD-MIT to the MIT team and the other GSSD partners, GSSD-China, GSSD-Arabic, and early phases of GSSD-French.

[4] In the following section, the solution-strategy developed by the GSSD team was framed by its system administrator, and reported in a Master's Thesis for MIT's Technology and Policy Program. See Haghseta (2003).

5.5 From Knowledge e-Network to Global Workflow

As noted, the technological and organizational challenges encountered in the course of this project issues that have arisen over the last several years have resulted in a substantial redesign of the GSSD system. A significant result of this work is the development of the global workflow process. Initially, GSSD was designed as a knowledge networking application, intended to foster the distribution and provision of sustainability-relevant knowledge, in local contexts, multilingual formats, and distributed geographic locations. However, the organizational and institutional priorities, and the subsequent technical requirements, helped to formulate a new experiment which transformed GSSD into a unique technical application for knowledge e-networking in a collaborative mode.

5.5.1 Global Workflow

At this point, we return to the workflow, introduced earlier in Part I. The purpose of this section is to review the workflow process we developed in response to the institutional problems identified above. Recall that the workflow is defined as the management of content that flows between users, databases, and servers that are distributed across languages and geographical spaces. Thus, content submitted to GSSD originates, in and from, a specific location. By the end of the workflow process, this content is converted into all supported languages and resides on all mirror sites of the GSSD network.

In this connection, there are three possible workflow scenarios for submitting an abstract:[5]

- *Local submission*: An abstract is submitted to a mirror site in the local language of that mirror site (e.g., a French abstract is submitted to the GSSD France server).
- *Non-local submission*: An abstract is submitted to a mirror site in a non-local language of that mirror site (e.g., a French abstract is submitted to the GSSD China server).
- *Multi-local submission*: An abstract is submitted to a mirror site which supports multiple languages (e.g., an Arabic abstract is submitted to the GSSD staging server, which supports both Arabic and English translation).

To clarify this process, we present an example of the workflow process step-by-step in a scenario consisting of a French abstract submitted to the

[5] The above differentiation was developed during the design of the new global workflow process, and helped to define the various combinations of pathways that were possible for an abstract submitted to the GSSD global system.

French server, which is then published in all supported languages and available on all mirror sites.

5.5.2 Example of Global Workflow

In this example, we assume that there are three languages in the system, each with its own database. In addition, there are three servers distributed across the world: China, US (Stage server), and France. Servers are also known as mirror sites. Each step is numbered, and the sequence as a whole represents the overall process. In the Scenario below, we follow the computational steps as *a French abstract (denoted as Fr below) is submitted to the French server (local language)*. The light shading of the Fr symbol (Fr) indicates its unpublished status. The darker shading (Fr) indicates that the abstract is published at that point in the workflow. We proceed thusly:

1. *The abstract is automatically located in "Submitted" status in the French database (DB)*. As soon as this abstract is submitted, it is read-only in the system.

China Server	*Stage Server*	*French Server*	
Chinese DB	Chinese DB	Chinese DB	
English DB	English DB	English DB	
French DB	French DB	French DB	Fr

2. *The abstract is replicated to all servers.* As a result, there is a copy of the abstract in the French DBs of all servers in the GSSD network.

China Server		*Stage Server*		*French Server*	
Chinese DB		Chinese DB		Chinese DB	
English DB		English DB		English DB	
French DB	Fr	French DB	Fr	French DB	Fr

3. S*ynchronization takes place on the Stage server*. Synchronization results in the abstract being copied to the English DB in "Ready for Translation" status. The abstract in the French and English DBs are synchronized with each other. This means that the system recognizes them as the same abstract, even though they will later be in different languages.

China Server		*Stage Server*		*French Server*	
Chinese DB		Chinese DB		Chinese DB	
English DB		English DB	Fr	English DB	
French DB	Fr	French DB	Fr	French DB	Fr

4. *The abstract is replicated to all servers*. As a result, there is a copy of the synchronized abstract in the English and French DBs of all servers in the GSSD network.

