

Advanced Virtual Enterprises and the Developing World

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Introduction

This document is an overview of the *virtual enterprise* business model, together with some history and examples of benefits. The positive political and economic effects of this type of organization are included, to indicate what makes it desirable at the macro level beyond the better, cheaper and faster products it enables. This paper is a quick introduction to why virtual enterprises stimulate business innovation, why they will be good for the developing world, how to make them happen and what a demonstration project will look like.

About Virtual Enterprises

A virtual enterprise is a collection of small and medium-sized companies that work together so effectively that, to the outside world, they appear to be a single corporation. They are “virtual” in the sense that they aren’t institutionalized members, like the suppliers to a giant car company. Instead, they are needs-based collaborators, like performers in a jazz pickup group. Members form specialized alliances, sometimes temporarily, so the key to their success lies in how they manage the alliance. In an established corporation, like Toyota, standardized practices, costs and schedules simply cannot keep up with evolving design. A government-sponsored study of enterprise models found that an innovative enterprise such as a virtual enterprise requires its own method of management.

Historically, the emergence of more agile business structures is the result of progression from the first generation firms of the industrial revolution. Ford, for instance, originally made its own paint and screws, while forming co-owned large companies for glass and rubber. Its operations had a high degree of vertical integration; everything was within one corporate envelope, with the market forces only acting between Ford and its customer. (In Ford’s case, even that was compromised, as Ford sold only to selected dealers who then dealt with the end users.)

We are now in the second generation of business enterprises. The illusion of a monolithic company still exists, but it is often not the case. People still think that Boeing for example makes the airplanes sold under the name *Boeing*, but Boeing is actually a family of thousands of companies, many of them small, integrated into a supply chain. Boeing still provides the oversight, but new internal corporate-to-corporate boundaries and associated market forces now exist. There are significant benefits from this: flexibility, explicit contractual responsibility, scalability (especially in terms of financing) and the ability to choose how much to avoid being involved in the detailed operations of the supplier.

However, these second generation enterprises have some significant disadvantages. They are profoundly costly to manage. In a typical aerospace product, 80% of the value comes from the suppliers but 80% of the final price paid by the customer goes for centralized management. That bloated cost funds administration, and mostly supports the alignment of processes and measurements — the “enterprise integration.” In other words, the Boeing brand exists not to primarily design and assembly of airplanes, but to coordinate the many elements that go into the design and assembly of the enterprise. The enterprise is the primary product with the aircraft an artifact.

The enterprise is maintained by management practices supported by and largely shaped by computerized tools. Unfortunately, these are notoriously bad and have been deemed a crisis for decades within industry. Because each large firm suffers under the same disadvantage, the usual check of competitive forces is no incentive to rectify the problem. No one other than the customer is alarmed. In the studies Sirius-Beta managed, the customer was the Pentagon, which was worried about the impossibility of getting effective products and their support systems in a realistic time and cost frame.

Second generation enterprises conceal other heavy costs. They harbor inefficiency; most of Boeing’s staff are employed to manage other managers. They are too slow to respond; Ford can add or subtract resources, making more or fewer cars depending on market demands, but finds it very difficult to adapt to changing market demands. Wang Laboratories was one of the biggest technical firms in the world, making word processors. It should have been easy for it to respond to the revolution in personal computing. Instead the company was too cumbersome. The very solidity and routines that allow them to stably coordinate large, complex supply chains keeps them from responding to changing markets, and made it redundant. Markets are now changing more quickly and radically than ever before.

Besides being costly and inflexible, there are other disadvantages of second generation enterprises:

- They are not innovative. Large companies now respond to consumer demand for innovation is by buying small companies that have developed a new process, product or market. Innovation comes from small firms; in fact, in the United States, every new job since World War II is the result of growth in small businesses.
- Their employees are not as happy, motivated or productive as those in healthy small firms. This stems from the top-down imperative; in order to keep its supply chain in line, a company needs a corporate culture and accompanying practices. These are famously uncomfortable for employees and can sometimes be illogical and frustrating. Workers are generally more fulfilled when their company thrives on their creativity and working methods.
- They perturb the market, reduce the efficiency of economies worldwide, and can even compromise political governance. This is obvious: the power of large compa-

nies often goes into restricting the market or changing the economy rather than making money the old fashioned way, by providing something valuable. The financial power of megafirms can literally derail the democratic process. Since the primary investment strategy for the developing world often involves investment by or for large corporations, the effects become neocolonial, with no path for developing economies to do much but provide cheap materials and labor. “Globalization” in this context means less about opportunity and more about exploitation.

