Civil Engineering: Anachronism and Black Sheep

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Abstract: The paper presents a thesis that the word "civil" in "civil engineering" is anachronistic and does not represent the works of the so-called civil engineer. The origin and root of the words "engineer" and civil are traced. Engineer is seen to have its roots via the Greek and Latin in the Sanskrit word *jan*, meaning life, whereas civil is traced to the differentiation that engineers of the 18th and 19th centuries created from their military engineer counterparts. The word engineer was used as far back as the 14th century, though, much of it in nontechnical terms. The evolution of the practice of civil engineering, and the history of the formation of societies are studied to determine how tasks relate to the word civil. Of particular interest is to see what the practitioners and founders of societies aimed to embody in this field of civil engineering. The paper aims to explore the factors and influences in the practice and naming of the civil engineer. It delves into the roots and origins of the names of a number of engineering disciplines, giving explanations and commentary on the implications of those names, and finds that all those names relate to technical functions. The paper concludes that the name of civil engineering does not represent the functional tasks of the civil engineer, in contrast to names of other engineering disciplines, and is, moreover, out of place with modern times. What's in a name? This paper seeks to find out.

DOI: 10.1061/(ASCE)1052-3928(2007)133:1(18)

CE Database subject headings: Engineering profession; Engineering education.

Introduction

By the time ASCE was formed in 1852, civil engineering already had a history, and the British Institution of Civil Engineers had preceded ASCE by half a century. Engineers had styled themselves as "civil engineers" and universities offered courses in civil engineering. The construction of public roads and bridges, and canals and drainage systems had been practiced since time immemorial, and had been recorded for thousands of years. But somehow, "civil engineering" came to be spoken of only in the 18th Century. The "engineer," however, has been around for centuries. Many engineers, especially today, have a misconception of the origin of the word engineer, thinking that it derives from engine; nothing is farther from the truth, as this study explores. This paper studies the origin of "civil engineer" and proposes that the word "civil" is an anachronism. Moreover, the name does not reflect the reality of the technical functions, nor the actual type of work performed in this glorious branch of engineering.

Does a name affect anything at all? Perhaps yes, or yet again, perhaps not, depending on how the issue is viewed. If it is viewed from the former perspective, then there can be cause for concern and chagrin. Nevertheless, this paper is the result of a study to determine whether there is a fit between civil and the "engineering" works performed by the civil engineer.

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Note. Discussion open until June 1, 2007. Separate discussions must be submitted for individual papers. To extend the closing date by one month, a written request must be filed with the ASCE Managing Editor. The manuscript for this paper was submitted for review and possible publication on September 20, 2004; approved on September 1, 2005. This paper is part of the ***Journal of Professional Issues in Engineering Education and Practice***, Vol. 133, No. 1, January 1, 2007. ©ASCE, ISSN 1052-3928/2007/1-18–30/$25.00.

Origin of the Word Engineer

Engineer comes directly from the Latin, French, and Middle English (McDonald 1914; ASCE 1970):

- Middle Latin: ingeniarius;
- Old French: engignier;
- Middle English: engyneour; and
- French: ingenieur.

Also related to these are the words ingenuity coming from the Latin ingenuita and French ingenuite; and ingenious comes from the Latin ingeniosus. Quite apparently, all have gen as their root term.

"Origin" (1910) has the best and most clear-cut explanation of the root gen. That article asserts "The root of both the words, Engineer and Engine is found in the Sanskrit *jan*, to be born, from which came the Greek form γεν and the Latin *gen*, the latter being embodied in the old verb *genere*, with its compound *ingenere* (changed into *ingignere*), to implant by birth, and in the later substantive *ingenium*, an innate or natural quality."

McDonald (1914), a Past President of ASCE, confirms from an independent study through the consultation of a lexicographer, that the Sanskrit root jan is the true origin of the Greek and Latin root of gen, which has led to the formation of many words in English in common use even today (see Appendix I). (This should not be surprising: numerous words in English have their root in Sanskrit.)

Consequently, the engineer is someone who gives life to ideas, bringing to life various machines and systems, which makes a lot of sense in modern day terms. Therefore, the Engineer "creates." He applies his "ingenuity," which has its roots in *gen*, to give "life" to things and develop new systems. Consequently, the word "generate" is understood to mean something that is given life to and put into action, where *gen*, again, is the root word. The word "genius" is understood in its derivation from *gen* as someone who can give life and vitality to words and things, which is what geniuses do when they invent new systems or solve difficult prob-

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lems. Similarly, the implied derivatives of the words listed in Appendix I can be traced back to gen, which is traced back to jan, which means life.

As a matter of record, jan does not really mean birth, but means life. In all likelihood, "Origin" (1910) made a minor error, probably because of unfamiliarity with Sanskrit. Birth is actually derived from jan, when life is given to a soul or entity, but is not jan itself (in Sanskrit, jan=life and janam=birth). Nevertheless, this does not detract from jan being the root of the Greek $\gamma\varepsilon\nu$.

Engine and Engineer

It is apparent that the word engineer has its roots in the root word gen, and not in the word engine, which itself is derived from gen. The common misconception that engineer came from engine is, however, understandable because the operators of steam engines were called engineers. The Oxford English Dictionary defined the engineer as one who managed engines or had charge of steam engines; in the United States, the driver of a locomotive engine was often called an engineer; the engineer was also known as a contriver or maker of engines. For instance the obituary of John Hampson, Esq., Engineer, in 1854, read at an ASCE meeting, stated (Hunt 1897): "Mr. Hampson aided in the construction of (as a machinist) and ran as Engineman, the first Locomotive Engine built in America . . ."

In history, actually, the water wheel was referred to as an engine, as it brought water up, whereas the designer and maker of the water wheel was known as an engineer, which is true even today. Various machines have been invented in the world going back to the time of Archimedes and before (The History Channel 2004). Is this a chicken and egg problem, as to what came first—the engine or the engineer? No. Clearly, the engine could not have been created without the brains of some engineer.

Moreover, the word *engineer* has nowhere been reported to be *derived* from *engine*, though the misconception is somewhat popular among people, especially after the onset of the steam engine in locomotives. Correspondingly, it is quite logical to understand that engine and engineer are related (Herbert 1633) and have their root in a common word, gen.

Early Use of the Word Engineer

May 26, 1716 is frequently credited with the day when engineering blossomed as a formal discipline, although all engineering was combined in one, and there was no differentiation between the disciplines. This was the day of the formation of the *Corps of Engineers* of the military of Great Britain (ASCE 1970). The Oxford English Dictionary subsequently carried a definition of engineer that reflected the military engineer: "One who designs and constructs military works for attack or defense." The *Corps of Engineers* was renamed *Corps of Royal Engineers* in 1787, and was charged with the designing and constructing of military fortifications, ramparts, canals, river management, railways, road, and bridge making. They were also tasked with penetrating enemy fortifications using whatever technologies they could muster. For instance, the battle-tank of World War I was a design of the Royal Engineers practicing general engineering, when they first installed steel plates around a four-wheel drive vehicle to attack infantry positions, though Leonardo da Vinci had first proposed armor around a cart to the Ruler of Milan in the 15th century.

Later editions of the Oxford English Dictionary in the 18th Century defined engineer as "one whose profession is the designing and constructing of works of public utility, such as bridges, roads, canals, railways, harbors, drainage works, gas, and water works," which we can see, are public works items. Therefore, by the end of the 18th Century, the word engineer, itself, was taken as *public works engineering*. As the use of engineer and civil engineer were practically synonymous with respect to civilians, the *civilian engineer* was distinguished on the professional level only from *military engineers* (Calhoun 1960). The French *Dictionnaire de la Langue Francais* of the 18th Century carried the following definitions of engineer, bringing out the fact that public works engineers in the civilian sector performed works undertaken by the military engineers, as well (McDonald 1914):

1. Engineer—one who plans, lays out, and directs field work and fortifications, for attacking, defending, or fortifying places.
2. Engineer—one who directs (private) works or public works, such as the construction and maintenance of roads and bridges, working of mines, etc. Engineer of bridges and roads. Mining engineer, naval engineer or marine engineer, railroad engineer.

Hence, the record of *public works* practice notes that the person engaged in such practice was, indeed, classified as an engineer, in that he designed and constructed new systems, and brought life to his constructions. The public used those systems en masse—for general consumption of the populace.