China Server		*Stage Server*		*French Server*	
Chinese DB		Chinese DB		Chinese DB	
English DB	Fr	English DB	Fr	English DB	Fr
French DB	Fr	French DB	Fr	French DB	Fr

5. *On the French server, the French team opens the English DB and observes that there is a French abstract that needs to be translated into English (under the heading "Abstracts for Translation")*. When they are done translating it into English, the abstract is marked as "Ready for Review." (The En indicates an unpublished English abstract.)

China Server		*Stage Server*		*French Server*	
Chinese DB		Chinese DB		Chinese DB	
English DB	Fr	English DB	Fr	English DB	En
French DB	Fr	French DB	Fr	French DB	Fr

6. *The translated abstract is replicated to all servers.* As a result, there is a copy of the English abstract in the English DBs of all servers and a copy of the French abstract in the French DBs of all servers in the GSSD network.

China Server		*Stage Server*		*French Server*	
Chinese DB		Chinese DB		Chinese DB	
English DB	En	English DB	En	English DB	En
French DB	Fr	French DB	Fr	French DB	Fr

7. *The reviewer on the Stage server opens the English DB and sees that the translated abstract is "Ready for Review."* The abstract is reviewed for English grammar, etc. as well as for content. If any changes were made to the English version of the abstract, a message is sent to the French team to check the original French version. At this point, the English abstract is published on Stage.

China Server		*Stage Server*		*French Server*	
Chinese DB		Chinese DB		Chinese DB	
English DB	En	English DB	En	English DB	En
French DB	Fr	French DB	Fr	French DB	Fr

8. *Synchronization takes place.* Synchronization results in a copy of the English abstract being placed in the remaining language DB with the status "Ready for Translation." The French abstract is also changed to "Ready for Review" status, with a link to the published English abstract and the note submitted by the English reviewer regarding changes made.

China Server		*Stage Server*		*French Server*	
Chinese DB		Chinese DB	En	Chinese DB	
English DB	En	English DB	En	English DB	En
French DB	Fr	French DB	Fr	French DB	Fr

9. *The published English abstract is replicated to all servers*. Also, there is a copy of the English abstract in the Chinese DBs of all servers under "Ready for Translation" and a copy of the French abstract in the French DBs of all servers under "Ready for Review."

China Server		*Stage Server*		*French Server*	
Chinese DB	En	Chinese DB	En	Chinese DB	En
English DB	En	English DB	En	English DB	En
French DB	Fr	French DB	Fr	French DB	Fr

10. *The French see the French abstract in "Ready for Review" (it is no longer "read-only"), where they can now make changes to it and prepare it for publication*. They check the English link in the abstract and the note submitted with the abstract to check for changes. Once the changes are made in order to match the English abstract, the French translation manager reviews and publishes the French abstract.

China Server		*Stage Server*		*French Server*	
Chinese DB	En	Chinese DB	En	Chinese DB	En
English DB	En	English DB	En	English DB	En
French DB	Fr	French DB	Fr	French DB	Fr

11. *The Chinese team opens the Chinese DB in China, finds the English abstract under "Ready for Translation," and translates the English abstract into Chinese*. Once the abstract is translated, it is placed under "Ready for Review."

12. *The Chinese translation manager reviews and publishes the Chinese abstract*. (The Ch indicates a published Chinese abstract.)

China Server		*Stage Server*		*French Server*	
Chinese DB	Ch	Chinese DB	En	Chinese DB	En
English DB	En	English DB	En	English DB	En
French DB	Fr	French DB	Fr	French DB	Fr

13. *Replication occurs.* As a result of replication, the synchronized abstract is now distributed amongst all databases and published in all supported languages.

China Server		*Stage Server*		*French Server*	
Chinese DB	Ch	Chinese DB	Ch	Chinese DB	Ch
English DB	En	English DB	En	English DB	En
French DB	Fr	French DB	Fr	French DB	Fr

The workflow process for this abstract is now complete. The scenario depicted above illustrates the extent of collaboration and cooperation needed to ensure successful operation of GSSD. There are several necessary technical steps, but also several requirements for human intervention throughout the workflow.

Even though these abstracts are located in different language databases and different servers, the GSSD system still recognizes them as the same synchronized abstract. Therefore, if the abstract is deleted at some point after publishing, all copies of that abstract will be subsequently deleted during the next synchronization and replication process.