Virtual Enterprises are the third generation. They can be seen as the evolution of the supply chain, so that all of the internal coordination can be handled by market forces. There are already instances of this in operation. Chinese manufacturing in Shenzhen was explicitly designed using agile virtual enterprise principles, with special legal and social provisions that supported it. The result in agility and profitability has been staggering. Here, a significant virtual enterprise can be formed in a matter of days, complete with process integration mature enough to produce prototypes.

There is a spectrum of virtual enterprise architectures; following is a brief overview.

Simple Virtual Enterprises

Simple virtual enterprises already exist in a range of forms. These small business teams tend to be physically collocated and known to each other. An example can be seen in Northern Italy, in the production of fashion shoes. The numerous, small companies have been in business for generations; they know what each manufacturer can make, how well, and how trustworthy they are. They can quickly put together a combination of firms to satisfy what is likely to be a large but temporary demand for a single product. They do it over and over, with different materials, companies, processes and designs.

The US and Indian movie businesses are well studied examples of the same phenomenon. In a matter of days, thousands of people in hundreds of small, specialized companies can be located, contracted, focused and put to work on a new film.

Simple virtual enterprises are usually formed from a pool of companies that have prepared themselves to be available in this way. They have advertised their abilities to each other and figured out logistics ahead of time. Their infrastructure will have been pre-harmonized, so their contractual, technical and business operations are easy to work with. They will have also devised trust and adjudication strategies so that when things go wrong or liabilities appear, the enterprise can recover easily. (There are a few such strategies.)

Finally, they will have figured out a way to present themselves to the outside world as a unified enterprise, the way a US film is branded as a unified product. While this simple form of virtual enterprise is easy to create, it does not exhibit the most radical benefits. For that, the advanced virtual enterprise is needed.

Advanced Virtual Enterprises

An advanced virtual enterprise will have some of the following qualities:

- The partners may never have met before and possibly be spread across the globe.
- Rather than harmonizing their technology, processes, culture and business practices, they may be radically different. These unique approaches are leveraged as competitive advantages in ways that are not possible in more consolidated organizations.
- They will be cheap to form and dissolve, allowing “promiscuous” experiments in new products, services and markets. Notwithstanding, if a project takes off, the enterprise can become permanent.
- They will not only be agile in how they form, they will also be dynamic in reforming. Once operational, they improve, either to optimize based on existing goals, or to adapt, refining the goals. Rather than have every partner jostling for a bigger role, partners are instead rewarded for improving the profitability of the enterprise, even if their direct role diminishes.
- They are capable of making something that has never been made before, or providing a service that has never been offered. They may use skills or equipment in ways that were not expected. During the adaptive operation of the enterprise, they might be aggressively learning or acquiring new skills and resources.
- A simple virtual enterprise often relies on a central agent to organize things; sometimes that agent also is the collective marketeer and trust adjudicator. An advanced virtual enterprise has these responsibilities distributed more among direct-value creating partners.

History of Virtual Enterprise Research

There is a significant history of research into advanced virtual enterprises.

In the 1990's the US military became concerned with the extraordinary cost of its advanced systems. Key studies showed that emerging aircraft and missiles were taking longer to build and costing more than equivalent projects in the civil sector. The problem was identified as the limits of the enterprise integration technology; in other words, the problem lay primarily with the information systems used to coordinate operations its effects on management practices.

These were the same systems and methods used in the civil sector, but in the military sector, they were used more thoroughly so the problems were more acute. Additional studies showed an even more dangerous cost: many advanced technologies were not being included the military's state of the art systems. We knew how to make them by themselves, but the integrating infrastructure simply couldn't accommodate them in a complex system. Not only were advanced fighter aircraft taking twice as long to design and build, and costing at least twice what they should, but they were not as capable as they could be!

