



Music as a framework to better understand Lean leadership

Music as a
framework

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Abstract

Purpose – The purpose of this paper is to explain why most senior managers have great difficulty comprehending and correctly practising the Lean management system, thereby handicapping their ability to lead enterprise-wide Lean transformations; to describe the depth and richness of relationships between the Lean management system and music; to help improve practitioners' understanding of Lean management and how to learn it; and to help senior managers recognize the need to personally apply Lean principles and practices daily to become capable Lean leaders.

Design/methodology/approach – The paper uses a qualitative examination of various characteristics of the Lean management system and music, based in part on the authors' experience implementing Lean in manufacturing and service businesses, and also in learning to play music over a nine-year period.

Findings – The Lean management system and music share numerous similarities, including the difficulty most people encounter learning each discipline. The paper highlights the importance of daily practice by senior managers to learn and understand Lean management in order to capably lead enterprise-wide Lean transformations, and to recognize and correct problems in Lean thinking and practice among themselves and others.

Research limitations/implications – Elucidation of the deep similarities between Lean and music does not answer the fundamental question of how to increase the number of senior managers who are interested in becoming capable Lean leaders.

Practical implications – The paper provides an answer to the question of why it is so difficult for senior managers, and others, to correctly understand and practise the Lean management system. It clarifies the deep level of personal understanding, leadership involvement, and daily routines required to have greater success with Lean management.

Social implications – Management practitioners who improve their understanding of Lean leadership will avoid common errors that undermine leadership credibility and morale among followers, and which impair the achievement of successful Lean transformations.

Originality/value – The paper presents a novel approach to understanding the Lean management system by using music as the framework. It shows how effective Lean leadership is more the result of daily practice than it is of the personal attributes normally associated with capable leadership. The deep similarities between Lean management and music have not been previously described in the literature.

Keywords Flow, Leadership, Lean, Music

Paper type Research paper

Introduction

Modern progressive management began over 130 years ago with the work of Frederick Winslow Taylor and his associates (Taylor, 1903, 1911, 1947), along with Frank Gilbreth (1911) and others (Emerson and Naehring, 1988). These pioneers established the fields of industrial engineering and management, and created what would become known as “Scientific Management.” Scientific Management evolved over time into a comprehensive system of management and is now widely known as “Lean management” (Arnold and Faurete, 1919; Woollard, 1954; Sorensen, 1956; Womack *et al.*, 1990; Schwartz and Fish,



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1998; Tsutsui, 1998; Shimokawa and Fujimoto, 2009; Woollard and Emiliani, 2009). Two fundamental ideas behind progressive management include process improvement and the elimination of queues to improve flow. If done consistently and correctly, the result is significant improvement in quality and throughput, lower costs, and dramatically reduced lead-times – which typically benefits customers and helps improve the value proposition. The Lean management system (hereafter, Lean management) can be used wherever information is processed and exchanged, regardless of the form of the information (i.e. a physical part or a report), and thus is applicable to any organization: manufacturing, service, government, non-governmental organizations, etc.

Since its inception, it has been difficult for management practitioners to understand (Taylor, 1947 (1912 testimony to Congress)) and correctly apply the principles of progressive management (Taylor, 1911; Woollard, 1954; Toyota, 2001), as well as its practices and methods (Monden, 1983, 1998). As a result, flow is rarely achieved and even more difficult to sustain, despite having made some improvements in efficiency through the limited use of selected tools and methods (Roth, 2010). In the Foreword to the 1947 edition of *Scientific Management*, Frederick Taylor's colleague Harlow S. Person wrote (Taylor, 1947, p. xii):

In the course of his testimony before the House committee Taylor was asked how many concerns used his system in its entirety. His reply was: "In its entirety – none. Not one." [...] Were Mr. Taylor alive to respond to the same question in 1947 – thirty-five years later – his reply would have to be essentially the same.

