Standards Scripts Developed for NIST Grant

Standards For Everyone: An Introduction

Welcome to our modular curriculum on standards and standard setting. We call it "Standards for Every One." And I would like to tell you why. What is it about standards that inspired me to develop this program?

Years ago I worked for a Congressional Agency--the Office of Technology Assessment. We called it "Congress' own think tank" Unfortunately, the 101st Congress--notwithstanding OTA's highly acclaimed non-partisan research--decided to no longer fund it. It was a great loss. While at OTA, I was asked to undertake a study assessing the performance of the US standard setting process--a process that I will describe in a subsequent module in some detail. At first I was disappointed in my assignment--what could be interesting about standards, I asked myself? I was in for a great surprise! Thirty years after having finished my OTA report, Global Standards: Building Blocks for the Future, the subject continues to be of great interest to me, as well as source of my research.

Today, what gives me great pause for thought is the fact that there are very few standards courses available within the university community. Nor are there many

educational materials that might be used to build courses. And you could count the number of students interested in taking courses on standards on one hand.

Ironically, this lack of attention to standards comes at a time when standards are becoming ever more critical, given our increasingly complex and interconnected world. Just consider the banking system; new forms of financial paper are being developed faster than we can develop standards governing their use. Would more and/or better standards have helped to limit the industry's collapse? A good question!

The food industry is also increasingly complex. Notwithstanding labels denoting organic foods, gluten free foods, genetically non-modified foods, and antibiotic free foods, we are somewhat at a loss when trying to sort out prices and ingredients. We all have read, with some horror, about adulterated baby milk in China, and chicken products in the United States. To my chagrin, I find that the 'kibbles' I have been feeding my dog contain ground up animal bones from most any kind of animal--even road kill; intestines and other organs; and even the scraps swept up from the food processing floor. Is there not room for standards here?

In trying to understand our limited standards educational tools and facilities, I have asked people in the field how they became involved in the subject. For the most part, they say that they entered through the back door. Trying to solve

problems of interest to them, they came face to face with standards. And it was only then that they became involved.

Our curriculum, *Standards for Everyone*, is based on this insight. We look at standards through the lens of different problems, and ask what role standards play both in the cause and the resolution. Hence our curriculum is intended not only for those who anticipate working in the field, but also for those who encounter standards in their daily lives.

Our approach reflects our belief that the tepid interest in standards is due, in part, to the narrow way in which we typically conceive of standards. For example, today, most standards efforts and analyses focus almost entirely on the technical and economic aspects of standards. No doubt, these topics are essential to an understanding of standards and standards processes, and they need to be front and center in any standards course. But these lenses fail to portray the full range of issues to which standards give rise. Standards are ubiquitous--we encounter them everywhere. By extending our frame of reference, and characterizing standards and standards issues more broadly, we can develop materials that attract a wide audience, while at the same time amortize the associated costs across a larger user base.

Given the wide range of standards and standards issues, we cannot create a universal curriculum to satisfy all. So, we have opted for a modular approach

that allows educators to pick and choose, tailoring their course materials to their specific needs. Faculty--ranging in disciplines from engineering, business to sociology, ecology, and English--can use the modules to build an entire course, or simply incorporate specific modules into their diverse course offerings.

Our first modules are prototypes, designed to illustrate the possibilities inherent in a modular approach. We have selected them to illustrate the broadest range of standards and standard setting issues. We have picked our initial modules to illustrate how standards play out in a number of different areas. These include, to name but a few: “Why Study Standards?” “The Standards Universe,” Standards: The Coin of the Realm,” “Standards: How the West Was Won,” and “Standards: The Building Blocks of Life.” Focusing on each of these sectors, we address topics ranging from business strategies and innovation to organizational roles, cultural memes, and personal identity. To help navigate the standard’s landscape, we employ social network analysis to create a map that--based on key words and topics--links modules, thereby illustrating the various ways in which each might be interwoven with the others.

Standards for Everyone, is built around an open architecture. We hope that you will not only find the content useful in your efforts to promote standards education, but also be inspired by the effort to contribute your own modules. We welcome your engagement in our project.

Why Study Standards?

When is the last time you thought about standards? Chances are the topic only occurred to you when you needed standards, and they were lacking. Maybe you thought about standards when you had to have a three-pronged plug, or perhaps when the sheets you ordered for your mattress didn't fit. Alternatively, standards might have come to mind when you committed a faux pas speaking a foreign language, or maybe it was when you struggled to adjust the shower temperature in a foreign hotel. Herein lies the Standards Paradox: Although, standards are so essential to our daily lives, we typically take them for granted. We seem to value standards most in their absence.

When we do focus on standards, however, we see that they are the basis for--or one might say the interface between--all interactions. As such, standards are the building blocks both of the natural world and society as well as the glue that holds everything together. For, in any given context, standards constitute an agreed upon set of meanings, scripts, and rules that guide behavior and govern relationships. Embodying critical information in a highly compressed and abbreviated format standards greatly simplify the environment. Signaling opportunities and constraining choices, standards make possible cooperation and coordinated behavior.

Let's just think about the origin of the word standard. It was originally a word that signified a flag or banner that was associated with a given leader, and hence was used to rally his troops in battle (Malone, 1942, 235). Standardized signals continue to play such roles today, even in the animal kingdom. Take slime mold, for example. Instead of rallying warriors to battle, they signal the presence of food, drawing individual slime molds into a cluster, so as to better harvest the meal. Likewise, ants employ pheromones to signal the location of food sources as well as the task that each is performing.

Language and simple gestures play a similar role for the human race. Based on a common understanding, they provide the shared frame of reference and sense of reality that allows us to have intimate relationships and establish common goals. Similarly, cooperation among individuals engaged in interdependent activities is greatly facilitated when people don't act randomly, or on a trial and error basis, but rather conform to common expectations embodied in socially constructed roles. Similarly, organizations gain greater access to resources and reduce their transaction costs, when they adhere to standardized rules and procedures institutionalized in their environments. In so doing, organizations themselves become standardized as the prevalence of bureaucratic forms clearly attests.

In the realm of technology as well, standard specifications and protocols add value to system components by allowing them to interconnect and interoperate in a transparent and seamless fashion. Equally important, when standards serve as identifiers, as in the case of trademarks, they help people sort through extraneous information and make better choices.

In fact, so ubiquitous are standards we ignore them at our peril. Just consider what happens to the man who reaches out to pet a dog, even though its hackles are raised? Similarly, what would you say are the prospects of the student who dresses inappropriately for a job interview? And one can only imagine the sorry sight of the driver who runs a red light.