Additionally, the companies involved in military systems were so huge that in order to justify the effort expended on any one design, there had to be many items made and purchased — often more than the military actually needed. The Pentagon preferred many different designs in small numbers, but this was impossible. When the waste was identified at tens of billions of dollars per year, a substantial research effort was chartered and assigned to the Defense Advanced Research Projects Agency, DARPA. The Pentagon sponsors of the work believed that if DARPA can create the Internet, surely they could improve on current methods of manufacturing.

A range of projects was funded at several hundred million dollars each, so as to surround the problem. They identified blockages in both technical and non-technical areas: management, financial, legal and cultural. A central program eventually resulted in the development of technical infrastructure that was mature enough to use on a specific project. At this point, the major defense contractors lobbied Congress to close down the research.

By that time, a research partnership with the European Union had been established. Europe is as dependent on the health of its small and medium sized companies as the US. In the decade since DARPA dropped the ball, the EU has funded many projects aimed at incrementally improving the virtual enterprise infrastructure, starting with the simple case. As a result, today there is a significant overseas community to support the paradigm: university programs, standards bodies, professional associations and their conferences, consultants and products.

But no one has taken the next step, to demonstrate the capabilities of an *advanced* virtual enterprise. One of the problems has been a lack of supporting technology, and a simple lack of awareness that the alternative exists. All the necessary infrastructure is now available for some cases; only a demonstration is needed. A successful, thoroughly-monitored and well-reported example will offer more choice in business paradigms, along the way boosting investment strategies for the developing world.

Barriers to Advanced Virtual Enterprises

A few, core elements need to be added to existing infrastructure in order to make advanced virtual enterprises flourish. These new ingredients balance technical and non-technical issues, with some of the more challenging non-technical elements mitigated by technology. As an example, one way that technology can help is during the “discovery” phase; simple virtual enterprises tend to be physically close because that makes it easier to know what everyone is doing. Specially networked systems can eliminate this barrier, so the same level of contact is possible across companies worldwide. Effort is expended in the maintenance of such a system, but the physically based monitoring method is costly as well.

Technical support for the next generation of business enterprise requires five new capabilities to be added. No one case requires all five, nor an extreme advance in any

one. But these five encompass all possible versions. In each case, the technology works with market forces and is geared towards value creation.

The below are listed from most easy to most difficult. Sirius-Beta and its partners have led research applicable to all, with a focus on the most challenging aspects (listed last).

- Discovery and Advertising (Internal and External).

Potential members need ways to advertise themselves and their capabilities. Similarly, partners need to be able to “see into” the market in order to match cooperative capabilities to market opportunities. The advanced virtual enterprise adds further difficulties because there are a range of new skills each partner might develop in the right context.

Those extra dimensions also exist on the consumer’s side: in addition to what markets want now, there are products that users will love, but won’t be able to imagine until they have been invented.

- Trust and Liability Management.

In the standard business model, the prime contractor plays the role of judge over a supply chain. Participants may not like the decisions handed down, but at least there is a simple way of handling problems. Each participant has a relationship with just one other entity, hovering above. No partner has to negotiate trust, or worry about liabilities with anyone but that parent.

In an advanced virtual enterprise, a problem between any two partners can destabilize the system. Depending on how distributed the enterprise is, the need to manage trust and deal with problems grows.

- Communicating Different Worldviews.

In a conventional enterprise, the prime company sets a culture and analytical approach, and smaller firms are “integrated” into it. The same is true of its computer systems. A well studied example occurs in the aerospace industry, where many engineering disciplines work on the same component — for instance, thermal engineers and structural engineers collaborate to make a hybrid car engine. These experts are currently forced to use blunter tools and abstractions than necessary in order to share an integrated product model.

One competitive advantage of an advanced virtual enterprise is the ability to cooperate with a partner that has a radically unique approach. Including that “rogue” in the process is relatively easy until other parties in the enterprise want to understand what is going on in some depth so as to reason about how everything fits together.

