The Entrepreneur and Standards[1]

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Abstract

For society to gain the most advantage from entrepreneurship, the entrepreneur's desire to control their products and markets must be balanced with the socially desirable impact of standards to distribute technology and market control. Groups of technologies sustain new waves of human civilization. In each wave of civilization the balance between the desires of entrepreneurs and the needs of society has been achieved differently. The information age is built on the technologies that create information systems. The expanding standardization of these technologies is a hallmark of the information age. However, proprietary control of information technology standards by entrepreneurs is changing the balance between private gain and public good. Post-information age standards offer the entrepreneur new ways to achieve commercial advantage yet support public standards.

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1 Standards are a Guide

Without the Egyptian talent, mina and shekel, standards of weight and value, trade could only occur among the trusted (Brooks, 1976, p. 21). Without the setat, an Egyptian land measure standard (100 x 100 cubits), cultivation would have been a less reliable food source (Berriman, 1953, p. 70). Technical standards have guided commercial development since the earliest human civilizations.

When the entrepreneurs Thomas Edison (lamps and electrical systems), Ernst Werner von Siemens (dynamo) and Joseph Swan (lamps and electrical systems) independently pioneered aspects of electric lighting systems, there was no standard electric lamp socket or electrical outlet. But a standard lamp socket and standard lamp base (now IEC 60061), defined electrical plugs and sockets (now IEC/TR 60083), and many other standards were necessary for the electrical lighting markets to develop. "The adoption of standards marks an important stage in the passage from a scientific novelty to a commercial product" (Holmstrom, 1947, p. 65).

2 The Standardization Dilemma

A technical standard is a codified and quantified rule, imposed by an authority, committee or market (Hayek, 1973). The terms specification and regulation are also used depending on whether a standard is privately controlled or required by an authority. Economics explains that a standard creates both private and public effects (Kindleberger, 1983). When a standard emerges as a specification, e.g., Intel x86 microcomputer interfaces, the entrepreneur controls the standard. When a standard emerges publicly, e.g., the metre length, governments control the standard (Metre Convention, n.d.).

Making public the Microsoft server-to-server interface specifications is seen as critical to open the Microsoft server markets to competition (European Commission, 2004). Should Microsoft's proprietary interface designs be given to their competitors without compensation to Microsoft? Making public the Apple iTunes to iPod interface is supported by the recent "iPod law," approved by the French Senate and National Assembly. In its review of the iPod law, required before a French law is promulgated, the French Constitutional Council highlighted the need for compensation to Apple to make their interfaces public (Crampton, 2006). These current examples illustrate the standardization dilemma: How does a standardization process balance the importance of private gain to motivate the creation of the new and improved with the importance of readily available standards to open markets to competition and provide gateways to future capabilities?

Standards have been employed throughout human history; standardization dilemmas have occurred before over train rail spacing, nuts and bolts, interfaces to public telephone networks and many others. Yet the current standardization dilemmas are more difficult because standards have greater impact as technology evolves.

3 The Successions of Standards

Since humans emerged as hunter-gatherers, three major waves of human civilization have been identified: agrarian, industrial and information (Toffler, 1980). Over time each civilization has discovered and invented the technologies necessary to sustain it: agriculture, manufacturing and information systems. The sum of all the technical standards that guide a wave of civilization is a *succession of standards*. Each standards succession commences in a specific age. The impact of that standards succession is most apparent, and contentious, during its initial age. In the following ages, the now on-going standardization of the same succession continues to provide necessary standards. Because the basic concepts are more widely accepted, this on-going standardization is less contentious.

Table 1 lists the succession of standards which began in four different historic ages and the emerging post-information age. It indicates the authorities' (alpha/ruler/government/law) view of standardization, the entrepreneur's view of the standards created, and the self-reinforcing mechanisms the standards enhance. The self-reinforcing mechanisms, which may cause increased economic returns, are additive in each succession of standards, i.e., measurement standards evidence coordination effects; similarity standards evidence both coordination and scaling effects, etc. Therefore standards in each succeeding standards succession have greater economic impact. Previously, David (1987) identified a similar grouping of three standards successions.