Early Use of Engineer in Nontechnical Applications

Prior to 1716, and even to this day, engineer was and is used in many other ways. For instance—to engineer a new scheme, or to develop a new idea or policy and seek its implementation even if it is not in the formal area of engineering (e.g., Mr. X engineered the adoption of his policies with the Board members for increasing market share of their product). The Cotgrave's Dictionary of French and English carried the following multiple definitions of engineer (McDonald 1914):

- Engineer—an engineer; a maker of engines;
- Enginer—engigner
- Engigner—a deceiver, beguiler, counsener; also an enchanter;
- Engin—an engin, toole, instrument; also understanding, policie, reach of wit; also suttletie, fraud, craft, wiliness, deceit; and
- Ingenieur—an enginer, engine-maker; fortifier.

Grimm's Deutsches Worterbuch is particularly remarkable in acknowledging the introduction of engineer from a foreign language and accepting the dual use of the word: "Engineer, n.–This word of the present day, for military architect, surveyor, introduced from a foreign language in the 17th Century, represented an artful calculating person in general. Ex. 'He who wishes to bring Germans into an understanding must be a very good and wise engineer (schemer, calculator).' "

Thus, it is easy to understand when Satan is described as *engineering* his deception on mankind (see the next section for quotes). It is not far-fetched to say that a primal power engineered the universe, because that was surely a gigantic engineering feat of construction, by any standard, and we are still searching for the laws, techniques, formulas, equipment, resources, and tools used for *that* construction!

However, the basic meaning of engineer had to do with one who devises, builds, and makes new. Thus, the use of the word is

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appropriate to the practices of the professions classified as engineering today. The dual use, including for nonengineering phrases and terms, is equally valid. However, people of the 21st century seem to have forgotten the dual use fundamentals, and raise eyebrows when engineering is used in any way not having to do with the practice of engineering. Most guilty of this are the engineers themselves, who often think their way of engineering is the only way and that other uses of the word are aberrations or adaptations.

Literature on the Use of Engineer

Usage of the word engineer preceded, by far, any formal recognition of engineering as a technical profession. Engineer was used commonly in medieval and earlier centuries for expressing ingenuity, planning, scheming, proposing, or improving the issue, system, or gadget at hand. Appendix II carries a list of quotations appearing in earlier centuries concerning the engineer, traced to the root words gen and jan. The quotes include both the technical and nontechnical uses of the word.

Roots of Names of Engineering Disciplines

Given in the following are the roots of names of common engineering disciplines (in alphabetical order):

"**Aeronautical engineering**" traces its origin to the prefix aer meaning air, gas, or atmosphere. Aer is originally a Greek and Latin word meaning air, so when we wish to study the flight of aircraft in air, it is quite logical to call it aeronautical engineering.

An "architect" is one who designs and supervises the construction of buildings—coming from the Greek arkhitekton, meaning master builder. It is logical to observe that "**architecture**" has been derived from arkhitekton.

Improving soil cultivation is "**agricultural engineering**." "Agriculture" comes from two roots—ager, meaning "field" in Latin; and cultura, meaning to cultivate. Ager has been the root word for growing of food and crops for many millennia. The meaning of the tasks and functions performed by agricultural engineering are immediately clear from their roots.

"**Biological engineering**," an up and coming field of study, derives from the root words bios—Greek for life—and logia—Greek for study. Nothing could more truly represent the engineering applied to the study of living species.

Chemistry has been around for ages—and anything to do with preparing chemical plants and kilns or handling chemicals was rightfully and justifiably given the name of "**chemical engineering**." The alchemist strove for centuries to transmute ordinary materials and chemical substances into gold. Medieval Latin referred to that pursuit as alchemia, alchimicus, and alchymia. The practitioner was called in New Latin as chimicus or alchemist. Therefore, it was quite natural to come up with the name of chemical engineering for the study of chemical plants and machinery, as chemistry was already known and derived from alchemia. The root is traced to the French chimic for "chemical," and Late Greek chemeia for "chemistry."

"**Computer engineering**" comes from the Latin word computare, meaning the ability to make determinations by numerical methods. For centuries, mathematicians had toiled with computing strategies until they hit on the abacus, the logarithm tables, slide rule, and then, finally, the computer after the discovery of electronics.

Goddess Electra was said to appear to mortals in the form of a *comet*. The bright light of the comet, its flare, and the ominous power of comets made quite an impression on humans. It was quite logical, therefore, for "electrical engineering" to be given this name for the study of electricity that dealt with power and light. Thomas Edison, if we recall, brought electricity from the *heavens* in his experiment with a kite that led to the light bulb. Going from *Electra* to "electricity" and then to **electrical engineering** was not far-fetched at all. Moreover, "electric" derives from the Greek electron, akin to Greek elektor meaning beaming sun. Elektor is reported to come from the Sanskrit ulka meaning fiery phenomenon in sky, or meteor. Hence, Goddess Electra was given a suitable name in reference to her characteristic.

The "**fire protection engineers**" took their name from the Old English fyr, meaning fire. They did not have to go far to find their name to represent their basic function.

The Society for "**hospital engineers**" takes their name from the modern "hospital," which took its name from the Latin hospitum meaning hospitality; the Latin hospitalis, meaning good treatment of a guest; and the Latin hospes, meaning host, as it is in the hospital that patients are treated with care and love (hopefully), much as traditional cultures treat well and respectfully a host or guest. The word Hospital refers to treating well those who come to the hospital, thereby reflecting a major function of the hospital and hospital engineers.

When workers sweat from their brow to produce industrial goods, and when people work hard in factories to produce goods, we know they have been "industrious" in the exercise of their duties—coming from the Latin industria meaning diligent, and Middle English industrie. It is no surprise that the branch of engineering dealing with workplace productivity and manufacture of goods is called "**industrial engineering**." The word "industrial is further composed of two roots—Indo and struus. Indo comes from Indu that comes from endo that means "within." Struus comes from the Latin struere that means to arrange and build; in this sense, it is similar to the root of "construction," explained later. Together, indo and struus mean "building within"—in other words, working hard, or diligent.

"**Marine engineering**" has to do with the oceans and seas, and it would be quite logical to expect marine to have something to do with ocean or sea. Marine comes from the Old French marin, which comes from the Latin marinus, which comes from mare, meaning sea. The "mariner" is, thus, one who explores the sea. Hence, we have a direct connection here to the functions of the marine engineers in their name.

Mekhane is the original Greek word for machine. Anything that is suggestive of or appropriate for performance of a machine is, therefore, quite logically given the name of "**mechanical engineering**." The word mekhane has been around for millennia, so it was reasonable when the word mechanical engineering was chosen for the study of modern machines.

"**Military engineering**" comes from the word military that comes from the Latin root miles meaning soldier and the Latin root militare meaning to serve as a soldier.

"**Mining engineering**," another very old and important form of engineering, considering how important metals such as gold have been through the centuries, even before Christ. The root of "mining" comes to us from the Welsh and the Old French. The Welsh origin, mywn, meaning "ore" is expected to be of Celtic origin. The Old French origin, miniere or mine, means "mineral."

"**Nuclear engineering**" deals with harnessing the power of the nucleus of atoms. The word "nuclear" derives directly from the Latin nucleus or nuculeus. In physics, "nucleus" represents the

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central region of an atom (whose energy is harnessed in nuclear engineering) and containing almost all of the mass of an atom. The word itself means the kernel—the most material and central part: The core. Nucleus further derives from nux, meaning nut, wherein it is implied that the nucleus of the atom is like a nut and grouping of subatomic particles.

"**Petroleum engineering**" deals with drawing oil from under the layers of rock and beds of earth. Truly enough, petroleum is derived from Latin petra, meaning rock and the Latin oleum, meaning oil, giving an instantaneous understanding of the type of work and tasks involved—where the name explains the functions.

Finally, **"safety engineering"** is one of the most obvious cases where the name of the engineering discipline directly implies the type of work being undertaken. Safety engineering concerns itself with being safe, free from danger or harm, unhurt—(of) maintaining health. The word safe comes to us from the Middle English sauf and from the Latin salvus meaning healthy.

Hence, it is apparent that the names of all major engineering disciplines (except civil engineering that has not been defined yet) come from root words that represent their technical functions.