Mishaps can occur on a large scale as well, and it is just such events that first peaked the public's interest in standards and standard setting. Unfortunate incidents accompanying the industrial revolution provided a major impetus. Thus, for example, boiler explosions averaging 1,400 per year led the *American Society of Mechanical Engineers* to write a comprehensive boiler code in 1910, and to good effect. Once most states and cities had adopted the code, such explosions were virtually eliminated. Likewise, the 1904 leaf fire on the grounds of the National Bureau of Standards had a similar impact. Dealing with the fire was problematic because the fire hoses could not be coupled due to differences in threads. The incompatibility between hydrants and hoses also accounted for the problems controlling the Baltimore fire of 1904. Buildings numbering 1,526

and all electric lights, telegraph, telephone, and power facilities in an area of more than 70 city blocks were destroyed before the fire burned out. Fire companies from outside the area couldn't help because their hoses were incompatible with the Baltimore hydrants.

Those who discount standards are likely to run into unanticipated setbacks, and forgo good opportunities. For standards have a strategic value in that those who control a standard also control the activities associated with it. Hence standards have been at the center of battles between industry titans seeking to control the market. In fact, the first "standards war" dates back to the turn of the century, when George Westinghouse and Thomas Edison fiercely competed to set the standard for electrical current (McNichol, 2011). Edison went to great lengths to assure that DC current, the basis on which he had built his electrical empire, would trump AC current, which was used by his competitor George Westinghouse. Thus, he engaged in a shameful public relations campaign designed to instill fear in the public about the safety of AC current. To provide evidence for his case, he supported a number of trumped up grizzly experiments involving the electrocution of dogs, cows, and horses. Notwithstanding Edison's efforts, AC current--which could travel further and was more efficient that DC current--won the war (McNichol, 2011).

Such battles continue to be played out--and almost as fiercely--today. The early *browser wars* provide a case in point (Sebenius, 2002). In 1995, Netscape

controlled the browser market, with a 90 percent installed user base for Netscape Navigator (Windrum, nd. p. 1). Notwithstanding Netscape Navigator's great lead in the market, the goliath Microsoft, although a latecomer to the game, was able to demolish its rival with a browser of its own--Internet Explorer. Because Netscape Navigator could be employed across multiple network platforms, and be used by software developers to create software for any operating system, it was a major threat to Microsoft's dominance in the operating system market (Ryan, 2010). It was only then that Bill Gates stood up and took notice. Determined to squash the competition, Microsoft made its browser free to all. It bundled it together with its operating system, thereby loading it on desktops of 50 million new computers each year; and then used its market power to make it the ISPs browser of choice (Windrum, nd, p. 8; Sebenius, 2002, p. 43). As a result, Internet Explorer became the Internet's default browser, as Netscape went into decline. Notwithstanding Netscape's first mover advantage, it could not compete with the financial resources and industry alliances available to Microsoft. It was subsequently taken over by AOL, which later spun the browser off to the nonprofit Mozilla Foundation (Stone, 2008). Today, it has reappeared in a new guise--Firefox.

It is important to note that network standards, such as browsers, increase in value the more that they are adopted, due to the growth of networks based on those standards and the externalities associated with them. The Internet standard TCP/IP provides a good example. In the early stages of the Internet's

development, there were few adopters, and even fewer commercial providers. However, as the network and the number of applications that it supported multiplied, businesses rushed in to capitalize on the increased value accruing from an open, interoperable standard (Garcia, 2013).

To take advantage of standards benefits, while avoiding the pitfalls to which they might give rise, requires that we have a much greater understanding of them. Our modular curriculum provides a tour of this fascinating standards universe. I hope you will follow along.

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The Standards Universe

Understanding the importance of standards in our lives begs the question of how we can best study them. Precisely because they are ever-present, it is difficult to get a handle on them. To help sort things out, we devote this module to defining standards; scoping out *the standards universe*; and laying out a framework that allows us to differentiate standards for the purpose of analysis.

How we define standards can have major implications. For example, business standard strategies will depend on the type standard at hand. If standards are set by a legislative body, as in the case of the DMCA, businesses will lobby to influence outcomes, whereas if standards are set in the marketplace, businesses will seek alliances with other like minded firms, or--given significant market power--employ competitive economic strategies to control standards outcomes. Similarly, governmental policy decisions will also differ depending on whether one's reference is compatibility standards, safety standards, or environmental standards. For this reason, broad definitions of standards used in everyday speech are not very helpful.

Hence, those who research standards typically formulate their definitions to conform to the specific questions to be asked and the problems to be solved. Economists, for example, generally seek to know how, and under what circumstances, standards are set in the marketplace. They tend to view

standards as an agreed upon set of specifications that define a particular product or that allow products to interoperate. Anthropologists, on the other hand, focus on questions of how individual interactions give rise to cultural norms. Thus, they view standards as the accepted rules of behavior that facilitate social interactions. Government policy makers are likely to consider standards as the means to address a societal concern or to achieve a social end. Thus, they often equate standards with regulations.

However, our curriculum--Standards *for Everyone*-- requires an inclusive definition of standards that cuts across a wide array of activities. We need a definition that applies equally to the standard roles that bind organizations together as well as the standard products, currencies and prices that unify markets. Viewed in the abstract, standards can be said to negotiate the boundaries between diverse phenomena. They provide the rules, or protocols, to be followed in order for objects to interact. Hence we define standards as the *interfaces governing interactions, be they individuals, machines, words, or elements of the natural world.* Accordingly, standard interfaces might govern the mode of interactions; define the conditions under which interactions take place; and/or signify the appropriateness of interactions. For example, to connect to the Internet, one must employ the TCP/IP protocol. Alternatively, to drive on the highways, cars must meet national environmental emission standards. Likewise, to select produce, consumers might look to foods that conform to ‘organic’ standards.

Notwithstanding their universal nature, standards can be differentiated according to their purposes, as well as by how they are established. We identify three different kinds of standards: control standards, product standards, and platform standards. Likewise, we point to three standard setting mechanisms: a *de facto* process, a regulatory process, and a voluntary consensus process. These three kinds of standards and three different standards processed can be matched to form a matrix, which we have labeled *The Standards Universe.*

The Standards Universe

	Control Standards	Product Standards	Platform Standards
Bottom up/ de facto	Traffic conventions	Popular fads; beanie babies	Language
Top-down/ prescribed	Hours of TV for children	Weights & Measures	Air Traffic control
Voluntary/ negotiated	AMA standards for med practies	Building Supplies	W3C standards

Control standards are designed to constrain interactions either by forbidding an action; by establishing performance criteria that an interaction must meet; or by prescribing the method or design of an interaction. For example, early environmental quality standards on automobiles were design standards: they required that cars be equipped with a catalytic converter. Later standards, based on performance criteria left the design to the automaker, requiring only that certain emission levels not be breached.

Product standards establish the conditions under and the criteria according to which interactions take place. These standards typically relate to product attributes in terms of their quality, safety, and appropriateness for an intended purpose. A simple example of a product standard is the screw thread standard. The thread is a ridge wrapped around a cylinder or cone, which serves to convert between rotational and linear force. Supporting one of the most prolific machine products produced each year the screw thread standard was first developed as far back as 1880.