	Age				
	Hunter Gatherer (before 3000 BC)	**Agrarian (3000 BC - 1750 AD)**	**Industrial (1750 - 1950)**	**Information (1950- 2000)**	**Post-Information (after 2000)**
Standards succession	Symbols	Measurement	Similarity	Compatibility	Adaptability
Authorities' involvement in standardization	Dominate	Authoritarian	Oversight	Limited or none	Future: Guidelines?
Entrepreneurs' view of standards	Unknown	Undesirable	Distrustful	Winner-take-all	Future: Fair?
Economic self-reinforcing mechanisms	Communica-tions	Coordination effects	Scaling and learning effects	Network effects	Gateway effects

Table 1. Standards Successions

Three trends across the standards successions appear in Table 1: the authorities' decreasing involvement in standardization activity, the entrepreneurs' increasing interest in standards, and the increasing economic impact of standards due to the cumulative self-reinforcing effects. These three trends identify why it has become more difficult to find a fair balance between the private gain and public good a standard enables. Examining the standardization processes in each age identifies how these trends have developed and what can be done to improve the balance.

4 Hunter-Gatherer Age

The first succession of standards, symbol standards, emerged as humans developed the common symbols of an early language. An early form of symbol standards was clay tokens to represent different commodities used in the Near East at a time when plants and animals were being domesticated (10,000 BC). Such tokens were found in the graves of high officials indicating the importance of these standards. Written numbers, possibly the first technical standards, emerged in Uruk (3000 BC) in Mesopotamia (Burke, 1997, pp. 29-45).

Today the Hindu-Arabic number symbol standards are the most commonly used technical standard in the world. This demonstrates how the desire to communicate and trade over a long period caused the consolidation of the many early number systems.

5 Agrarian Age

Measurement standards, the second succession of standards, were a significant factor in the development of agrarian civilizations. "Nomadic tribes have no need for land measurements. Division of the lands of a primitive people does not become a necessity until society has reached the level of settled agricultural development" (Richeson, 1966, p. 1).

Measurement standards provide the weights and measures used for planting, cultivation and collecting taxes, thus assisting in the rise of Babylon and Egypt. By 3000 BC, the definitions of measurement standards were kept by an authority, such as a pharaoh or temple (Skinner, 1954). In economic terms, widely utilized measurement standards create coordinating effects which serve to make transactions easier. By 2250 BC, economic measurements (currency) enabled more complex transactions and further expanded trade (Berriman, 1953, p. 102).

The need for common measurement standards continued as civilization developed. The English barons forced King John of England to sign the Magna Carta on June 15, 1215. The Magna Carta included the pledge to define standards for the measurement of wine, ale, corn, cloth and weight (Magna Carta, 1215). These mandated measurement standards were not widely adhered to (Hall, 1929).

The succession of measurement standards, like each of the standards successions, continues into the current age. Additional measurement standards are required as new technologies develop. In response to different standards for electrical measurement in different countries, the 1904 International Electrical Congress in St. Louis, Missouri, USA, supported by technical delegations from 15 countries, authorized the electrotechnical standardization activities of the International Electrotechnical Commission. The IEC then standardized world-wide electrical measurements that have guided all the electrical and electronic discoveries and inventions of the electric century (IEC, 1981). The IEC example points out that later attempts at measurement standardization were more successful than earlier (e.g., 1215), because the need for common measurement standards was better understood.

Common measurement standards assist the growth of trade, but the benefits of measurement standards accrue primarily to buyers (Hemenway, 1975, p. 62). Early electrical measurement equipment entrepreneurs calibrated to their own parameters, so standardized parameters reduced any competitive advantage they might offer (Keithley, 1999). Entrepreneurs, even just a vendor of produce, have long recognized that standards reduce their advantage by increasing price competition (Shapiro & Varian, 1999, p. 231). "...Schumpeter's key insight is that the entrepreneur's occupation is the search for profitable opportunities to upset any equilibrium" (Baumol, 2006). This includes the equilibrium created by measurement standards.

Some authorities promoted their own public measurement standards as a way to increase their income, e.g., by using weigh houses to levy taxes (Lewes, 1638, p. 32-35). Measurement standards offer value to the public but no value to the entrepreneur. Without entrepreneurial incentives, the deployment of common measurement standards has been a slow process. Over a long period the coordination effects of common measurement standards assisted trade, causing local measurement standards to merge into regional standards and eventually into the International System of Units (SI) measurement system (IEC, 2006).

6 Industrial Age

Similarity standards, the third succession of standards, expanded greatly during the industrial revolution to define the results of repetitive manufacturing processes. "The rise of the machine industry, which we associate with the Industrial Revolution (1760 - 1830), was made possible, technically, by the existence of a vast number of standards..." (Industrial Standardization, 1929).