Early Evolution of Civil Engineering

No single civilization can lay claim to having discovered or invented engineering. From the earliest times, human settlements have sought to construct dams and barrages for water supply; move earth to build embankments; quarried and hewed to patterns and line; dug rivulets to increase irrigation for the fields; and applied the lever, roller, and the inclined plane from Sumeria to Mohenjo-Daro, Egypt to China. All known ancient civilizations of Assyria, Babylonia, China, Etruscia, India, Misr (Egypt), Persia, and Phoenicia built canals and aqueducts, docks and harbors, palaces and cities, roads and suspension bridges, and drainage and water supply systems. All these activities were performed for humankind to quench their thirst, grow crops, keep the environment clean through sanitation, and basically improve their quality of life. The urge to improve one's lot is a characteristic of the human race. Biblical records tell us that Noah used bitumen in the construction of his ark; bitumen was also used to make watertight, the casket in which Moses was committed to the Nile as a forlorn baby (Watkins 1891). These were the humble beginnings of the field of study known as civil engineering. Later to be added to this field were military pursuits, such as fortifications and ramparts, moats and bridges, tunnels and catapults.

Three prime examples out of the hundreds and thousands that were executed of the practice of engineering in the ancient world—marvels of ingenuity in their time–that are all infrastructure projects, are as follows (Watkins 1891):

- 1000 B.C.: Phoenicia: Harbors of Tyre and Sidon;
- 875 B.C.: Assyria: Tunnel at Negoub connected to an open channel excavated in rock, for the purpose of conducting water of the river Zab to the city of Numrud; and
- 800 B.C.: Assyria: Construction of sewers at Khorsabad with pointed arches that supported the earth above them; construction of docks and warehouses at Port Cadiz; working of tin mines. All these were done for the purposes of trading everywhere along the Mediterranean.

Interestingly, the construction of buildings is nowhere mentioned as primarily an engineering work, though references to engineers supporting the master-builder architect are discovered in literature. The many wonders of the ancient world–the pyramids, construction of palaces and halls, or the beauty of cathedrals and temples are placed in the realm of the master-builder architect, and are nowhere recorded as falling under the purview of the engineer or public works engineering.

The Medes, Carthaginians, and Greeks were to follow the Phoenicians and Assyrians with larger infrastructure projects for the maintenance of their cities. Similarly, we know that Julius Caesar was an expert on public and infrastructure works prior to his ascension as the Ruler of Rome. For instance, he was called upon to solve the transport crisis in Rome, much as we would have transportation engineers do today. As "all roads (literally) led to Rome" owing to Rome's central position in the trade and commerce of the nation, Rome was afflicted with a severe traffic problem for which Julius Caesar presented solutions, not all of which were successful, though (Singh 2000).

The Romans were known to have enormous engineering accomplishments to serve their war machine, and applied their skills to public works too. There were estimated 250 mi of aqueducts during the Roman period, 50 mi of which were supported on stone arches. It was estimated that these aqueducts poured into Rome over 300 million gallons per day (Watkins 1891).

Rome continued to build canals and locks, being among the first in relatively recent times to build canals, especially in Milan, a city dependent on canals, and later aided by Leonardo da Vinci who offered his services as an infrastructure expert to the Ruler of Milan. Interestingly, these public works were distinguished from building works.

Public works applications are evident throughout the world from China to the Mayan Empire, Viking maritime operations in Northern Europe to Central Asian road constructions, and they cannot all be mentioned. Suffice to say that it is discovered that all the works undertaken in earlier millennia that led to the modern practice of Civil Engineering cover *infrastructure works* for *public improvements*.

Calhoun (1960) opines that the "precise definition of the term 'civil engineer' can cause needless concern." From a practical perspective, he has a somewhat valid point. He argues that civil engineering evolved over time from the many activities of a large variety of engineers, coming from a mixed source of agrarian, mercantile, and military origins, in addition to newer industrial ways. The ingenuity of the public works or civil engineer had to be applied to a *vast array* of applications in *many fields* of activity. In addition, a name is often the superset of dynamic language, culturally inspired, and socially shaped. Moreover, as Calhoun implies, the tasks and functions of the civil engineer do not change no matter what the name is. Further, the name has been in vogue for many decades and has been accepted, so why bother with the name at all? Nevertheless, it is obvious that the name has caused concern to people, as Calhoun implies; we do not know whom, though. However, the name, or lack of an appropriate name, is a matter of interest to the author.

Practice of Public Works Engineering: 1776–1852

The term civil engineer was already recognized among professionals by the time ASCE attempted to begin its business in 1839, and by the time they formed themselves in 1852. The practice of infrastructure engineering was already accepted in the Western world, since many ports, railroads, and canals had been constructed, engineers from West Point had been engaged in the construction of various locks on rivers, and much of America had been surveyed (Fig. 1). Sewer lines were in operation in Boston by 1800. South Hadley and Middlesex Canals in Massachusetts

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Source: Wikipedia: The Free Encyclopedia, http://en.wikipedia.org/wiki/Amerigo_Vespucci, accessed October 2005.

The Latin American coast was surveyed by a Florentine navigator and cartographer named Americus Vespucci (1454-1512). America was named in his honor. Vespucci hailed from Florence during the period of the Renaissance. Several doubts are attributed to his American voyages, but it was through his letters that Europeans largely became aware of the new continent at a time when even Columbus maintained he had reached India. A sketch of Vespucci is given here.

Fig. 1. Americus Vespucci—first surveyor of the American continent

(1793 and 1804); Erie Canal (1825); Union Canal, Pa. (1829); Morris Canal, N.J. (1831); and Chesapeake and Ohio Canal (1851) had been constructed (Adams 2004). A total of about 300 mi of canals had been constructed by 1840, stimulating inland navigation, commerce, and transport of factory goods. In 1850, there were 83 municipal water supplies (Calhoun 1960).

Much infrastructure engineering work had also been accomplished in the nonmilitary area. The 1787 law establishing the Northwest Territory decreed that 2% of land revenues be allocated to construction of the National Road, the "Cumberland Pike" from Washington to the Ohio River. By 1820, the United States had 9,000 mi of rock and gravel surfaced roads (Wisely 1974). Railroads greatly stimulated the need for infrastructure engineers. In 1840, there were 9,000 miles of railroads in the United States; 30,000 in 1850, with about $300 million being invested that year for the construction of railroads (Houghton Mifflin 2004).

America carried over much of the European social patterns. As Europeans came to the new world in search of a better life, all the skills and trades were brought with them. It was necessary to build the new nation from scratch. European society had recognized the military engineer, the architect, and the civilian engineer as appropriate men to plan and direct large public works (Calhoun 1960). The year 1785 saw a surge in the hiring of engineers, for example, for the improvement of navigation in the Potomac River by the Potomac Company, whose President was George Washington himself (Kaylor 2005). It was difficult to get an engineer all the way from Europe, and earlier personnel selected by the Potomac Company to manage the engineering proved unsatisfactory in their work. Engineers were in short supply, and the shortage continued to be felt through to the civil war. John Quincy Adams, then Minister to Great Britain, once transmitted the application of an English engineer anxious to seek employment in the United States. However, European engineers were generally hard to get. The preference was usually for French engineers who were considered more scientifically educated (Calhoun 1960).

There was confusion as to the type of engineer that could be found for infrastructure projects. Architects often doubled up as managers of works, such as Benjamin Latrobe who worked as a civil engineer on the Susquehanna navigation survey, Philadelphia works, and the Chesapeake and Delaware canals. For various reasons, he felt himself not appreciated in America. The owners and presidents of canal and river improvement companies themselves felt uncertain on how to find the necessary supervision for their projects. They tried various personnel, meeting with disappointment for a long time, until they finally realized, as in the case of Mr. Phillip Schuyler, President of Western and Northern Inland Lock Navigation Companies, that only the hiring of experienced, professional *infrastructure engineers* would fulfill their needs and demands of project success (Calhoun 1960). Basically, it is evident that those who had worked specifically on infrastructure projects would be qualified then for the type of work we call civil engineering today.

There was some difficulty in hiring architects to fulfill engineering roles. The architect's task is largely to arrange materials artistically to enhance the internal living experience as much as possible. The training of an architect did little to equip him with knowledge of soils for moving earth, or properties of channel flow for river training, or the sinking of caissons for bridge foundations, which was knowledge required in the practice of infrastructure development.