Platform standards define the architecture that links objects one to another in a networked configuration. For example, TCP/IP is the primary standard that governs access to the Internet. Designed as an open standard, TCP/IP has spawned multiple on-line users and uses. Because platform standards are the foundation for higher-level activities, which ride atop the platform, they facilitate

innovation. Thus, for example, the World Wide Web was built atop of the Internet platform, while YouTube rides over the WEB.

Each of these three types of standards can come about in one of three different ways. Some standards are unplanned; they emerge, from the bottom up, in the context of repeated interactions. For instance, imagine you are walking down the street, and you encounter a passerby coming in the opposite direction. If you are like most people, you will shift your step to the right, as will the passerby. Based on this learned standard of behavior, ingrained over time, each of you will limit your choice of action to avoid a collision. Such *de facto* standards also emerge in the market place, through iterations of consumer choices or because interested parties have successfully sponsored them. Nature, likewise, gives rise to *de facto* product standards through the evolutionary process of variation, selection, and replication. Thus, for example, flowers give off an electric current that has evolved over time, while the bee has coevolved to recognize the current as signaling the amount and quality of pollen to be harvested from that flower. Platform standards can also emerge from the bottom up, as the development of languages clearly attests.

Many standards are prescribed from the top down by some legitimate authority. Thus, for example, the CEO of a firm can establish the formal roles that employees play, as well as the behavioral expectations associated with them. Such workplace standards are best illustrated in the classic 1955 movie, *The*

Man in the Gray Flannel Suit, in which the protagonist, played by Gregory Peck, struggles to maintain his independence in the face of the pressures of a dominant material culture. Governments, operating at all levels, also impose standards in a top down fashion so as to achieve public policy goals. Thus, they may set control standards to regulate emissions, product standards to assure safety, and platform standards to provide for interconnection. The demand for standards often coincides with the emergence of new, advanced technologies. Most recently, for example, the prospect of private drones has led Google to call for privacy standards to regulate them. In the United States, the government relies, when possible, on voluntary consensus organizations to develop standards, which are subsequently mandated by law.

Midway between the market and the government is the voluntary consensus standards process, carried out in the private sector by standards development organizations (SDOs). This voluntary consensus process resembles top down processes insofar as voluntary standards derive their authority from the consensual process in which they are developed. However, voluntary consensus standards approximate market-based standards in that the influence that participants in the process exert to promote a standard often reflects their market power.

In the United States, the first SDOs emerged to address the problems and issues associated with industrialization. New SDOs were formed in response to specific

needs as they arose. Hence they took a variety of forms, and operated independently of one another. Notwithstanding their independence, American standards organizations resemble one another in several ways. In particular, they all arrive at decisions through a process of consensus and provide some level of due process. In addition, they all have mechanisms for participation, comment, and appeal. In contrast to top down, prescribed standards, the adoption of SDO standards is voluntary. However, conformance to such standards is high, given the network externalities associated with a standard that has a wide spread appeal.

This characterization of the Standards Universe provides a reference model for categorizing standards according to the problems they seek to address and the issues to which they give rise. As well, by depicting standards and standards processes according to a variety of dimensions, this reference model provides a basis for drawing new insights about standards based on a comparison of a broad range of contexts in which standards are developed.

Standards: How the West Was Won

President Theodore Roosevelt's four-volume account, *The Winning of the West* (1889-1896), colorfully details the drama, determination and daring adventures of

those pioneers, cowboys, and cavalry who led America's expansion westward. Far less gripping and exhilarating, although no less significant, is the untold story of standards and how, operating under the radar, they contributed to this great westward expansion.

Recall that standards are interfaces that govern all interactions, whether between people, machines, or people and machines. With this idea in mind, picture the vast stretch of territory making up the North American continent. Imagine, then, the boundless number of standardized interactions required to pave the way west. Often *ad* hoc in nature and negotiated *en route*, standards became *the infrastructure*--or platform--upon which, and according to which, travelers journeyed; battles were lost and won; trade was established; and a frontier culture was born.

At the same time, the US westward expansion generated an ever-growing need for standards. As pioneers moved west, they built homesteads, set up mining claims, established general stores, banks, and other small businesses. While located far from the teeming economic activity in the East, these western enterprises were dependent on their far-flung eastern counterparts for supplies, market information, customers, etc. In turn, eastern establishments sought to increase their gains by expanding their markets westward. But, even though trading was in everyone's interest, it was inhibited by a lack of market information and the uncertainties associated with doing business at a distance. Absent a

communication infrastructure that could provide adequate east-west feedback, standards specifying product information and the means of exchange, served to reduce uncertainty and thereby greatly expand trade. As trade increased, so did the scope and intensity of interactions, and hence the need for additional standards.

Not surprisingly, given this context, some of the most important standards developed during this period were those related to the communication of market information and the mechanisms of exchange. As the late James Beniger pointed out in his seminal work, *The Control Revolution: Technologic and Economic Origins of the Information Society,* market conditions and prices fluctuated widely from place to place. Lawlessness and opportunism were commonplace. To generate the stable conditions and levels of trust essential for trade to take place, standard economic processes and practices were required.

Consider the standardized roles of the middlemen who managed the trading process. They were central in this regard. Included among these roles was that of the *commission agent, or factor*, who carried out business on behalf of a merchant in distant markets; *the broker*, who brought buyers and sellers together; *the financiers* who provided a credit network to cover the up-front costs of transporting, processing, and distributing goods, as well as *retailers and other distributors*, such as *auctioneers* and *wholesale jobbers*, the latter being of upmost importance in supplying western retailers.

Equally important were the standardized trading forms and formats that helped to regularize trade by providing greater predictability. Standard invoices, for example, were used to document sales. The bill of lading was employed not only as a receipt, but also as proof of ownership, as well as a negotiable instrument that could be traded for goods or used as collateral to back a loan. Equally significant were catalogs that displayed standardized products, and listed their fixed prices.

Formal institutions, which led to the standardization of business practices, emerged as well. Among these were common carriers--such as the postal service and the railroads, which--operating according to standardized procedures and a fixed schedule--allowed trade to take place on a consistent, periodic basis. Of equal consequence, according to Beniger, was the development of commercial law and legal precedents standardizing corporations; government prescriptions laying out a framework for interstate commerce; the chartering of insurance companies and commercial banks; businesses providing commercial credit ratings, and standardized ways to sort, grade, weigh, and inspect agricultural products, to name a few.

Eighteenth century standards served not only to facilitate east-west trade; by conveying product information, they also provided greater quality control. One of the first product areas to benefit from standards was that of food. For example,

responding to scandals in the meat packing industry, Congress passed the Pure Food and Drug Act of 1906. This legislation not only protected against misbranding and food adulteration; it also standardized containers for marketing fruits and vegetables, thereby eliminating false measurements and deceptive shapes.