Similarity standards, including process standards and quality definitions, define the minimum admissible attributes. While the litre measurement standard defines the units to measure the volume of a bottle, similarity standards define how similar in size, shape or materials one bottle is to the next (ISO 9058). Entrepreneurs recognized that similarity standards, like measurement standards, increase price competition, potentially reducing their profits. However, similarity standards also offer the entrepreneur advantages of scale and learning which can improve efficiency in manufacturing, distribution and use.

The importance of similar parts was first identified for the rapid repair of guns after a battle. Thomas Jefferson paid a visit to the French gunsmith Le Blanc in 1785 and reported on the value of similar gun parts to the US Congress (Gilbert, 1958, p. 437). In the early 1800s, similar parts were possible only among the guns from the same manufacturer. Maintaining similar parts gave the buyer a strong reason to make follow-on purchases from the original entrepreneur, thereby limiting secondary competition and potentially increasing the entrepreneur's profits. Examples of proprietary products in this period that precluded secondary competition: guns, train track gauges (Puffert, 1991), fire hydrant flanges (Cochrane, 1966, pp. 84-86), and nuts and bolts (Gilbert, 1958, p. 433). The importance to the public of interchangeability among multiple entrepreneur's products was eventually recognized for all these products.

Many times the authorities stepped in to require similarity standards, as example, for train track gauges in England and America or the USA War Industries Board during World War I which dramatically reduced the variation among similar consumer goods (Hemenway, 1975, p. 22). With government direction, entrepreneurs focused on the advantages of scaling effects enhanced by similarity standards. The manufacturer could gain in production efficiencies, the distribution chain could gain in handling and promotion efficiencies, the end users could gain in operation and maintenance (learning) efficiencies, and the public gained by the potential for increased competition. Entrepreneurs have learned to recognize the advantages of similarity standards, but they still want to control their markets and increase their profits.

The market control the entrepreneur may lose by public standardization may be compensated with patent royalty fees. The patent's value to the entrepreneur (private gain) is a royalty fee per unit. The value to the public (public good) of the coordination and scaling effects associated with similar products includes the lower production, distribution and use costs per unit. In the simplest case, as long as the royalty fee is less than the effect of lower production, distribution and use costs, the public good is served by patents controlling similar products. Similarity standards with patents as entrepreneurial incentives offer a better balance of private gain and public good than measurement standards.

7 Information Age

Compatibility standards, the fourth succession of standards, emerge when two independent similarity standards are no longer sufficient to define an interface. A plug and a socket, each defined by different similarity standards, may or may not be compatible. The relationship between the plug and socket, whether compatible or incompatible, is defined by the interface between them, which identifies how the plug and socket standards relate to each other. Defining a compatible interface requires a compatibility standard.

A defined interface is necessary for public connection to a telephone network, a computer operating system, the internet or a cellular network. Defining a complex interface requires defining the physical and multi-layered protocol interfaces. The Open System Interconnect (OSI) standard ISO 7498 describes seven possible layers of technical standards for an interface. The definitions of all the layers required for a specific interface form the compatibility standard of that interface.

The difference between similarity and compatibility has a significant impact on the entrepreneur's motivations. Compatibility is of little value unless there are a reasonable number of products or services to be compatible with. Compatible interfaces are necessary for a communications market to develop beyond an entrepreneur's initial customer base (Katz & Shapiro, 1985). In economic terms, compatibility, whether standardized or not, enables network effects in addition to the coordination and scaling effects associated with similarity. The network effect describes that the value of each network interface grows faster than the number of interfaces (Briscoe, Odlyzko & Tilly, 2006). Network effects draw users to the larger network and away from smaller competing networks, eventually creating lock-in. Lock-in, a winner-take-all effect, gives the entrepreneur who controls an interface, control of the market(s) that interface enables (Arthur, 1988). The possibility of achieving lock-in motivates entrepreneurs to patent interfaces or be first to the market in the hope of controlling an interface. Where a single entrepreneur cannot control an interface, a consortium of entrepreneurs may attempt to develop, promote and control interfaces that are potentially valuable (Updegrove, 1995).

The value of patents on compatible interfaces, for the entrepreneur who controls such patents, may be much greater than the value of patents controlling similarity. Lock-in enables the entrepreneurs who profit from controlled interfaces to reap greater rewards (Bensen & Farrell, 1994). Microsoft (software interfaces) and Intel (x86 micro-processor interfaces) are examples of the enormous value created when the entrepreneur controls an interface that locks in a large market. In the 1990s, the US Patent and Trademark Office expanded patents to include communications algorithms (e.g., CDMA for cellular systems). This exacerbated the shift toward private gain in compatibility standards (Scotchmer, 2004).