The difficulty in acquiring competent engineers prompted the U.S. Congress to establish West Point, as a starter, for training engineers for military infrastructure projects. This set the stimulus for private schools to begin civil engineering instruction. In 1816, the states of New York, Virginia, and South Carolina sought engineers for canal and road building. Whereas, the preference was for an engineer, the jobs were still filled by architects, land surveyors, contractors, and draftsmen owing to a general shortage of qualified engineers. It is reported that the total number of engineers or quasi-engineers active or available in the United States up to 1816 never averaged more than two per state (Calhoun 1960). However, they were all engaged in *public works*. They came from all over—they were surveyors, landholders, speculators, builders, contractors, lawyers, architects, and military engineers.

Thus, it is straight to see that the tasks engineers performed for which they were later named civil engineers were what we commonly know today as *infrastructure engineering*. It was nowhere for building engineering that they were called civil engineers, but basically for *public works* improvement projects of an *infrastructure* nature. The fundamental finding of this section is that the skills that employers sought in civil engineers related to public works or infrastructure works, a somewhat embodied field of knowledge by the mid-19th century. The shortage was not felt for building works, since there were architects available for the design and construction of buildings.

Origin and Definition of the Term Civil Engineering

John Smeaton, an eminent civil engineer of his times is recorded as the first person to sign himself as a civil engineer, in 1761 ("Origin" 1910; McDonald 1914). Wisely (1974) mentions that Smeaton signed himself in as civil engineer, as he was engaged in the building of roads, structures, and canals in England in a civilian capacity. Fairweather (2002) reports that Smeaton signed himself so while presenting testimony to the courts in 1782. This was probably in addition to his signing in 1761, but there could be confusion on the dates in the historical records, but this does not detract from the fact that Smeaton is credited with being the first person to style himself as civil engineer.

By 1761, it can be inferred that calling oneself an engineer meant one was in the *Corps of Royal Engineers*. As Smeaton could not misrepresent himself in court, he had to come up with an alternate to engineer and military engineer. Moreover, there was no precedence in the matter before Smeaton, and he suitably struck on civil engineer. It is probably logical to speculate that he took counsel in the matter, that he had support of the professional community, and that others in the profession had been referring to themselves as civil engineers in the vernacular.

The distinction between military and civilian engineering was

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brought out by the French *Dictionnaire de la Langue Francaise* of the 18th Century, carrying the following definition: "Civil Engineer—name given to engineers who are not trained in technical schools or who work for private industry."

An interesting part of this definition is the portion about training in technical schools. Though no one today could be recognized as a civil engineer without training (education) in a technical (engineering) school, only military engineers were trained in school in 18th Century France. The others, who worked in the civilian sector, earned their credentials through the *School of Hard Knocks* (which refers in the colloquial to learning that takes place on the job or on the streets, in contrast to formal learning in school). Thus, civil engineers were differentiated from their military engineering counterparts in 18th Century France through the above-mentioned definition.

The Society of Civil Engineers (SCE) in Great Britain was the first civil engineering society in the world, formed in 1793 following years of effort that dated back to 1771, a good 55 years after the formation of the British Corps of Engineers, and at least a decade after Smeaton had styled himself as civil engineer. The SCE served to formalize and embody what was only loosely used—the term and style of *civilian engineer*, or *civil engineer*, for short.

The SCE transformed in 1818 to the British Institution of Civil Engineers (ICE). Thomas Telford, who had a career as a surveyor, and road, bridge, and canal builder, was appointed its first President in 1820, in which position he served until his death in 1834. He helped ICE get a Royal Charter in 1828—a recognition that helped establish ICE as the preeminent organization for civil engineers ("Encyclopedia" 2005).

At home, the U.S. Congress legislated the Army Corps of Engineers in 1794, and the U.S. Military Academy was created at West Point in 1802, with the specific purpose of supporting military engineering functions. In 1821, the Congress enacted legislation specifically directing the U.S. Army Corps of Engineers to conduct surveys of roads and canals jointly with "engineer officers" of the Corps and engineers from among *civilians* engaged in such work, who the Congress referred to as civil engineers. Hence, this was the first official recognition of this special nature of work being given the name of *civil engineering*. In 1824, Congress further passed an act authorizing the President to use engineer officers from the army, as well as *civilian* engineers, to make surveys for roads and canals considered of national importance (Wisely 1974; Calhoun 1960).

When the Oxford English Dictionary enhanced its definition of engineering in the 18th Century, they contrasted works that the military performed with identical works performed in the civilian community, defining such professionals in the civilian community as a *civil engineer*, for distinction from the military engineer. It was not until ICE had been formed that in 1828 they formally defined civil engineering as ". . . that species of knowledge which constitutes the profession of a civil engineer; being the art of directing the great source of power in nature for the use and convenience of man; of the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks, for internal intercourse and exchange; and in the construction of ports, harbors, moles, breakwaters, and light-houses; commerce; and in the construction and adoption of machinery; and in the drainage of cities and towns."

Somewhat similar to the ICE definition was the West Point definition of civil engineering prepared in December 1831 (U.S. Congress 1831). It differed partially from the ICE definition to the extent that the West Point definition incorporated building engineering within the field of civil engineering: "*Civil Engineering*, viz.: the properties, preparation and use of materials; elementary parts of buildings; composition and distribution of buildings; art of construction; decorative architecture; manner of laying out and constructing roads; discussion of the different kinds of stone, iron, and wooden bridges, with the methods of construction; consideration of the obstacles impeding the navigation of rivers, and their remedies; details of the various constructions on a canal; survey, location, and construction of a canal; calculation of the economy of canal transportation; different kinds of rail-roads; survey, location, and construction of a line of railway; economy of transportation on railroads; and construction of artificial and improvement of natural harbors."

However, the word civil in civil engineering is nowhere seen to explain any activity being undertaken: Civil actually traces its roots to the Latin civilis meaning polite; "civilian" is derived from civilis, which comes from the Latin, Middle English, and Middle French word of civis, meaning citizen. Civil also means mannerly, presentable, courteous, courtly, gallant, chivalrous, forbearance from rudeness or unpleasantness (refer to *The American Heritage Dictionary* of the English Language, 3rd Ed.), none of which represent the engineering functions of civil engineering. In contrast, the word "military" is derived from the Latin miles meaning soldier, which well explains the military engineer. Civil is not a technical root of engineering functions, and therefore is a gross misnomer for civil engineering. Civil is used from out of convenience rather than to represent function, thereby making civil engineering the sole exception to all engineering disciplines mentioned in this article.

University Courses in Civil Engineering: 1763–1852

As in England, which was reaping benefits from its colonies around the world, immigration and the conquest of a large frontier in North America was increasing the need for infrastructure projects there, largely for transportation purposes that had a direct impact on economic activity and personal mobility. Moreover, the U.S. military needed the same type of infrastructure for the conquests of the vast frontiers. This demand led to West Point being started as the first engineering academy in the country in 1802, as was mentioned earlier. At the time, the primary engineering tasks taught were surveying, road making, and design and construction of hydraulic locks and railroads.

Prior to 1802, there was no formal education in civil engineering in the United States, and practitioners acquired their knowledge through apprenticeship and fieldwork, with some of them having completed a course of study in the sciences and mathematics. However, the first and oldest school of civil engineering was the *L'Ecole Militaire de Saint Cyr*, established in Paris in 1763. For a long time, it was considered a fine institution, ranked high among all nations. French engineers, graduates of that institution were highly sought (Calhoun 1960), especially by the U.S. government between the period 1775 and 1825, during which time French military engineers helped Napoleonic power become the premier world power. Colleges and universities in the United States that began to offer civil engineering instruction following the creation of West Point are listed in the following (Wisely 1974); the dates given represent the first degrees offered, and it must be noted that the universities began their civil engineering programs a few years before these dates (refer to Phelan et al. 1995):

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- 1821: American Literary, Scientific, and Military Academy (renamed Lewis College, and later renamed Norwich University), known popularly as the "Partridge Academy" after Allen Partridge, its founder;
- 1835: Rensselaer Polytechnic Institute;
- 1845: Union College;
- 1846: Yale College; and
- 1846: Harvard College.

In spite of this education, there were only 512 civil engineers by 1850. For even those who listed their profession as engineer in contrast to civil engineer, most worked on canals and railroads, which goes to show again how synonymous and interchangeable the two terms were. To many, the engineer was known as a person responsible for infrastructure, industrial, and municipal improvements (where the most commonly understood infrastructure improvements were railroads; canals and locks for river navigation and agriculture; roads, highways, and bridges) (Calhoun 1960). Popular literature of the early 19th Century assumed that the engineer was mainly a designer of *internal improvements*—what we would call infrastructure today; the 1824 Act of Congress, mentioned previously, was overseen by a *Board of Engineers for Internal Improvements* in the War Department.