When employed as trademarks, such quality standards increased the value of goods; they allowed producers to differentiate their products from those of their competitors, and to price products to different markets. To this end, American farmers played a major role in setting agricultural standards. They realized that by grading and classifying their products, they could set up separate distribution channels and increase their profits. Thus, when moving west, farmers labeled their products by their region of origin, while wholesalers used these names--Goschen butter, Genessee flour, and Herkimer cheese--as designations of grade. By the end of the century, these quality standards efforts took the form of branding. Notable in this regard was Henry P. Cromwell's success in packaging and advertising oats, previously considered fodder for animals, as a healthy breakfast cereal using the brand name Quaker.

With the deployment of the telegraph and the completion, between 1851 and 1854, of the four major trunk lines linking the East and West, one might say that the West was finally won. With the advent of steam powered railroads, activities and interactions that had once taken place at a snail's pace were suddenly

accelerated, greatly increasing the flow of people, goods, innovations and investments to the West. But, it is well worth noting that the railroads, operating on such a vast scale, could not have played this role without a rash of new standards to alleviate the system's complexity. As described by Beniger (----), these included not only standardized role assignments and operating procedures, but also innovations such as through bills of lading, standardized cars, uniform standard time, standardized track gauges, as well as standardized automatic couplers and air breaks.

We have seen how critical standards were to the US western expansion. In subsequent modules we will consider how lessons about standards from earlier periods can be applied to our understanding of their role in the expansion of the global economy.

Standards: The Coin of the Realm

I'm old enough to remember penny candy. When growing up, I was a frequenter at the store around the corner from my house where one could buy newspapers, comic books, soda pops, and, yes, penny candy. While my friends browsed the comics, I surveyed the candies, spread out on the counter much like colorful jewels. My favorites were the sugar dots lined up in rows and columns on long strips of paper. As I nibbled on the dots, making new patterns with each bite, I

marveled at the treasure one penny could buy. How things have changed! Today's merchants are often willing to round out a bill just to avoid dealing with pennies. And despite the 'good luck' associated with them, people rarely stoop to pick a penny up.

The changing value of a penny makes one stop to wonder. What are coins? Where did they come from? How is their valued determined? What is their relationship to money? To answer these questions, we need to think, once again, about standards. For coins are standards of value that govern interactions.

Although economists have typically interpreted the value of coins solely in terms of their convenience for market exchange, more recent scholars show that money and coinage are far more multifaceted than that. In fact, as Ash Amin and Nigel Thrift tell us, the origin of coins is rooted not in the marketplace, but rather in social and cultural relationships. As telling, coinage only emerged and was widely disseminated given the rise of centers of power and authority--be they cities, religious institutions, or empires. To understand coinage in its entirely, therefore, we need to assume a more interdisciplinary perspective, one that emphasizes all of the mediating aspects of standards that are described in the module, *The Standards Universe.*

To appreciate the role of coinage as a broad-spectrum standard, let's consider, first, the more narrow, economic perspective, which attributes the emergence of coinage--that is to say, commodity money--to interactions in the limited sphere of the marketplace. I first heard this account, years ago, when studying neoclassical economics based on Paul Samuelson's classic text, Economics: An Introductory Analysis, first published in 1948.

In my day, this text served as the font of all undergraduate microeconomic wisdom. In making his case, Samuelson employed a functional argument, based on methodological individualism. Accordingly, he posited that individuals, interacting in the market, and pursuing their own self-interest, logically progressed from bartering goods and services to a trading system based on coinage--that is to say, commodity money pegged to a common standard. Samuelson contended that this evolutionary path occurred spontaneously, driven by the desire for convenience, greater efficiency, and a reduction in transaction costs. It is noteworthy, in passing, that the scenario Samuelson described mirrors today's de facto standards process, insofar as it relies, in some form or another, on self-organization, or--one might say--the invisible hand. In so doing, it seeks to explain the past in terms of today's institutional structures--somewhat of a problem, as we shall see.

Samuelson's account has not gone unchallenged, however. More recent, evidence-based, archaeologically and historically oriented scholars point to a

number of deficiencies in its logic. These scholars contend that, in contrast to a bottom-up process, coinage was established through a top- down process, via the imprimatur of some legitimate authority. Randall Wray's (1999) critique is especially telling in this regard. Noting that choosing a medium of exchange requires common consent, Wray questions whether, and how, early societies might have coordinated the building of a consensus, favoring one coin over another, especially given the lack of a preexisting market. How, he asks, could an agreement come about, given the broad range of candidate objects ranging from barley, porpoise teeth, sea shells, to various metals, each of which might have served just as well--and often did--as a monetary standard.

Ash Amin and Nigel Thrift provide an alternative vision. They point out that money emerged in many cases as a means of governing social interactions and cultural practices long before it was used in market exchange. Coins were employed, for example, as bride and blood money, as ceremonial objects, and for religious purposes. Moreover, as Amin and Thrift attest, the advent of coinage was far from spontaneous; rather it was associated with the rise of institutional structures that could legitimate coins and attest to their value. That explains why minted coins that were guaranteed by governing powers were more highly valued than the actual metal--be if bronze, silver, or gold--that constituted them.

Early Athenian coins, for example, said to be the first commodity coins produced, provide insights about the complex role of coins as standards. The most prominent Athenian coins, the tetradrachm were standardized not only by weight but also by the state images featuring the head of Athena on the obverse side and the owl and olive spray on the reverse. These coins were first produced in the mid-sixth century, when an extraordinarily rich vein of silver ore was discovered in the Laurion area of southeast Attica. They served to regulate both social and economic interactions. That these coins were able to serve, equally, as social and economic standards was due in part to their origins in the Greek polis. As Peacock (----) emphasizes, just as the developing state played a key role in the emergence of coinage, so too did Athenian coinage play a major part in enhancing the legitimacy and power of the state. As the polis gained in authority, taking on both administrative and judicial roles, it laid claim to taxes, as well as allocated money to pay public officials and settle private disputes. To execute its roles in a fair and just manner, the polis needed a standard medium of exchange. What better medium than coinage?

Athenian coinage gained what today's standard experts would describe as a *first mover advantage.* By requiring that all debits and receipts be made in Athenian coinage, the state created a critical mass of users who then became locked-in to the use of Athenian coins. Athenian coinage increased in value not only because of the growing number of users, but also because the state's stamp served as a sign of the coins' redeemability. The popularity of Athenian coinage

was enhanced even further, when its standardized form was enshrined in law in the late 4th century under the Athenian Declaration on Coinage And Standards. This declaration required that all coin within the Athenian territory be reminted and converted into Athenian coin. Not surprisingly, by 490 BC, Athenian mints were mass-producing the tetradachm to meet the growing demand of much of the Mediterranean world. In so doing, they provided a major boost to the Athenian economy. As John Kroll (----) describes it: "Athens' silver industry effectively functioned as an 'industry of money.' " But, even as Athenian coinage promoted trade and development, it also--and as importantly--fostered political unity at home, as well as tremendous political prestige and imperial expansion abroad.