Controlling interfaces can be very valuable for the entrepreneur but may increase incompatibility. In response to the entrepreneurs' attempts to control important interfaces, different interfaces often emerge: US Federal Communications Commission Part 68 rules created new public interfaces to AT&T's network, Ethernet (IEEE 802.3) is an alternative to IBM's patented token ring networks (IEEE 802.5), the Chinese have developed TD-SCDMA cellular technology to bypass foreign, patented cellular technology. While examples in the three previous successions of standards suggest that a single standard for a single requirement benefits the public by facilitating trade, these examples of compatible interfaces suggest that attempts to require a single controlled interface, even if formally standardized, may complicate trade. This appears to be caused by the winner-take-all aspect of compatibility standards.

Some government actions also indicate concerns about this winner-take-all effect:

- The French government's concern that only Apple iPods can download music from Apple iTunes web sites.
- The Chinese government's push for their own communications technology in Chinese communications systems (Qu & Polley, 2005 p. 49-52).
- The European Union and previous US anti-trust actions over Microsoft's proprietary software interfaces (Krechmer & Baskin, 2000).

Such government intervention to force local compatibility standards usually does not create successful solutions (David, 1987). Resolving these winner-take-all concerns requires new standards created by consensus. Reducing the iPod lock-in requires an iPod to iTunes compatibility standard. Then other personal audio entrepreneurs could negotiate for the rights to distribute songs. In the Chinese communications systems, adaptability standards, the next succession of standards (see below), can still enable world-wide compatibility. The EU has required Microsoft to create a server-to-server interface specification, possibly a solution worse than the problem, as such an interface will be very difficult to change, limiting everyone's innovation. The EU is correct that a server-to-server compatibility standard is needed. But such a standard needs to be created and maintained with the consensus of all the interested parties.

Widely available interfaces, standardized or not, can also become gateway interfaces to alternative technologies or whole new applications (David & Bunn, 1988). Telephone jacks, the Internet (IP standards), personal computer application programming interfaces, and cellular air interfaces became the gateways to huge new markets for private telephone equipment, the World Wide Web, personal computer applications software, and cell phones. Such new markets may be of considerable value to the public but are of little value to the entrepreneur unless the entrepreneur controls the gateway interface. Up until 1975, AT&T fought in court to prevent any public interfaces to its telephone network (Bingham, 1988, p. 37-40), more recently Microsoft fought the US government to control Windows™ applications programming interfaces (Krechmer & Baskin, 2000), Qualcomm patented CDMA based cellular interfaces (West, 2001), and Microsoft is continuing to fight the European Union to control its server-to-server interfaces. Gateway effects increase even further the entrepreneurs' desire to control potential gateway interfaces.

The entrepreneurial incentives have tilted too far when applied to compatibility standards. The combination of coordination, scaling, network and gateway effects is too enticing to entrepreneurs; this is the root of the intransigency of competing entrepreneurs in gateway standardization discussions (e.g., the current stalemate between the Blu-ray Disk and HD-DVD video disk formats). Fortunately, the evolution of technology offers new approaches to address these standardization dilemmas.

If the equipment/software providing a gateway interface is programmable and changeable, such as cellular phones or personal computers, then multiple different products may be supported on the same equipment (e.g., Mozilla and Microsoft Internet Explorer gateways to the web on the same computer). Users could select between the different products or use a converter when they know what to change to achieve compatibility. When users are not aware of what to do to achieve compatibility, which is most often the case, an automatic means to select among multiple different programs, protocols or interfaces is needed. Such a means is termed adaptability.

8 Solutions for the Post-Information Age

The post-information age is beginning to develop adaptable systems which are based on ubiquitous and automatic gateways. Adaptable systems occur when autonomous elements of a network can identify, negotiate and select among different capabilities to implement the most desired compatibility. All three functions, identification, negotiation and selection, must exist for a system to be adaptable. When systems – including their interfaces – are micro-processor based with low cost read-write memory, they can be adaptable if the appropriate standards are supported. Different forms of adaptability standards already exist and some are quite successful.