This quote illustrates the propensity for senior managers to take shortcuts rather than learn and practice what they need to in order to understand the system of progressive management in its entirety. Despite Taylor's great influence, and more recently that of Toyota Motor Corporation (Shingo, 1981; Monden, 1983; Ohno, 1988; Womack *et al.*, 1990; Womack and Jones, 1996; Fujimoto, 1999; Liker, 2004; Liker and Hoseus, 2008; Shimokawa and Fujimoto, 2009), management practitioners – especially the leaders of organizations – have found it very difficult to convert from batch-and-queue material and information processing to flow. Rare is the organization that practices Lean management with distinction to achieve flow (Emiliani *et al.*, 2007) throughout the enterprise, inclusive of its two principles, known today as "continuous improvement" and "respect for people" (Taylor, 1947 (1912 testimony to Congress); Woollard, 1954; Sugimori *et al.*, 1977; Toyota, 2001; Emiliani, 2008a, d). Instead, it is far more common to find senior managers who terribly misunderstand and misapply Lean principles and practices (Jargon, 2009; Roth, 2010; Aeppel, 2011; Carter *et al.*, 2011), or who view Lean as something workers should do but not senior managers (Elkind *et al.*, 2011; Voreacos *et al.*, 2011) – and which often results in layoffs after productivity gains have been realized.

The question, then, is why is it so difficult for senior managers, and others, to correctly understand and practice progressive Lean management? After more than 100 years of effort, it remains common to find organizations that selectively apply certain Lean tools to achieve short-term improvements in operating results (Schmidt, 2007; Roth, 2010), often accompanied by backslide into classic batch-and-queue processing caused by changes in management or changes in ownership (Emiliani *et al.*, 2007). Application of the system in its entirety, inclusive of both principles and all related methods and practices, remains elusive (e.g. Davis, 2001; Bhuiyan *et al.*, 2006; Roth, 2010; Aeppel, 2011). This suggests Lean management is far more difficult to understand and practice than is indicated by popular writings on the topic (e.g. Imai, 1986; Womack *et al.*, 1990; Liker, 2004).

Lean management, while conceptually simple (Womack and Jones, 1996), requires significant hands-on involvement to learn and understand (Monden, 1983; Ohno, 1988; Imai, 1997; Emiliani *et al.*, 2007). In addition, it contains dozens of important nuances and details that are impossible to grasp without daily practice (Emiliani, 2011). This explains why most senior managers seeking to adopt Lean management fail to understand it, as they have for decades been engaged in daily routines and habits that are non-Lean and very difficult to break. It also suggests that Lean management is more closely connected to activities requiring highly developed skills acquired through long-term capability building, such as music. To become a capable musician means to learn a new language, which requires years of study and practice (Levitin, 2006), much like learning the new language of flow.

This paper uses music as a framework for understanding why Lean management, as well as its antecedent, Scientific Management, has been so difficult for senior managers to understand and practice, as well as to lead its practice in organizations. The music framework serves as a creative and accurate reference for exploring this long-standing problem. The numerous similarities between Lean management and music reveal a depth of association that has not been previously reported in the literature. This paper seeks to improve practitioners' understanding of Lean management, how to learn Lean management, and help management practitioners clearly recognize the need for their own personal daily application of Lean principles and practices.

While operations and operations management are used in this paper to aid in the explanation of the association between Lean management and music, the overarching perspective in this paper is of Lean management in the general sense. This reflects the long-wave trend of Lean management moving beyond operations into all functions and all processes in an enterprise (Emiliani *et al.*, 2007; Kenney, 2011). With respect to the music framework, the context in which it is used is not specific to any music genre. Rather, it too is the general case, where the main point of comparison made is between music that flows and that which does not flow. We emphasize the importance of daily practice to become an effective Lean leader. This should not suggest that senior managers need to have been operators to practice Lean management correctly, just as leaders need not have been accountants to be proficient in an organization's costs.

Finally, in the context of Lean management, a definition of leadership must pertain to leaders' ability to enable information flow between people and in processes. In addition, a definition of leadership must reflect an outward-looking servant leader role because that is much better aligned with the Lean principles, "continuous improvement" and "respect for people" (Toyota, 2001). Thus, Lean leadership has been defined as (Emiliani, 2008a): "Beliefs, behaviors, and competencies that demonstrate respect for people, motivate people, improve business conditions, minimize or eliminate organizational politics, ensure effective utilization of resources, and eliminate confusion and rework." This definition is practical, specific, and actionable with respect to improving information flow by eliminating waste, unevenness, and unreasonableness.