Looking much later at the evolution of coinage in late Iron Age Britain--that is from the late second century BC to the Roman annexation by Claudius in AD 43--we can gain a better appreciation of the symbolic role that early coins played in integrating a community and sustaining an institutional authority. John Creighton, in his book Coins and Power in Late Iron Age Britain (----), provides a detailed account. As he points out, Britain in the late Iron Age was characterized by turbulence, due to border incursions from the continent and the rise of an elite group of warring individuals, who together with their *comitatus*, or loyal body of horsemen, jockeyed among themselves for power. The leaders of these groups lavishly bestowed coins and other gifts, such as rings and torcs, on their followers in order to recruit and retain them. Power and influence was

thereupon accorded to those who exhibited the greatest wealth and number of clientele. Horses played a central role in the social structure, as attested to not only by a growing equestrian material culture, but also by the imprinting of the man/horse's image, albeit incrementally modified over time, on the series of coins associated with this period. According to Creighton, this image legitimated the leader by metaphorically linking him to the spiritual world. Moreover, evidence suggests that, given the artistic and technical skill required to mint these coins, their production was carried out through spiritual rituals, practiced over generations and executed by a special class of shamans, such as the druids. As Creighton contends:

> I believe the horse/man image denotes the right to rule through the alliance of a leader and nature, represented by the horse. Since in many ways this is a mystical union, the development of this imagery along lines associated with altered states of consciousness should not be seen as particularly surprising (53)

Looking at the standardization of coinage from an historical perspective provides some useful insights for the study of standardization today. Much of the existing standards literature is theoretical, based on tools that are derived from microeconomics and game theory. Often it seeks to apply universal theories to site-specific problems. The history of the evolution of coinage suggests, however, that standards emerge out of unique social and political contexts, which must be

taken into account. Recognizing this fact is evermore important today, as we strive to develop new, cutting edge standards, as for example, those governing financial transactions and interactions, in an increasingly global society.

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Standards: The Building Blocks of Life

We have seen that standards play a central role in every day life. In this essay, we explore the role that standards have played in the evolution of life itself. As we shall see, just as living creatures, natural phenomena, and artifacts coevolved in relationship to a changing environment, so too did the standards and protocols that linked them together. In fact, as the complexity theorist Stuart Kauffman tells us in his book, At Home in the Universe (1995), it was only by virtue of the standard interfaces inherent in the universe that the diverse entities that comprise all phenomena were able to interact, repair, coevolve, and recreate themselves. According to Kauffman (1995), it is the laws of the Universe, embodied in these standards that have given it its natural, hidden order. Although we are as yet far from understanding all of these laws, we know that they account for the complexity of the universe, as well as signature patterns such as oscillations, power laws, and phase transitions (Beinhocker, 2006). Most importantly, these standards provide the platform upon which evolution takes place (Kauffman, 2008).

How did these standards come about, and what role do they play in facilitating life's processes? According to Kauffman (1995), standardized rules, as reflected in the behavior of cells--the constituents of all living things--facilitated the autocatalytic processes that spawned life on our planet. Autocatalysis is a chemical process by which the interaction among chemicals generates a product that is itself a catalyst for the very same reaction. According to Kauffman, given enough diversity among life's elements, all serving as both products and catalysts, and operating according to prescribed rules, life emerged--as in a phase transition--in one fell swoop. With adequate inputs of energy and food molecules, life's processes became self-sustaining.

What about human beings? Where do we fit in? Do we exhibit autocatalytic processes? Do we function according to some preexisting rules? Are we standardized? Well, while we can differentiate ourselves from other species according to any number of variables, we share many standardized characteristics. One need only reflect upon our anatomical structures. As David Godsell points out in his book, The Machinery of Life, creatures as diverse as birds and mammals, reptiles, amphibians, and fish have similar digestive and nervous systems, as well as an architecture that configures all bones and muscles around a head, torso, and four limbs (Goodsell, 2010). As significantly, when we hone in on the cellular and molecular levels, we encounter an even deeper resemblance among all living things. In fact, it is such commonalities in our make-ups that have allowed scientists to draw inferences and derive insights

about human beings based on their research of such diverse entities as plants, animals, and bacteria.

To appreciate the role of standards in the make up and functioning of life, let's look more closely at the cell, where we can grasp a clear picture of a rule-based, emergent order. Cells are non-equilibrium, complex adaptive systems that evolve based on rules, which have evolved, from the bottom up, in response to the actions of their component parts, as well as to their changing environments. Cells are made up of different types of molecules, which are comprised in turn of the atoms carbon, oxygen, nitrogen, sulfur, phosphorous, and hydrogen. Notwithstanding this limited range of materials, these molecules, which are mostly proteins, can combine and recombine in a variety of ways depending on their chemical makeup. Each specific configuration allows the molecules to carry out distinct functions necessary to the survival of the cell. The specifications--or one might say, the standards--for their behavior and replication are housed for the most part in the nucleus of the cell, where they are encoded in nucleic acid, more generally known as DNA (Deoxyribonucleic Acid) and RNA (Ribonucleic Acid).

Looking at the overall functioning of cells, Goodsell (2010) describes them as molecular machines. Like the standardized, interchangeable parts of modern machines, the components of molecular machines connect with each other when their parts--defined by their chemical make up--fit snuggly together. Although

molecules encounter one another randomly when swimming in the cell's fluid environment, they only bind together when the interaction is complementary--that is to say, when their interfaces are perfectly matched to a common standard. Proteins serve as enzymes that function to speed up the process. The combinations and configurations of molecules within the cell are optimized to perform specialized roles. To expand their behavioral repertoires, molecules can be connected to divergent molecules when they are linked together via specific chemical interactions and/or salt bridges that serve--much like a modem in a communication network--to translate between incompatible interfaces. Water in the cell also affects the make-up and behavior of molecular machines. Whereas some molecules are attracted to water, others are repelled by it. Drop a teaspoon of oil in a bowl of water, and you will see what I mean. Depending on how molecules interact with water, they can be attuned to perform specialized tasks.

Of course, one of the most important functions of cells is their preservation and replication. It is here that DNA and RNA--the so-called library of life--play a decisive role. DNA is comprised of two long polymers made up of simple units called nucleotides. These are attached along a backbone made of sugar and a phosphate group. The two strands of DNA, which consist of four bases--adenine (A), cytosine (C), guanine (G), and thymine (T)--line up to one another in opposite directions but in a complementary fashion. Hence, A is always aligned with T, while C is always aligned with G. The specifications, which are encoded in the sequences of these bases, constitute the genetic information that

determines the make up and behavior not only of the molecules in a cell, but also the cell's offspring. The code is transferred, read and transcribed by copying segments of DNA into the associated RNA nucleic acid, where it is then translated into proteins. When cells divide, the chromosome, which contain much of an organism's genetic information, are duplicated, so that each new cell contains a complete set of chromosomes with specifications for the unfolding of subsequent cells. The information does not, however, serve as a top-down prescription for the next generation. As Steven Johnson points out in Emergence: The Connected Lives of Ants, Brains, Cities and Software (2001), cells make choices about how to implement the genetic script, based on the activities of other cells in their neighborhood. It is a bottom up, emergent process.