- Financial Value Tracking.

Accounting systems are set up for monolithic organizations. This is because the cost of every aspect of the work is in theory measured against how much value it adds. In this approach, the rewards for that value do not follow the same accounting metrics, only the investment decisions do. The reason is simple: it is the organization as a whole that makes the profit.

In an advanced virtual enterprise, there are many players, and each wants to profit. Specialized infrastructure will include a two-way accounting system. The first measures the contribution of a partner to the organization — the value added to the product (or service). The second will be a way to reward the value added to both the product and the building and maintaining of the enterprise. Such a measuring system will use “value features” that are richer than numbers. Only later, after the pool of income is to be divided, will the accounting of the value metric be reduced to a dollar amount.

- Self-organizing Process Coordination.

In a traditional enterprise, a manager connects all the processes among the supply chain. It is never done as well as it could be, but the methods are well established. In the extreme virtual enterprise, each process “negotiates with” others via information infrastructure, and collectively figures out the roles and sequences that best deliver value. Clearly, there is a spectrum between the “one boss” and the “self-organizing beehive” models. Even the smallest degree of self-organization can have tremendous competitive impact.

These five challenges already have hundreds of millions of dollars of government investment toward understanding the technical issues.

Virtual Enterprises and Microlending

Microlending has already proven its success in the developing world. Small loans that are made for discrete purposes improve wellbeing and enjoy a sustainable lending model. But the productivity of the borrowers is limited to their aspirative labor alone. There is only so much that can be done for an economy, when the reach of any business is the work of one or a few men and women.

The next step is to enable virtual enterprises in the developing world: small hard-working groups that collaborate to create value. If the overhead can be kept lean, the team will always create greater value than the sum of the individuals working alone. Microlending offers an immediately leverageable model for building a virtual enterprise. Three elements are of particular interest:

- The goals of the microlending establishment are to enhance the public good while tapping into existing economic forces. This notion of using established market forces, entrepreneurial drive, capital lending and intrinsic self-esteem are at root. These combine with the larger purpose of lifting damaged nations is entirely congruent with the notions of the advanced virtual enterprise: independent achievement and direct societal benefits.

- Most common microlending processes involve a field agent who knows the locale and intuitively the proper balance of trust. A similar agent will also be needed in some versions of the advanced virtual enterprise to serve as trust agents. They can also be communicators of capabilities and opportunities and to some extent translators to and from local approaches to problem-solving. Existing and future web-based infrastructure will start to take over some of these roles, but the humans on the ground can service this need immediately.
- Virtual enterprises can adopt any existing business practice that works, low or high tech, but they do have to add some new ones. From experience, the one new practice that is hardest for traditional Western enterprises is evaluating value apart from cost. We have basic methods of reasoning about this but again, it boils down to trusted intuition and domain knowledge. Currently, the granting of microloans is based on this notion of “soft” accounting, eschewing quantitative business plans and working on a more common sense level. In this respect, virtual enterprises will draw many benefits from the microloan community.

The aim in the developing world is to achieve sustainable economic prosperity. Virtual enterprises are a safe, implementable model for achieving this. When current microlending practices are examined, a collaboration among these small, distributed businesses is the next step. The microloan community has expertise, infrastructure, working capital and common values. It is poised for the next level of success.

Virtual Enterprises and Rwanda

Why work in the developing world? If advanced virtual enterprises make such good business sense, why not demonstrate them in the West, get all the kinks worked out, and then bring them to Africa?

- Sirius-Beta has humanitarian motivations, yet limited resources. As well as moving business to a better model, we are committed to doing good work where the need is greatest. Both goals are targeted with this single project.
- Western case law presents artificial barriers to next generation virtual enterprises. The legal and financial systems are so bound into conventional models that first instances will have undue friction in the system, particularly with accounting and liability issues. Because the needs are greater in the developing world, and the legal structure not so governed by existing business models, there is room for innovation in approaches to business in places like Rwanda.
- Because of strife and other factors, central Africa has untapped human and natural resources. With more potential for rapid growth from the existing state, a more dramatic demonstration is possible.
- One of the benefits of advanced virtual enterprises is the federation of common cause among diverse ethnicities and cultures, but without requiring homogenization. There are numerous regions in Africa where this is a problem. If harnessing

that diversity resulted in competitive advantage, that explosive energy now producing strife can be channeled into creative collaboration.