Allen Partridge was formerly a Superintendent of West Point, from where he resigned after clashing with his superiors. He opened the Partridge Academy at Norwich, used the same textbooks as West Point, and offered his graduates jobs on the New York canals. In 1825, Partridge wrote to the Governor of New York, De Witt Clinton, that his course was "to prepare young men for the scientific discharg (sic.) of the duties of Civil Engineers." He felt that if the country could prepare its own engineers, they would never have to look to Europe for them.

Rensselaer Polytechnic Institute (RPI) taught mensuration, surveying, and engineering. Professor Amos Eaton, who taught the course, felt that advanced mathematics was unnecessary to teach to engineering students, and even politely criticized the text used by West Point instructor, Mahan, *Elementary Course in Civil Engineering*, a textbook that was popular and saw seven editions from 1837 to 1868 (Calhoun 1960). The opinion of Professor Eaton resonates today in the education of the modern construction manager in the United States, exemplified in university curricula accredited by the American Council on Construction Education (ACCE), whose graduates supervise construction projects identical to the construction engineers from ABET-accredited schools.

However, much of the earlier civil engineering courses were taught by professors of mathematics at a variety of schools—a disposition that somewhat characterizes the profession and is reflected in the heavy mathematics required today for civil engineers in an ABET-accredited curriculum. In Hanover College, a professor of mathematics taught civil engineering courses; at the University of Michigan in 1837, the professor of mathematics was also professor of natural philosophy and civil engineering; whereas at the University of Virginia in 1836–1837, professors of mathematics and natural philosophy taught civil engineering courses; in 1837, Charles Hackley, a professor of mathematics taught civil engineering at the University of New York (Calhoun 1960). The first half of the 19th Century was to witness the slow but steady maturing of civil engineering as a profession, largely through formal education.

Other schools offering some kind of engineering courses between 1831 and 1852 included the following:

- Geneva College;
- Dartmouth College, Hanover, N.H.;
- Lehigh University, Pa.;
- City Academy, Washington, D.C.;
- William and Mary College;
- Georgetown College, Ky.;
- Elijah Slack's School, Cincinnati;
- Miami University, Miami;
- University of Alabama;
- St. John's College, Md.;
- East Tennessee College; and
- Virginia Military Institute.

However, these engineering courses were no more than a minor part of the instruction. It is important to observe that their emphasis was the teaching of *infrastructure engineering*—the main job market of engineers of the time being railroads, canals, roads, bridges, barrages, and harbors. Building engineering was added quite as a consequence, since the principles of science for analyzing and designing bridges was identical to that for buildings, essentially those pertaining to Newton's laws of motions and calculus.

As can be evidently observed, the courses and content in all universities were geared to the training of engineers for infrastructure development—whether they were in the military or civilian practice. However, by the early 1800s, the name of civil engineer had become "stuck," and universities had no opportunity to give a different name to their training.

Graduating Civil Engineers: 1802–1852

The number of West Point graduates entering civilian service began in 1818 with one individual. This number slowly increased until it reached approximately 10 in 1828, 15 in 1830, passed 25 in 1833, was 39 in 1836, 96 in 1837, and 107 in 1838. The cumulative number of civilian engineers, however, was more than this, probably reaching 200 in 1837. Compare this to about 200,000 civil engineers in the United States today. A total of 231 West Point engineers from 1802 to 1837 went into *civilian service* at some point in their lives (Calhoun 1960).

Between 1826 and 1843, the Partridge Academy produced about 40–50 civilian engineers. RPI produced 48 civilian engineers from the 102 who graduated from their program between 1835 and 1843.

West Point, Partridge Academy, and RPI were the three main suppliers of public works engineers in the days 1802–1843. Other on-the-job trained engineers continued to exist. There are no available formal census figures for the number of engineers and civil engineers in the United States before 1850.

However, alarmed by the number of West Point graduates leaving military service for civilian service, apparently for better fortunes based on their excellent education, Congress forbade all army engineers in 1838 to take employment with private companies. This put pressure on private universities to take up civil engineering education, resulting in Yale and Harvard to begin teaching the subject. With the formation of the American Society of Civil Engineers and Architects (ASCEA), civil engineering education would be given a major boost, and the need to debar military engineers from entering civilian service would be slowly diminished.

Nevertheless, we again see that the engineers were primarily sought to work on internal improvement projects such as railroads, canals, harbors and docks, and roads and bridges—items required for military mobility, as well as trade and commerce. Thus, it is evident that the West Point engineer and the training imparted at West Point served immensely to define the discipline

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of Civil Engineering, as did the *L'Ecole Militaire* of France, and the Corps' of Engineers of Great Britain. It is also evident that the Partridge Academy and RPI were formed as a consequence of the existence of West Point. Further, there was none to little distinction between the work of West Point graduates engaged in military projects and those of Partridge and RPI engaged in civilian public works projects. The only feature that distinguished them was their uniform and their work in the military or civilian sectors. Hence, the concretization of civil engineering.

Moreover, those who could, went on to college, but they still ended up working alongside those who did not or could not go to college. Slowly, those with college degrees would increasingly take up design works, creating an exclusive distinction from those in construction who had no college degrees. But, the discipline and work function was still the same—*infrastructure engineering*.

Early Background of Civil Engineering Societies

The Society for Promoting the Improvements of Roads and Inland Navigation, which sought to promote the technical functions of civil engineers, was perhaps the earliest public works organization in North America, being founded in 1789. They concerned themselves with activities such as canals, locks, bridges, roads, tunnels, tramways, breakwaters, harbor works, and industrial installations.

Given that the military engineers of *L'Ecole Militaire* were considered the finest, most sophisticated, and that the *Royal Engineers* in Britain had already been formed, *West Point* had started to produce military engineers engaged in infrastructure projects, and the fact that *The Society for Promoting the Improvements of Roads and Inland Navigation* had already commenced its activities, whereas *ICE* had received a Royal Charter, a group led by Mr. John Jervis proposed to start a national civil engineering organization, in 1836, that was distinct from the poorly trained builders, on the one side, and the military engineers, on the other. There was a need to make that distinction as the civilian and military engineers worked on identical types of infrastructure and public works projects, and the realities of contracting as well as professional pride dictated such a distinction necessary. However, it was not until 1839 that this group was able to coordinate its efforts to meet in Baltimore (Fairweather 2002; Calhoun 1960). During their deliberations, there were divisions among the attendees, and the effort to form a civil engineering society was not successful. It was not again until 1852—a long, 13 years later—that the group of 1839 met with a slightly expanded group, reinforced by those in the building trade, and formally established the "American Society of Civil Engineers and Architects" (ASCEA).

A statement crafted by the committee in 1839 to describe the work of their profession, brings out that their major interest was *public infrastructure works*. They also recognized the success of the Institution of Civil Engineers (U.K.) (Wisely 1974), thereby accepting de facto ICE's definition that constituted the art and practice of civil engineering. Though journals of civil engineering appeared later, the *American Railroad Journal* was already in existence, and an article in that journal in 1840 explained reasons behind the collapse of the 1839 effort in forming a civil engineering society, basically disagreements where the members were not convinced of the need, not to mention that some participants came from varying states and had not known each other. Railroad engineering was quintessentially the same field of study as other infrastructure engineering fields, such as roads and bridges, the principles of alignment and curve being similar. In this regard, it is interesting that the *American Railroad Journal* was started in 1832, some time before the civil engineering societies were formed.

The Boston Society of Civil Engineers (BSCE), founded in 1848, was consequently the first civil engineering organization in America, not to mention that it was the first engineering society of the United States, as well. Boston had a large concentration of public works engineers, and Massachusetts was among the first colonies to induct European technology, much of it from Great Britain, becoming economically and technologically well developed. Boston had a bustling harbor, an elaborate road feeder system, and was a cultural hub for two centuries from the 17th to the 19th Centuries. But, as the BSCE was restricted to Massachusetts and Connecticut, a civil engineering society was indicated to serve the nation at large. A New York Institute of Civil Engineers was formed in 1848, but ceased activity in 1850 for lack of support. Though the ASCEA was formed in 1852, the architects opted out and formed their own society in 1857, thereby prompting ASCEA to change their name to just "ASCE" in 1868. It was going to be 1877 before the name, ASCE, was registered legally (Fairweather 2002).