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As we move up the hierarchy of livings things, we observe similar emergent patterns derived from routine, standardized behavior. Consider, for instance, the humble slime mold described by Steven Johnson. Slime molds are amoeba like globular organisms that typically can be found in the wet areas of the forest on decaying logs, or in piles of leaves on the forest floor. Although slime molds lack cognitive abilities, they respond to their environments in predetermined and predictable ways. When food is readily available they converge and become a single glob; however, when faced with scarcity, they desert the pack and proceed on their own separate ways. How does this happen? Given their limited intelligence, how does the slime mold know when to come and go? You might be

surprised. It took scientists some time to realize that there was no central commander in charge to tell the slime mold what to do. Instead, slime mold behavior is a bottom up, emergent process, in which standardized rules and signals are repeatedly at work. Depending on whether there is feast or famine, individual slime molds alter the amount of the pheromone ANP that they secrete, which--much like the switches in a computer--signal to other slime molds which route to take (Johnson, 2001).

Interactions among diverse species likewise exhibit a hidden order based on emergent, rule-based, self-reinforcing behavior. A recent discovery made by researchers at the University of Bristol is illustrative in this regard. Looking at the relationship between flowers and bees, the researchers found that, flowers employ not only their bright colors, the attractive patterns in their petals, and their sweet aroma to romance the bees; they also seek to attract them via their electrical fields. As Young (2013) recounts in his coverage of this new research, bees typically carry a positive charge, whereas flowers carry a negative one. As the bee approaches the flower, the flower greets it with a release of pollen that contains important electronic information about the quality and quantity of nectar to be found in the flower. And by most accounts, flowers don't lie! As importantly, once the bee has pollinated the flower, its changes the flower's electrical charge, so that other bees will know that the flower is no longer a good source of pollen.

This type of rule-based, emergent order is ubiquitous in all complex systems; it is to be found not only in all life forms, but also in the ways that organization takes place, be it in ecosystems, the human brain, cities, markets, and technologies--all subjects of other modules in this series. Stuart Kauffman (1995) calls this type of self-organization order for free, and claims that it is essential for evolutionary processes to take place. As he contends, if the changes brought about by evolutionary selection are not to lead to system chaos, then selection must operate on a platform that is both stable and flexible--that is, order at the edge of chaos--a location that, in fact, evolution selects for.

Understanding the role of standards in the life process yields some important lessons for the study of standards and standardization today. Many studies of standards are presently based on case studies that focus on single component technologies, individual or firm entities, or single standard setting events. Their aim is often to determine how X standard was chosen from among alternative others as well as how businesses might best position themselves in standards processes so as to become more innovative and/or gain a competitive advantage. However, our brief look at life's standards suggests that a more holistic analytic approach is in order. For, just as life emerges from the collective interactions of a wide array of molecules, proteins, etc.--each performing their own standardized roles--so too do technologies, organizations, cities, and cultures. To fully grasp the role of standards, their evolution, and their impacts, we need to paint with a broader brush, one that captures not simple a specific

standard, but also its relationship to the standards in its community as well as its environment (Brian Arthur, 2009).

There is an even broader significance to appreciating the role standards play in the emergence of living things. For years, social scientists have struggled to link behavior at the local level to that of outcomes at the global level, but to little avail. One problem has been dealing with complexity and the non-linearity of processes as they evolve over time and in different contexts. Perhaps standards could provide the missing key to linking the micro and macro levels without sacrificing our notions of the complex, hidden order. By identifying the interfaces across diverse boundaries, whether they are cellular membranes or national borders, standards both facilitate and help account for transitions and adaptations over time and space.

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What's New? Platform Standards and Innovation

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"The thing that hath been it is that which shall be, and that which is done is that which shall be done; and there is no new thing under the sun" (Ecclesiastics 1:9, *King James Bible*). As can be seen from the Old Testament, creativity during the early Hebrew period, as well as long before, was considered the sole prerogative of God. As Weiner describes, because God had established the world *ex nihilo*, all subsequent creations were considered to be bi-products of God's handiwork. Given this Biblical perspective, innovation was disparaged, and creators' efforts went unrewarded (Montuori and Purser, 1995; Weiner, 2000; Sawyer, 2006, 13-14).

Notwithstanding the admonitions of the Book, the world has, beginning in the mid-seventeenth century, witnessed a greatly accelerated rate of invention and innovation (Johnson, 2009). Speaking in 1965 about the accelerating change in the semiconductor industry, Gordon E. Moore, the co-founder of Intel Corporation, predicted that the number of transistors in a dense integrated circuit would double approximately every two years, a prediction that has proven true at least until the present (Moore's Law, *Wikipedia*). Rae Kurzweil then extended Moore's notion to include all technological progress. As he claimed in his 2001 essay, "The Law of Accelerating Returns":

> The history of technology shows that technological change is exponential, contrary to the commonsense 'intuitive linear' view. So we won't experience 100 years of progress in the 21st century—it will be more like 20,000 years of

progress (at today's rate) (http://www.kurzweilai.net/the-law-of-accelerating-returns).

How do we account for the exponential growth of inventiveness? Can we reconcile the biblical idea that there is nothing new under the sun with this continuous surge of creativity? *Might standards help solve the puzzle? Might not they play a role in bridging the old world and the new? Might not they be the infrastructure for evolution itself?* I think so. For, according to our definition of standards, they are the interfaces that link things together, even the past and the future. And, as we shall see, inventions and innovations are all about making these linkages (Johnson, 2010, 46; Arthur 2009).

Brian Arthur, for one, shows us how. In his book, *The Nature of Technology: What it is and How it Evolves* (2009), Arthur asks the question: "Where does technology come from?" His answer is somewhat surprising. Technology, he argues, begets itself. Hence, notwithstanding rapid technological advances, there is—as in the biblical sense—nothing new under the sun. Arthur's contention merits further inquiry.

According to Arthur, technologies are designed to take advantage of some natural phenomenon—such as electricity, the sun's energy, etc. and, based on some principle, turn it to a useful purpose. As he says, "A technology is a programming of phenomenon to our purposes" (Arthur, 2009, 51).

Technologies, moreover, are modular; they are made up of a central assembly of interconnected technologies, each of which is supported by a number of sub-assemblies of technologies that are sustained--in turn--by sub-sub-assemblies of technologies on down to the last module (Arthur, 2009, 32-35). Because these modular parts are

configured to work seamlessly with one another, technologies can easily be reconfigured and used to build other new technologies (Arthur, 2009, 42, 43). Designed in this way, "technology becomes a complex of interactive processes—a complex of captured phenomena—supporting each other, 'conversing' with each other, 'calling' each other much as subroutines in computer programs call each other" (Arthur, 2009, p. 55).