- These new business models are especially friendly to communities without rigid infrastructure. Given the potential, Africa can become an engine of innovation.

Virtual Enterprises and Ethnomathematics

Investigations of cross-cultural mathematical practices, such as those by Helen Ver-ran, Donald Crow and Paulus Gerdes point to the existence of many systems of abstraction in different cultures, including fundamental variations in mathematical reasoning. Societies evolve different ways of conceptualizing their world and concerns, sometimes quite different from each other. Researchers have shown that groups in Africa mathematically reason in ways that are different from the prevailing paradigm. The study of this phenomenon is called “ethnomathematics.”

Scholars are still discovering a vast range of indigenous reasoning systems. Previously thought to be quaint folk traditions, they are now finding that these are often sophisticated, complete representational reasoning systems. Like all else in terms of cultural diversity, these are disappearing at an alarming rate — faster than some can even be identified and understood.

An emerging notion is that many of these systems likely have practical merit against contemporary problems. Some of these systems are every bit as sophisticated as the mathematics taught in the West, and might be leverageable for practical, analytical use. They are not regarded as useful because they have no persistent representations that can be passed in artifacts; they lack “communication technologies.” But they may be valuable if they can be tapped and integrated into enterprises.

Ask any mathematician why a problem seems intractable and she will respond that it is because the right abstractions have not yet been found. As a result, theoretical mathematicians spend their lives increasing the ways that the world can be abstracted, while practical mathematicians labor to match these abstract systems to problems. Having a variety of abstractions makes innovation possible, but only if they can be used.

In the same way, business also thrives when many pockets of expertise work on the same product from different angles, each expert using their own conceptual toolkit while contributing to a collective endeavor. Consider the aerospace case, where many engineers work on the same jet engine but use highly specialized abstractions: heat flow versus tensile strength, for example. In pharmaceutical research, breakthroughs are directly related to the novelty in how a biomolecular phenomenon is modeled. Novel approaches to mathematical abstraction could expand the context for problem-solving, and in the best case plug directly into new product development.

Advanced virtual enterprises as a matter of definition can allow for and even encourage partners with these novel ways of thinking.

We speculate that in Central Africa, novel indigenous abstraction systems still exist, and can be preserved in a virtual enterprise context. This may not be true, and it may not be desirable to attempt in a project designed to be a clean demonstration. But it is a topic worthy of serious consideration.

Virtual Enterprises and IBM

Five new capabilities were listed earlier, as being necessary to evolve current business models into the next generation: advanced virtual enterprises.

The first three (advertising, trust and worldview management infrastructures) can be mitigated by cultural means, human agents and hands-on practices. We know they can be handled by motivated people and low technology as described below, perhaps with a microloan partner.

The latter two challenges (reward-for-value tracking and process coordination) require new technical capability. IBM has some tools that can apply to this domain but that are not yet geared towards it.

Ideally, these two will be handled with one technical solution, because it makes sense to evaluate good process combinations in terms of beneficial value combinations. The same metrics used internally, to design the product's processes, can also be applied to externally, in order to compensate the partners for the value they've added.

Our generic demonstration suggests the use of tools currently in development by IBM. This event processing software is called *InfoSphere Streams*. It is a whole new category of software. Instead of dealing with bits of data, it manages streams of information, which interact. Instead of the usual processing of discrete data, IBM's architecture allows information about events to affect and cause other events. This makes it perfect for the management of process integration in an enterprise. The research already undertaken by Sirius-Beta will add new capabilities; this robust platform will support it.

The following example scenario is proposed, turning the microlending model into a virtual business enterprise, using the above infrastructure and research.