In any case, the ASCEA founded in 1852 met regularly until 1855, after which it experienced a hiatus of 12 years, much of which can be attributed to the civil war, but also due to the fact that the first President, James Laurie, a prime mover of ASCEA, took assignments in Nova Scotia for two years, evaluating railroads and planning extensions; and six years as Chief Engineer of the New Haven-Springfield and Hartford Railroad. Interestingly, James Laurie was one of the founding fathers of the BSCE, in addition to his activities in ASCE (Fairweather 2002).

Other societies were formed in the United States after ASCE, as follows:

- American Institute of Architects, AIA: 1857;
- American Institute of Mining Engineers, AIME: 1871;
- American Society of Mechanical Engineers, ASME: 1880;
- Institute of Electrical and Electronic Engineers, IEEE: 1884; and
- American Institute of Chemical Engineers, AIChE: 1908.

ASCE, ASME, IEEE, and AIME were founding members of the United Engineering Trustees, which operated the United Engineering Center in New York that had been kindly provided with a $1 million donation by Carnegie. ASCE is thus the oldest of the American engineering societies. ICE is perhaps the oldest engineering society in the world, none other known to exist before her. This correlates well with infrastructure engineering being the first known engineering activity of ancient times, and with all engineering being considered synonymous to civil engineering.

Basically, it appears that the move to form civil engineering societies was to embody the knowledge pertaining to the practice of infrastructure engineering and building construction. Much as in earlier years, where all engineering was synonymous with civil engineering, ASCEA first sought to be the society for *all* engineers and architects. ASCEA opened applications for its membership to architects, mining engineers, mechanical engineers, and naval engineers. It was a mistaken and arrogant judgment, in the writer's opinion, that motivated the civil engineers of the day to feel that all engineers should come under their umbrella, when they well knew that not all engineers understood the designing of machines and naval ships, neither through education nor through training. It is understandable, however, to see why they sought to include mining engineers, as the mining engineers moved and supported earth much in the same way as the construction engi-

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neers did. It is also understandable to see why they sought to include the architects because the constructors of buildings were among those who worked on internal improvement projects as well, and West Point had defined civil engineering to include building engineering and architecture. However, the industrial progress of the 19th Century was to exert alternate forces that would lead to other engineering bodies forming their own societies, the architects to break away from ASCEA, and for ASCE to stop asking mining, naval, and mechanical engineers to join their society.

Roots of Names of Civil Engineering Subdisciplines

The roots of the names of civil engineering subdisciplines are given here.

"**Construction engineering**" takes directly from the Latin construere meaning to make, build, or erect, thus directly relating to the activities of the construction engineer. Basically, all that the construction engineers really do is put together, organize, assemble, and build.

"**Cost engineering**," we understand, implies the optimal management of money, which comes from the Latin word constare, meaning to cost. There is no doubt what cost engineers aim to achieve with respect to their profession.

"**Environmental engineering**" takes from the French word environ meaning "around," implying *around* the city, the surrounding area, or the city outskirts, which is what environmental engineering concerns itself with—of the surrounding areas of habitation, the forests, greens, and other life-supporting surrounds. Environ comes from two syllables in French—en (meaning "in")+viron (meaning circle, circuit). Hence, environ means to enclose a circle, or encircle. Ment is a suffix suggesting "about." Thus, "environment" means "about the surrounds."

"**Geotechnical engineering**" has geo as the root word, coming from the Greek geo, which comes from ge, meaning "Earth." Obviously, "geotechnical" has to do with the technical properties of soils and rocks that are of the Earth, and so their name represents the functions they are engaged in.

"**Hydraulics engineering,**" that studies the movement of water and liquids, takes from the root word hydro meaning water, which was the initial liquid studied as a general standard, not to mention that rivers, lakes, and canals were all largely made of water in contrast to other liquids. Hydro is a later adaptation of the Greek hudor meaning water. The original form of hydraulics is the Greek hydraulikos, which comes from three syllables—hydr (meaning water)+aulis (meaning a reed instrument through which water is conducted)+ikos (meaning "relating to"). Hence, hydraulics means relating to the flow of water through enclosures—a very functional description.

"**Sanitary engineering,**" which is often studied under environmental engineering, relates to tasks that improve health conditions. "Sanitary" comes from the French sanitaire and the Latin sanitas—meaning of or relating to health. Hence, the phrase "sanitary engineering" portrays the area of emphasis of their work.

"**Structural engineering**" comes from the Latin structus and structura—a past participle of struere, which means to construct, which is what structural engineers primarily purport to do. Their designs serve to allow construction to take place.

The French word surveiller meaning to watch over, and the medieval Latin word supervidere meaning to look over, both contribute to the development of the modern word "survey" from which we have "**surveying engineering**." There is no doubt that surveyors "look over" the land and observe it [for its features]. The Middle French carried the words surveeir, surveer, and surveoir, meaning to look over. These words are composed of two syllables—sur (meaning "above, up")+veeir (meaning "to look," "see"). When the surveyors peer through their theodolites, they are literally "looking over" the topography.

"**Transportation engineering**" takes from the Latin transportare, meaning to carry from one place to another. Hence, we see that automobiles, planes, and ships that pertain to transportation engineering all carry goods and/or people from one destination to another.

All the names for the previous engineering disciplines, within the broader discipline of civil engineering, represent the activity they engage in. There is no divergence or exception on this account.

The Importance of a Name

"What's in a name? A rose by any other name would smell as sweet" [Shakespeare (1564), *Romeo and Juliet*]. Then, why give a name at all, if that is the case? However, names are important for representation and identification. It is the name that makes a person. Names are the nom de plume of people, institutions, and nations.

Agonizing hours and days are often spent in giving names to new committees, a newborn child, and to new institutions. All those hours are meant to serve a purpose. Often, people are urged to "live up to their name," implying that only reputable, ethical, legal, and honorable tasks should be done. It is the name that buys reputation and prestige. A name says it all!

Native Indian names attempt to represent an activity of a person. Names of people in most parts of the world carry a *meaning* to them. Names of institutions generally seek to represent the given *activity* they are engaged in. For instance, no one can doubt that the American Concrete Institute deals with concrete. I cannot see how anyone can deny that the name of an institution must be representative of its activities. But, in the case of ASCE, civil engineering just does not represent the functions of its engineers.

Observations

By tracing the history, evolution, and education of civil engineering, it becomes clear that nothing that is not infrastructure, public works, and building or factory construction is civil engineering. It is important to see this in the opposite way to understand what civil engineers are all about. When we look at the history and origin of civil engineering, we discover a pattern of activities in infrastructure activities for both civilian and military use, with building engineering added later starting with West Point's definition of civil engineering.

That notwithstanding, there is no cogent reason for civil engineering to be given the name it has, for it to have relevance in the modern world. Moreover, its activities are undertaken by military engineers as well, and we all know that military engineers get their degrees in civil, electrical, and mechanical engineering from civilian schools. Military engineers use civil engineering technologies to build houses, roads, ports, harbors, airfields, and so on for military installations. Military engineers are extremely involved in construction, hydraulics, and environmental engineering. Military and civil are all mixed up here! The prime difference

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between them and their uniformed brethren is not at all in the engineering tasks performed, but in that their uniformed brethren learn to carry a rifle, are trained in combat and bomb disposal techniques, and learn military strategy. There are many other engineering activities practiced in the civilian sector—such as electrical and mechanical—that are not called civil engineering, even though the military uses those fields of engineering. Hence, there is little logic in assigning the name of civil engineering to the activities of *civilian* engineers alone engaged in *infrastructure* works.

The evolution and origin of the names of engineering disciplines is very logical and meaningful in representing the activities they are engaged in, tracing to Greek, French, or Latin words, sometimes to mythology, *except* for that of civil engineering.

There is no use for civil engineers to continue living in the past for the constraints of military and civilian that are not applicable in the emancipated and educated society of today where globalization is commonplace. The militaries of the 18th and 19th Centuries in Britain and France were particularly elitist, and this created a class distinction between the activities of the military engineers and other engineers engaged in similar works. There is no compelling reason today for the discipline to distinguish itself from the military engineers. The British military, for instance, and some other professional militaries around the world, as well, have a Corps of Signals responsible for communication services—having electronics engineering as the core discipline there. Armies also have a Corps of Electrical and Mechanical Engineers for repair and maintenance of ordnance, weapons, and armaments, including battle tanks; this corps has mechanical and electrical engineering as its basic functions. Apparently, even the name Corps' of Engineers is past in its value, as mechanical, electrical, industrial, or chemical engineers, or any other engineer save civil engineer do not become members of the corps. Correspondingly, *Corps' of Engineers* is an anachronism, as well.