Of course, for any communication act to take place, there must be—as in language—standard protocols. The modules serve this purpose. Over time, says Arthur, modules become standardized units that serve as mechanisms of heredity, linking the past and the present. By combining standardized modules in new ways, innovative technologies can be created that serve new purposes (Arthur, 2009, 37). It is in this way that Arthur accounts for the accelerating pace of technological change. As he says, the larger the store of previous technology modules, the more possibilities there are for assembling new technologies (Arthur, 2009}. When technology is viewed in this way, it appears to be not just a working object; rather, given standard interfaces, technology is a whole ecology of living objects that evolve over time through their combination and recombination in novel ways (Arthur, 2009).

As Arthur describes, as technologies evolve, they create platforms upon which higher level and more complex technologies can flourish. (Arthur, 2009; Gawer, et al., 2009; Johnson, 2010). It is standards that provide the interfaces that facilitate and govern these linkages. Moreover, because standard platforms can be reused to create a broad array of products and processes, they are the source of economies of scale and scope as well as positive externalities. As described by Baldwin and Woodward:

> A platform architecture partitions a system into stable core components and variable peripheral components. By promoting the reuse of core components,

> such partitioning can reduce the cost of variety and innovation at the system level. The whole system does not have to be invented or rebuilt from scratch to generate a new product, accommodate heterogeneous tastes, or respond to change in the external environment (2009, 19).

To appreciate how platforms add value one need only consider the Internet's layered construction. The initial TCP/IP protocol, developed under the auspices of ARPA, not only provided a platform that bred a critical mass of users and applications; it also spawned the emergence of higher level platforms riding atop it, such as browsers, YouTube, and Facebook, each of which generated additional externalities (Johnson, 2009, 130; Garcia, 2015 forthcoming).

Nowhere is the innovative role of standards platforms more evident than in the biological world, where creativity and evolution is the norm. Consider, for instance, coral reefs made up of tiny coral that, simply by going about their own business, create the scaffolding that houses and feeds so many other ocean creatures. As Johnson describes:

> The tiny Sceractina polip isn't actively trying to create an underwater Las Vegas . . .Nonetheless out of its steady labor-imbibing algae and erecting those aragonite skeletons—a higher level system emerges. What has been a largely desolate stretch of nutrient-poor seawater is transformed into a glittering hub of activity (Johnson, 124-5).

Biologist and complexity theorist Stuart Kauffman (1995) explains why these emergent, standards-based platforms are necessary for evolution. As he notes, if changes in

species were to occur in an unstable environment, chaos would ensue. On the other hand, a rigid environment would preclude any changes at all. Evolution takes place at the edge of randomness and order, a condition that standards—given their relative flexibility—provide for (Kauffman, 1995; Baldwin and Woodward, 2009). As importantly, because platform standards generate changes from the bottom up, outcomes at the macro level encompass system-wide learning and adaptations (Kontopoulos, 1993; Monge and Contractor, 2003; Beinhocker, 2005).

While Arthur tells us how standards platforms foster new technologies; and Kauffman explains how they generate new species; Powell and Padgett (2011) describe how standards platforms promote the evolution of new organizational forms and business models. The authors show that organizational innovations takes place when there are spillovers across diverse domains. As they explain, the sharing of knowledge and practices across different domains engenders the emergence of *new standards of behavior,* which over time form the basis of innovative business cultures. They are quick to point out, however, that what allows diverse domains to collaborate is the existence of an 'anchor tenant.' If the anchor tenant is open and amenable to multiple business approaches, it can serve, much like the coral reef, to attract and accommodate a variety of new and diverse business practices (Powell and Padgett, 2011).

These depictions of standards platforms contradict the long-held view that standards impede innovation. The argument against standardization is based on the fact that standards generate positive externalities and network effects (Arthur, 1983; David, 1984; Farrell and Saloner, 1985; Grewal, 2011). Accordingly, as more and more users adopt a standard, it value continues to increase, leading to the standard's adoption in ever-greater numbers. Such a 'bandwagon' effect (Rolfs, 2001), it is said, sets a standard on

a self-perpetuating trajectory whereby alternative standards are eliminated; users are locked in to a single approach; and innovation is thus greatly impeded.

Our evolutionary perspective suggests, however, that such an outcome need not ensue. In the case of evolution, the setting of platform standards is an open, flexible, and constantly adapting process. As such, it is the fulcrum of diversity. There is an important lesson here. For platform standards to foster innovation, the architecture of the standardization process as well as the standards themselves must be much the same, open, flexible, and extendable. (Grewal, 2011; Johnson, 2009)

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Standards & Identity: Who Are You

I recall the time several years ago, when I was making a presentation to a conference in Japan on standard setting. It was my first trip to Japan, and I didn't quite know what to expect. To screw up my courage and buffer my morale, I donned a brand new outfit, decorated with feminine frills accented by a stylish pair of pumps. The speech went exceptionally well, and I returned how, brimming with pride. Not long thereafter, I received some nice photos of the event. What a surprise! Despite my efforts to portray a certain image of myself, the photos of me were labeled **Mr. Garcia**. Apparently, I had little control over my identity; how I was defined, it turned out, had little to do with my appearance and everything to the role that I played as a 'standards expert'—a role clearly associated in Japan with the masculine sex.

I had not remembered this experience until this morning when reading The New York Times. From a piece written by Didi Kirsten Tatlow entitled, "IN China, a Respected Ms May be Labeled Mr.," I learned that in China today, female opinion leaders and scholars are referred to in masculine terms. In fact, such labels are considered a sign of respective. As described by David Moser, a Chinese language specialist, "Sometimes a

women just has to be one of the guys" (as quoted by Tatlos, A7). It seems that in Japan I had met the standard for 'standards expert,' but failed to live up the standard for women.

Thinking along these lines, I am reminded of Alice's encounter with the Caterpillar during her adventures in Wonderland. You might recall the instance as well.

The Caterpillar and Alice looked at each other for some time in silence: at last

The Caterpillar took the hookah out of its mouth, and addressed her in a languid, sleepy voice.

'Who are YOU?' said the Caterpillar. This was not an encouraging opening for a conversation. Alice replied, rather shyly, "I hardly know, sir, just at present--at least I know who I was when I got up this morning, but I think I must have been changed several times since then."

'What do you mean by that?' Said the Caterpillar sternly. 'Explain yourself!'

'I can't explain MYSELF, I'm afraid, sir' said Alice, 'because I am not myself, you see.' I don't see, said the Caterpillar.

'I am afraid I can't put it more clearly, 'Alice replied very politely, 'for I can't understand it myself to begin with; and being so many different sizes in a day is very confusing,' (Lewis Carroll, 2009)

Alice's problem--believe it or not--was a one of standards. In that strange, wacky Wonderland, Alice lacked a common standard against which to define herself. In today's terminology, Alice was experiencing an "identify crisis" (Erikson, 1968). Much as I had witnessed during my trip to Japan, Alice became unsure about her identity when she found herself uprooted and in a strange environment in which her physical persona was in constant flux. What does this say about our identities? Like Alice, in today's interconn1ected global society, we find ourselves playing increasingly diverse, and often conflicting, roles. How do we manage our personal identities in such a complex world? Does viewing our identities as "standards,' help us to figure this out?