Example Demonstration

- First, a business domain will be selected, one that can be characterized by simple process events. Businesses can be modeled as events, or processes, or both. For the challenging low-tech enterprise, it is preferable to start with the more realistically supportable events-based approach. The low tech partner thus has only a small burden in accommodating the technology

Some example events are: Planting a crop of flowers for sale in the Dutch Aalsmeer auction. Grading a container of coffee beans for a specific use by Philz Coffee franchises in the US. Receiving requirements from a smartphone assembler for just-in-

time shipping requirements. Those are large events. Alternatively, we can describe a continuous sequence of very small events, such as monitoring a process that checks the thickness of conflict-free tantalum films from Coltan, for smartphone components.

By contrast, a *process* is the combination of the thousands of changes that occur in order to reach the outcome of an event. For example, instead of the statement “planting a crop of flowers for sale,” in a process-orientated model, you will model the transforms associated with preparing the seed, tilling the land, and putting the seed in the ground. Working at the model level makes it possible to build much more innovative chains later on because you have a sort of copy of the world in the machine.

But if we choose the first case wisely, we can reduce the technical and human demands of modeling an enterprise to one of simply reporting events and streams of events. From this, modeling experts can later infer models that will allow for more systematic development of the infrastructure. Later demonstrations can reuse these models.

- Second, these real-world events must be supported by processes in the information infrastructure. We will use *declarative methods* in computer modeling — a technical approach that requires some expertise. While the results are intuitive and easy to use, getting there requires a state-of-the-art technical development team.

Much of the DARPA and Sirius-Beta work was geared toward this implementation. Today, the IBM Research Center (in Yorktown Heights) is the center of expertise for declarative modeling of business processes and events. The demonstration will most likely use the methods they have developed and tested.

- Third, a robust state of the art complex event processing system is needed. A parallel group at IBM Research has developed a system very friendly to declarative virtual enterprise event processing. This is a fielded new product: *InfoSphere Streams*. The technical work already undertaken by Sirius-Beta is implementable in *Streams*.

- Fourth, use the local mobile phone networks. In many areas of the world, the most available, reliable and understood technology is the cellular network. In some of those areas, the tracking and billing infrastructure of the phone system is already integrated into microloan processes. If the events can be reported via simple mobile devices, it will hook into existing local practices.

- Finally, it will be prudent to employ key European research centers to troubleshoot translation issues among partners with differing approaches. This addresses the diversity problem, which in technical parlance is “ontological federation.” As it happens, steady EU funding in virtual enterprise and enterprise integration research has produced some very fine university research groups with exactly these skills. We will turn their efforts towards any arising challenges in the demonstration domain.

The EU Future Internet Enterprise Systems Program

Our demonstration will be enhanced through collaboration with an initiative currently receiving investment in Europe, called “Future Internet Enterprise Systems ” or FInES (pronounced: “finesse”). Funded by the European Union, it aims to support the advanced virtual enterprise case.

As with most EU research programs, it is burdened by politics and excessive administration. But the goals are squarely applicable to the problems that concern us. Its goal is to support a revolution in business models based on opportunistic affiliations, among small and medium-sized businesses worldwide. FInES describes the advanced virtual enterprise this way:

- They are “inventive enterprises,” both in product and practice. They are continually inventive, internally motivated to be so. In the process, they may exhibit non-linear behavior, for instance radically restructuring in response to needs.
- They are “cloud enterprises,” which simply means that they leverage the advantages of modern information infrastructure.
- They are “cognizant enterprises.” FInES describes it in different language, but the underlying point is that everyone involved — including the customer — knows more, and can use that knowledge to advise the system on how to be better.
- They are “community-oriented enterprises.” Doing good for a partner means doing good for the society in which it exists.
- They are “green enterprises.”
- They are “global enterprises.”

EU research investment has built a vibrant community of virtual enterprise researchers, and FInES is attracting the strongest talent. Sirius-Beta will partner with them.

Sirius-Beta

Sirius-Beta is committed to seeing the already committed investments in the future pay off. We are very much focused on the dual goals of improving the way business is done, and helping the most stressed economies.

Contact: Ted Goranson at tedg@sirius-beta.com for more information.