5.5.3 Relevance of GSSD Global Workflow

The new GSSD framework and its implementation offers promise for new IT applications that promote sustainable development, but can also be utilized in other domains where collaboration is required. This is especially relevant for user-groups who require reliable distributed networks and a workflow process that responds to their distribution and diversity, and such as multinational companies and international institutions, for instance. Later on in Part II we provide a specific example of such a case.

This new global workflow methodology has wide applicability because it operates on the premise that a partnership or organization is distributed across multiple geographic locations and languages. Such characteristics are becoming more and more prevalent and are shaping the needs of complex, multinational, and international institutions.

Furthermore, this workflow innovation is particularly significant in today's global reality because it recognizes the importance and the value of their diversity among the partners, and provides a platform harnessing gains due to differences as well as similarities perspectives – irrespective of location or situation, These features contribute to leveling the playing field for all parties in the e-network, enhance synergy and cooperation as relevant, and ensure an increasingly effective workflow process.

5.6 Contributions to it for Sustainability

The GSSD system contributes to the body of research findings in the IT and sustainability in a number of ways, only two of which we note below:

First, GSSD provides a valuable case experience of an interactive IT technology that successfully leverages IT enables capabilities, while addressing some of the barriers that impede transitions toward sustainable development.

Second, the global workflow application is an innovative response in support of global GSSD vision. As such, it demonstrates the practical and flexible features provided by advances in information technology, as well as the potentials and possibilities.

Third, the GSSD-related challenges addressed in this chapter are essentially human-centered in nature and help us appreciate the importance of human-to-human interactions in the course of developing new e-products and processes.

Experiences such as these generate important lessons in e-networking theory and in practice. In the absence of precedents for this type of worldwide collaborative initiative, any innovations in the technical or physical aspects of networking must be matched by commensurate advances in institutional and organizational contexts.

GSSD represents an application in information technology that leverages multiple positive linkages between IT and sustainability. These linkages create synergies due to the implementation of the convergent capabilities or functionalities that include: (a) a potentially powerful tool that contributes to social empowerment through *provision of knowledge* about sustainability challenges and local initiatives; (b) a *computational platform* for integrating a vast amount of valuable and relevant information related to various aspects of sustainability; and (c) a *knowledge networking architecture* that utilizes the power of the Internet and related IT tools to strengthen and ensure continued evolution of the GSSD knowledge-base.

Among the GSSD features designed to enhance understanding and reduce distortions in communication, interaction, knowledge provision, as well as knowledge access and retrieval three sets are especially notable. First is an operational definition for sustainability and a *conceptual framework* that reduces, even prevents, ambiguity while supporting the analysis of inherently complex sustainable development issues; second is a well-defined and structured *quality control process*, which maintains and ensures high quality and reliability in the GSSD knowledge-base while also allowing it to be populated in a distributed and collaborative manner; and third is an effective set of capabilities to directly *address digital* and *knowledge divides*.

This third set of design features includes multilingual support and inclusion of a wider audience with diverse demographic and cultural characteristics; an interface that enables the development and provision of local content, to help support local action initiatives related to sustainable development; and extensive search capabilities available to everyone on a "non-premium" basis.

5.7 Conclusion

This chapter illustrates some of the operational challenges involved in the development and deployment of GSSD as a global knowledge e-networking system. In particular, we highlight the importance of human-centered constraints associated with implementing information technology initiatives in complex and globally-distributed institutions and organizations. Advances in information technology play a significant role in overcoming barriers to knowledge e-networks if, and only if, potential challenges, even limitations, are identified and addressed effectively.

The key task for researchers and policymakers is to assess how to utilize changes in information technology to advance institutional and organizational goals and to minimize the risks. For example, the GSSD project relies on Lotus Notes, one of the most prevalent "groupware" technologies. Would some of the organizational and institutional challenges described in this chapter be better served by a different technological platform?

Applications of information technology do not automatically create the transformations needed for an effective knowledge e-network. However, they allow do us to effectively utilize the greatest natural resources available for these endeavors: human intelligence, creativity, and ingenuity.

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