While we can easily understand the role that standards play in determining the identity of a thing, as for example in the case of a product description, it is

somewhat more difficult--especially if we are technologists--to think about the role standards play in identifying people in standardized terms. After all, we pride ourselves in fostering individualism as well as diversity! But, in fact, even in today's individualist culture, it is standard identities (or roles) that provide the interfaces that allow us to interact and cooperate with one another. For in any given societal context, individuals occupy positions that carry with them a complex set of role expectations defining appropriate behavior, obligations, and values (Merton, 1949; Biddle, 1986; Burke and Stets, 2009). Individuals form their identities by taking on and performing standard roles from the repertoire that, in the context in which they are situated, are available to them. Individuals recognize each other and develop expectations about each other based on the identity roles that each chooses to play. It is in this way that coordination takes place.

How does this all come about? According to psychological identity theories grounded in the works of Erik Erikson (1968), and sociological identity theories based on the symbolic interactionism of George Herbert Mead (1934) and Herbert Blumer (1969), identity formation is the product of three components: the core personality, the self in interaction, and the social structure in which interaction takes place (Cote and Levine, 2002, 30). Individuals define themselves not only by virtue of their unique "core" personal characteristics but also, and perhaps more importantly, by reflecting upon and adapting to how, in any given situation, others perceive them and communicate their role expectations in the course of meaningful communication acts, which is to say, "symbolic interaction." In the process, the self becomes encapsulated as a symbol or standard (Burke and Stets, 2009, 10).

Although not formally associated with symbolic interactionism, Erving Goffman's view of identity formation is in many ways consistent with it. In fact, Goffman goes so far as to use a theatrical metaphor to describe the process of symbolic interaction. In his schema, the individual (actor) performs certain roles, during which he strives to frame his image and the situation so as to gain approval from his audience, while "others" in the audience are doing the same. In contrast to Mead and Blumer's emphasis on individuals 'taking on' societal roles, Goffman claims that actors gain agency by consciously manipulating their performances--through their appearances, demeanors, and behaviors--to construct a mutually agreeable role (Goffman, 1959). Of course, the extent to which individuals can do so will depend not only on the specific context, but also on the resources (identity capital) available to them, a point that Stryker and Serpe (1982) emphasize in their exposition of "structural symbolic interaction."

Based on these analytical perspectives, we can see how identity constitutes a negotiated standard attached to a particular role, position, or thing, which is the

product of meaningful symbolic communication that occurs within a specific, structured social situation (Burke and Stets, 2009, 4). Hence, our identities--like all standards--serve as interfaces that mediate our relationships to society (Burke and Stets, 2009, 4; Hogg, et al, 1995). By adopting socially agreed upon identity roles, individuals determine with what/ whom and how they are able to interact. This relationship between individual selves and social structure is reciprocal. At any one time, the roles available to us reflect the structure of society, which can be conceived of as a web of interdependent roles, whereas how we perform our roles will serve either to reinforce or to undermine this structure (Stryker and Serpe, 1982, 206; Burke and Stets, 2009).

Not surprisingly, therefore, the repertoire of available roles and the way they are allocated among a population has differed significantly from situation to situation and from society to society (Taylor, 1989). Thus in Roman times, roles were associated with a hierarchical social pyramid of legal statuses, each rung being linked to a distinct social style reflected in clothing, art and architecture (Stewart, 2008, p. 40). In the Middle Ages, chaos reigned, but a semblance of stability was maintained through strict adherence to prescribed roles and relationships as established by the chivalric code, monastic life, and long-standing traditions based on feuds, blood ties and gift exchanges (Becker, 1981, 4; Huizinga, 1999, 1). The Renaissance witnessed a more individualist, open-ended approach to role formation due in part to the proliferation of the bourgeoisie statuses that accompanied the rise of a mercantile culture. Linking these identities together Italian humanists provided a common script that defined codes of behavior for all Renaissance Italians, while the literati wrote extensive treatises, such as Machiavelli's The Prince, outlining the behavior expected for specific roles (Kristeller, 1990). During the Enlightenment, the search for universal scientific facts based on observation and reason rather than religious precepts and tradition led to efforts to classify all phenomena according to common, standardized definitions, the prime example being Diderot's Encyclopedie (Gay, 1977). At the same time, new role identities proliferated due to greater specialization and a deepening division of the labor (Burke and Stets, 2009, 45). These trends intensified during the Industrial Revolution, so much so in fact that formal standard setting arrangements became required to designate and define the growing number of economic products as well as organizational roles (Beniger, 1986).

Growing up today in the land of High Modernity (Giddens, 1991), Alice might believe that she had returned to Wonderland. For once again she would find herself confronted with a multitude of shifting circumstances requiring her to adjust her demeanor and take on any number of possible roles. How would she manage? What if her identities conflicted? This is a question that many identity scholars ponder. Some predict that, given a world in which digital technology and

social networking abound, Alice would have much greater agency and many more options in determining which roles to play and how to perform them. They note that, to support her identity claims, she could select from the wide variety of props and appurtenances afforded by today's consumer society (Cote and Levine, 2014). Others are less sanguine. They point out that Alice, operating in an uncertain world, and absent the type of community connections and institutional arrangements that provided existential security in pre-modern cultures, would lack a guiding compass and coherent basis for making her identity choices. Overwhelmed, she might not be able to make any choices at all, and in the process lose sight of herself (Cote and Levine, 2009; Giddens, 1991; Burke and Stets, 2009, 259-261).

How successfully identity claims are worked out has implications not only for individuals like Alice but also for society in general. For, as is argued by structural symbolic interactionists, the way individual actors perform their role identities feeds back to determine the network of interdependent role identities that constitute the social order. Hence, we might ask, if role identities become excessively fragmented, what might be the consequences for society as a whole? This is a question that preoccupied Emile Durkheim in the early modern era, and the answer that he provided then is still relevant today (Durkheim, 1984). Noting that increased specialization and a deeper division of labor threatened to undermine the cohesion of society, he said that norms—that is to say standards—were needed to hold society t0gether.

Recall that standards are specifications that define the relationships between the parts of any given whole. As such, they are the rules of the game, bounding the system as well as providing affordances and constraints to the actors within it. However, in the period of High Modernity, the number and variety of role identities has increased exponentially together with the complexity of society, but the institutional arrangements to integrate these roles have not kept pace (Grewal, 2009). Thus, it would appear that just as problematic as the individual identity crises that many people may experience is a larger societal crisis due to a lack of institutional standards, making it extremely difficult for individuals to connect to others and integrate themselves within society in any meaningful way (Giddens 1991).

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