The most widely used adaptable systems currently are based on etiquettes (Krechmer, 2000). An etiquette is a communications protocol that shuttles back and forth between communicating ends to implement application-specific adaptable systems. Much like an etiquette between humans, etiquette protocols only address how to communicate. Examples include: The International Telecommunications Union (ITU) Digital Subscriber Line (DSL) standards which use G.994.1 (an etiquette) to support forward and backward compatibility among the different types of DSL transceivers; ITU T.30 (an etiquette) has maintained compatibility between Group 3 facsimile machines for about thirty years; In the Internet Engineering Task Force RFC 3261, Session Initiation Protocol (an etiquette), is used to negotiate multimedia communications including Voice over Internet Protocol (VOIP).

Other approaches to adaptable systems include meta languages such as Standard Generalized Markup Language (SGML, ISO 8879) and its derivatives including Extensible Markup Language (XML standardized by the World Wide Web Consortium). Meta languages provide a means to identify relationships, leaving negotiation and selection to other processes.

Ricoh, a Japanese facsimile machine manufacturer, offers an example of the balance possible between public good and private gain using adaptable systems. Starting in the 1980s, Ricoh offered over time several proprietary higher speed G3 facsimile capabilities to its corporate customers. Each higher speed facsimile enhancement was proprietary and available only between two Ricoh facsimile machines. Several years after each Ricoh proprietary higher speed product was introduced, a higher speed enhancement similar to what Ricoh offered was standardized in G3 facsimile. The T.30 etiquette standard defined for G3 facsimile machines supported compatibility with both Ricoh proprietary features and the G3 standards. This ability to offer desirable proprietary features while maintaining compatibility with the widely used G3 facsimile standard contributed to Ricoh's position as the largest corporate facsimile supplier for many years.[2]

Proprietary functions are identified across public adaptable interfaces using a legally controllable identifier (e.g., a trademark) that is transferred between the communicating ends. Only when each end presents the specific identifier is the proprietary function supported. In this manner Microsoft could offer public software interfaces to network servers and personal computer applications, yet offer proprietary operation of specific capabilities that Microsoft wishes to control, similar to the Ricoh example.

The use of adaptability standards allows entrepreneurs to charge for their proprietary technology used via public standardized interfaces. If the proprietary technology is valuable, implementers or users will have reason to pay for its use. Many different mechanisms are possible to compensate the entrepreneur: charge for downloads, per implementation fees, usage fees, periodic maintenance/support fees, or simply the sales advantages of offering improved performance.

9 Adaptability Standards Can Resolve the Standardization Dilemma

The standardization dilemma arises because the entrepreneurs' motivation is to control gateway interfaces and the authorities' have reason to be concerned about any entrepreneurs' domination of large markets. Recognizing the trends toward decreasing government involvement in standardization and the entrepreneur's increasing interest in standards suggests how to rebalance compatibility standardization. The authorities need not dictate specific interfaces, the authorities and standardization committees only need to support the on-going trend toward adaptable systems. The French, Chinese and EU standardization dilemmas can be resolved without government regulation by requiring adaptability standards for each controlled interface.

Using regulation to open communications markets limits innovation. Standards function as feathers that guide the arrow of technology. While feathers are light and seemingly trivial on an arrow's shaft, without feathers, few arrows find their mark. Without standards, few technologies find their market. Using standardization, in particular the creation of adaptability standards, to guide technology allows both open and innovative communications markets, resolving the standardization dilemma.

[2] Author's personal knowledge from participating in G3 facsimile standardization.

Instead of regulation to open proprietary interfaces, the development of adaptability standards, defined in public standardization committees, is needed for each controlled interface, formally standardized or not. There is also a need to review some standardization policies. The standardization committees' reasonable and non-discriminatory (RAND) intellectual property policies have worked reasonably well for similarity standards but are not sufficient for compatibility standards. Standardization committees need to create adaptability standards for new gateway interfaces (e.g., 3G, 4G, WiFi, WiMax). Any controlled technology in public compatibility standards should be negotiable, unless the controlled technology clearly offers greater public good than private gain. Adaptability standards allow the market to find the balance, where the public good is at least equal to the private gain. This increases the likelihood that a new technology will quickly find useful applications.

For thousands of years technical standards have guided technology to market and increased trade, dramatically improving the human condition. Entrepreneurs have always focused on their private gain, as they should. The authorities have often intervened to require public standards, as they should. With a better understanding of how each standards succession achieves a balance between public good and private gain, the arrows of new technology can fly more directly to their markets and increase the good of all.

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