Military engineering has vastly changed in composition, nature, and emphasis over the past 150 years. Similarly, civil engineering is no longer applicable for the profession it wishes to represent, belonging instead to an era long gone by. Quite frankly, it is strange for military engineers to call themselves civil engineers as they do these days: quite an oxymoron, since military is the antonym of civilian.

Many civilian activities are not engineering, many civilian engineering activities involve other disciplines, and many military engineering activities incorporate civil engineering. Hence, civil engineering fits in neither one mold nor the other. There is no apparent need for the profession of Civil Engineering to play second fiddle to Military Engineering. But, tracing the origins of Civil Engineering, it is apparent that *Civil Engineering* was second or subordinate to *Military Engineering* in the 18th and 19th Centuries. It therefore seems that it is time to give a true name to the practice of civil engineering works, such that it can stand in its own right, rather than being in contrast or comparison to any other discipline or profession.

What Should We Name Ourselves?

The thesis rests here after bringing out the inappropriateness of the name civil engineering. A name change is a logical step, and could be considered by the ASCE Board of Directors. Some additional brainstorming among the larger committees and groups of ASCE may be the formal route for discussion and debate to initiate a name change. It is, however, beyond the scope of this paper to discuss what the new name should or should not be, whether it really should be changed to follow the logic presented here, or whether a suitable alternative name can at all be found.

Black Sheep

So, the problem and interest persists, but it is quite obvious that civil engineering is the only *black sheep* of all engineering disciplines, especially from among the 25 major engineering disciplines and subdisciplines of civil engineering considered in this article, as its name does not represent the technical functions and activities undertaken by its practitioners.

Conclusions

The word engineer is appropriate enough to describe the activities of the civil engineering profession, having been a word that traces to the 14th Century, and deriving from the Greek γεν that originates in the Sanskrit jan, meaning life, implying that engineers give life to creative ideas. Up until the 18th Century, engineer was synonymous with the tasks of infrastructure engineering, and it was not until John Smeaton was compelled to submit his testimony to court that differentiation became necessary between the military and civilian engineers. The British Corps of Royal Engineers were commonly known as engineers and performed functions of all engineering disciplines. Even today, the British and U.S. Army Corps of Engineers are known as just that—"Corps of Engineers"—not "Corps of Civil Engineers," even though the functions of the Corps of Engineers are subject matter learned in civil engineering schools. The study confirms that engineering was the name assigned, since the very beginning of civilization, to activities such as the construction of roads and bridges, aqueducts, river training, and irrigation, and represent the application of ingenuity. The word engineer, it was seen, also has nontechnical applications in the English language.

However, the word civil in civil engineering was a word coined out of convenience—not to represent any function of the engineers practicing infrastructure development—but to differentiate those working in the civilian sector from those engaged in military engineering. Whereas, the roots of names of all the other engineering disciplines discussed in the paper—*industrial, mining, electrical, chemical, mechanical, agricultural, safety, etc.*—are traced to a specific function they perform, civil can best be traced to civilian and the Latin *civilis* meaning polite. This renders civil engineering the only engineering discipline to have a name that does not represent the works it undertakes.

The roots of all civil engineering subdisciplines—*geotechnical, surveying, structures, transportation, cost, and hydraulics*—are also all seen to have their root in a term that represents the functional applications of the subdiscipline, which is consistent with what we are seeking. Again, civil engineering is the only exception, even in comparison to its subdisciplines. Consequently, civil engineering is a term whose era is past and application is null.

To differentiate the military engineer from the civilian engineer is a meaningless concept rooted in the past, with no significance today, because all functional tasks performed by the civilian engineers are performed by the military engineers, as well. There is an incongruity between calling some military engineers as civil engineers for at least three reasons:

1. The works he does are undertaken by civil engineers, as well;

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2. Civil is already an antonym of military; hence, the fact they are *oxymorons*; and
3. Numerous engineering activities taking place in the civilian realm are not those related to infrastructure or public works engineering. Thus, mechanical and electrical engineering, for example, would also be called civil engineering if the logic of the 18th Century were to be applied today.

Thus, the oldest engineering discipline, and the very first engineering society of the United States still in existence today—ASCE—has a name that has lost its relevance. This paper extracts—after a comprehensive study of the history, evolution, and formation of the discipline and its societies—that the name of civil engineering is void of substance that does not connote what the discipline is about. (This does not imply that civil engineering itself is void of substance, and no such meaning is intentioned.) This indicates that a name change may be in order.

So, what's in a name? Actually, plenty is. A name is the nom de plume of an institution. Civil engineers cannot boast of their name representing the tasks and functions they perform. What the new name should or should not be is not attempted to be addressed in this paper.

Appendix I. Contemporary Words Having Their Root in Gen

(Word source: American Heritage Dictionary, 3rd Ed., 1996)

Whereas engineer has its roots in gen, other words of the English language also have their root in gen—related to life or giving birth. For example, "renaissance" means giving birth to the new; "innate" can be understood as having life as natural; "genocide" is the taking away of life; and "gene" is the basic (form) of life; "pregnant" is the (state) before life. Similarly, the reader can extend the interpretation of the words below to terms of life and birth—all of which go back to the Sanskrit jan, meaning life.

- Gentile, genteel;
- Gendarme, general, generality, gender, generate, generation, generic, generous;
- Genre, genus;
- Congener, degenerate, engender;
- Gene, genealogy, genocide, genotype, heterogeneous, homogeneous;
- Genial, genius, congenial;
- Engine, ingenuous, ingenuity, engineer, engineering, genuine,
- Indigen, indigenous;
- Germ, germane, germinal, germinate;
- Genesis;
- Genital, genitive, gender, gent, gentle, gentleman;
- Pregnant, progenitor, progeny, primogenitor, primogeniture;
- Benign, malign;
- Naïve, nascent, natal, nation, native, nature, natural;
- Agnate, cognate, cognize, cogent;
- Connate, innate, neonate, puny, puisne, renaissance; and
- Kin, kindred, king, kind.

Hence, the engineer shares something in common with pregnancy (Engineering is romantic and exciting, after all!). These 71 words are not all; there are other variations of these words not mentioned that trace to gen.

Appendix II. Quotes from Literature in Earlier Centuries concerning the Use of Engineer

(Source: Oxford English Dictionary online, 2004)

1325 *Coer de Leon*. 1387 A tour ful strong, That queyntyly engynours made.

1420 *Metr. Life St. Kath*. (Halliw.) 14 In hys court was a false traytoure, That was a grete Yngynore.

1579 Digges *Stratiot*. 144 Expert Enginers and menne of excellent knouledge in the art of Fortification.

1583 T. Stocker *Hist. Civile Warres Low Countries* I. 50b, The buylder and Engyner whereof (of the Castle of Antwerpe) was one Pachiotto.

1592 G. Harvey *Pierce's Super*. 8 The dreadful enginer of phrases insteede of thunderboltes.

1600 Holland *Livy* XXIV. xxxiv. 532 But a more wonderful enginer for devising and framing of artillerie, ordinance, fabrickes, and instruments of warre.

1602 Shakes. *Ham.* III. iv. 206 (Globe), For 'tis the sport to have the enginer Hoist with his own petar.

1606 Holland *Sueton*. 249 An Enginer also…promised to bring into the Capitoll huge Columnes with small charges.

1611 Rich *Honest. Age* (1844) 36 Yet you cannot deny them to be the deuil's enginers.

1623: Then there's Acilles, a rare Engineer. If Troy be not taken till these two undermine it, the wals will stand till they fall of themselves (written by Thersite in Trollius and Cressida) (Source: McDonald 1914).

1627 Drayton *Agincourt* 8 The Engineer prouiding the Petar To breake the strong Percullice.

1628 F. Greville *Sidney* (1652) 40 A skilful Engenier, an excellent Musician, or any other Artificer of extraordinary fame.

1635 R. Sibbes in Spurgeon *Treas. Dav.* Ps. ix. 15 That great engineer, Satan.

1637 Blount *Voy. into Levant* 31 The Gran Master and a chiefe Engeniere.

1638 Suckling *'Tis now, since, etc.* (R.), My tongue was engineer; I thought to undermine the heart by wispering in the ear.

1653 Holcroft *Procopius* II. 49 By the advise of Theodorus, a famous Ingineer.

1654 Bate *Myst. Nat. & Art* 72 According to the fancy and invencion of the artist or Engineer.

1680 *Lond. Gaz.* No. 1547/1 A new Port at Nizza..A famous French Ingenier..has been consulted about it.

1680 Butler *Rem.* (1759) I. 300 Certainly these are the most prime Engineers of Oaths, that ever the World knew.

1686 *Lond. Gaz.* No. 2023/4 Major Martin Beckman, His Majesties chief Ingenier.

1691 T. H[ale] *Acc. New Invent.* p. liv., This Engine was invented by..an excellent Engineer.

1702 Swift *Wks.* (1841) II. 478 The engineers of this bill [a bill before the House of Commons] thought they had obtained a great advantage against me.

1707 Farquhar *Beaux' Strat*. V. ii, Rise thou prostrate Ingineer, not all thy undermining Skill shall reach my Heart.

1734 Desaguliers *Course Nat. Philos.* I. 69 The skill of a good engineer may be advantageously applied in changing the form or altering the parts and motions of a machine.

1747 *R. Campbell Lond. Tradesman 248* By engineer I . . . mean . . . the tradesman who is employed in making engines for raising of water, etc.

Annotated Bibliography

Adams, J. Q. (2004). The White House, ⟨http://www.whitehouse.gov/history/presidents/ja6.html⟩ (July 2004). The presidency of John Quincy Adams (1825–1829) was particularly noteworthy for infrastructure engineers. He proposed that

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the Federal Government bring the States together with a network of highways and canals, and that it develop and conserve the public domain, using funds from the sale of public lands. In 1828, he broke ground for the 185 mil C&0 Canal thereby giving impetus to public works engineering.

Calhoun, D. H. (1960). "The American civil engineer: Origins and conflict." The Technology Press, Cambridge, Mass. In March 1794, Congress authorized George Washington to construct fortifications for the protection of harbors along the East Coast. As there were few engineers in America, the President temporarily hired French engineers for the task. The reason for French engineers to be selected and preferred is given in (Watkins 1891). One reason why they were somewhat preferred was because of *L'Ecole Militaire*, which was considered the finest institution of its time, and whose graduates had left the military to work in the civilian sector, and were thus available to prospective employers.

Fitzgerald, M. (2005). "Workshop advances implementation of global principles and guidelines: Participants urged to sign anticorruption charter." ASCE News, 30(11). This article brings out that the reputation of civil engineers is tarnished because of the corruption prevalent in the industry. It is thus possible to impute that there is serious concern in the community that *civil engineers* are *impolite* and *uncivilized* in the practice of their contractual obligations, a commentary on a meaning of their name that is not.

Herbert, G. (1633). "Temple, Church Porch." *st.* xli, ⟨http://www.worldofquotes.com/author/George-Herbert/1/⟩ (July 2004). "Wit's an unruly engine, wildly striking sometimes a friend, sometimes the engineer." This quote shows the close proximity of use of the words "engine" and "engineer" during the formative centuries of the development of the word engineer.

History Channel. (2004). "In search of history: The Library of Alexandria." *Item No. AAE-40425*, ⟨http://www.historychannel.com/⟩. The Library of Alexandria, where Archimedes studied, and which was unfortunately consumed by fire, was a major repository of drawings of ancient machines and inventions plus a storehouse of information on the science and engineering of the ancients. Many building materials of today, such as lime, bitumen, and brick are among the oldest construction materials known to mankind in the centuries before Christ.

Houghton M. (2004). "Railroads: The readers' companion to American history." College Division, Online Study Center, ⟨http://college.hmco.com/history/readerscomp/rcah/html/ah_073400_railroads.htm⟩ (July 2004). (1) Railroads formed the backbone of the advancement of American civil engineering, as public works engineers gained experience and expertise in that area. There were 93,000 miles of railroads in 1880; and 164,000 in 1890. Strangely, Calhoun (1960) reports only 500 mi of Railroads in 1850! This cannot be expected to be an accurate estimate, since more reliable historical records, as quoted above, are available. (2) There was $2.5 billion investment in railroads in 1870, equivalent to approximately $131 billion in 2004 dollars—a sizeable amount. Hence, railroads were a major source of employment for public works engineers.

Kaylor, D. (2005). "George Washington—The First US Engineer," ASME Public Information, National Engineers' Week, ⟨http://www.eweek.org/site/News/Features/gw.shtml⟩ (July 2005). The first President of the United States is credited with being the nation's "first engineer," with *Engineers' Week* being traditionally celebrated during the week of his birthday—the last week of February. George Washington started as a surveyor apprentice at the tender age of 15 and went on to become reputed for his surveying skills. However, he attended no formal, technical school, but was certified as a fully qualified surveyor by William and Mary College upon the passing of an examination. This article says "On June 9, 1778, at Valley Forge, Pennsylvania, General George Washington issued a call for engineers and engineering education. This order is considered the genesis of a U.S. Army Engineer School, which found its permanent home at Fort Belvoir, Virginia." Again, "In 1794, President Washington established a Corps of Artillerists and Engineers to be educated and stationed at West Point in New York, which later become the US Military Academy at West Point." The author adds "He [George Washington] promoted construction of roads, canals, the Capitol, docks and ports, water works, and new efforts to extract coal and ores and develop manufacturing resources." The infrastructure and know-how to build infrastructure thus developed, helped USA expand westwards in the 1800s.

Leonardo. (2004). "The life of Leonardo da Vinci," videocassette, Public Broadcasting Station, Item No. LLDV401, ⟨www.shoppbs.com⟩. (1) This video, among other biographies of this great genius, demonstrates the development of engineering in the minds of inspired and creative people. (2) Engineering needs are seen to have their source in the needs of war. The Ruler of Milan was beset with foes, and Leonardo offered various original inventions to him for his defense. Such military needs were carried on to later centuries, with the military becoming the foremost user of engineering skills, which is what led to civil engineering receiving the name it did.

London Gazette. (1787). No. 12850 London 197. The decree posted in this gazette stated, "The Corps of Engineers shall in future take the name of the Corps of Royal Engineers."

Shipley, J. T. (1984). *The origins of English words: A discursive dictionary of Indo-European roots*, The John Hopkins University Press, Baltimore. It is not surprising that a very large number of English words have their roots in Sanskrit. O. P. Varma (2005). "Firm roots in Hindi," Deccan Herald, January 13, ⟨http://www.deccanherald.com/deccanherald/jan132005/edu10.asp⟩ reports that about 25,000 English words in common usage are derived from Hindi and Sanskrit. Among many words, Shipley writes that the words "bind, bond, band, bandage, bondage, riband, and ribbon" trace to the Sanskrit *bhendh {*currently *bandh}*, meaning to "tie." The words "gnosis, gnostic, and agnostic" trace their root to the Sanskrit root *gn* from whence came *gyana* (meaning "knowledge"); Shipley reports that the word, "know, knew, and [knowledge]" follow from *gn*, and this can be recognized as the phonetics of *gn* and "kn" are the same in English. More interestingly, he reports that the words "come" and "go" follow from the Sanskrit *gua* and *gue(n)* (commonly known as *agayo* and *ga*), respectively, though the transformations to "come" are not explained. . . . Whereas, he alludes to Sanskrit roots for prolific variants of "stand," he fails to mention that the Sanskrit *sthun*, meaning stationary and *sthan*, meaning fixed place, are the derivatives of words such as "stand, stay, stance, circumstance, status, static, standard, density, destination, constant, constitution, store, storage, statue, statutory, station, stationary, and tenure." Further, the words "create and creator" bear a striking resemblance to the Vedic Sanskrit *karat* (to do) and *kartar* (meaning creator); other religious words in English, such as "saint and santa" appear to be derived from the Vedic Sanskrit root *sant*,

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meaning saint. Shipley does concur that the words "new, nouveau, neophyte, novice, neologism, nova, innovate, and renovate" come from the Sanskrit *nayam* (meaning "new"). At ⟨http://home.vicnet.net.au/~umbidas/is_english_an_asian_language.htm⟩, the web site asks "if English is an Asian language?" further stating that the word, "ignite, igneous, and ignition" derive from the Sanskrit *agni* (meaning "fire").

Smeaton. (1797). SMEATON *Rep.* I, Pref. 7, U.K. The first meeting of this new institution, the Society of Civil Engineers, was held on April 15, 1793.

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The origins of words are taken from the following dictionaries:

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