Lean and music – simple associations

To me, it was like looking at a symphony. Everybody knew their instruments and their music. They knew when to come in and when not to come in.

This is a description of manufacturing given by Gary Convis when he first visited Toyota Motor Corporation's Takaoka plant in 1983 (Collier, 2006). Convis, who would later rise to become chairman of Toyota Motor Manufacturing Kentucky, immediately

recognized the precise timing and synchronization apparent in a highly developed flow production system. This general characterization is a common one to people both experienced and inexperienced in operations (Hopkins, 1994).

A more specific characterization of the association between Lean and music is related to takt time, which is the rate of customer demand. Takt, is a German word for “beat,” while takt time signifies the number of beats per unit time (LEI, 2008). Takt time is important because it connects the production activity on the shop floor to actual marketplace demand, and is calculated by dividing the production time available per day by the customer demand per day. For example, 450 minutes available production time divided by a demand of 900 units per day means one item must be produced every 30 seconds. Takt time is similar to the time signature in a music score, which tells musicians the beats per measure.

These two examples are normally the extent to which the association between Lean management and music are made.

Lean and music – advanced associations

Table I lists numerous similarities between learning and practicing music compared to learning and practicing Lean management. Anyone who has had experience with learning both music and Lean should easily recognize the accuracy of each item. The significance of Table I is that it indicates learning Lean management is a task of similar magnitude to a student who is serious about learning music. Both require one to think differently and do things differently than one would normally do. While many people experience music education in their youth, few actually persist and learn to play music well. Likewise, while many senior managers experience Lean in classroom education, few actually persist and therefore do not learn Lean management well enough to lead their organizations forward.

Only about 6 percent of the US population plays a musical instrument two or more times a week (USCB, 2011), while the population of senior managers (standard occupational classification (SOC) codes 11-1011 and 11-1021) in the USA is 0.7 percent (Bureau of Labor Statistics, US Department of Labor, 2011). If levels of management down to line supervisor are included, then the total population of people in management positions is likely around 2 or 3 percent. This figure is comparable to the 3-4 percent of large- and mid-size companies practice Lean management with distinction. In most of these cases, senior managers are personally participating in the daily application of Lean principles and practices. In contrast, the majority of companies claiming to practice Lean management have extensive senior management support (e.g. Davis, 2001; Bhuiyan *et al.*, 2006; Roth, 2010), but little or no actual participation by senior management. Instead, senior managers typically delegate the use of Lean tools and methods to lower-level people. Table I suggests many specific reasons for the widespread lack of senior management knowledge and involvement with Lean management (e.g. lack of fine thinking skills, lack of a sensei, etc.).

Table II shows the structure of the information that is processed in music (Ashley, 2005) and in Lean. Notice how one exactly parallels the other. As shall be shown later, this is because both music and Lean (flow) are rooted in physics (Hopp and Spearman, 2001; Monden, 2008). The term “part” in the Lean column refers to a physical part that is processed in manufacturing operations, but it can also be a discrete item of information that is processed in service operations. There is no fundamental reason for there to be any distinction; the term “part” is used solely for convenience.

Music	Lean
Requires development of fine motor skills Most people need a teacher to learn music	Requires development of fine thinking skills Most people need a sensei (teacher) to learn Lean Cannot practice Lean correctly if you cannot remember the principles (especially the nuances and details)
Cannot play song correctly if you cannot remember the notes Must practice every day Requires a great deal of personal motivation and discipline Follows strict rules for timing, sequence, and synchronization with other people (instruments) Cannot just play music (do). Musician must think and do Errors are broken down into minute parts, investigated thoroughly, and corrected Typically a small group activity, and requires real teamwork Establish the basic chords and fingering, then work out the problems one-by-one over time Must adhere to standardized work (sheet music) Must know both your part (the detail) and the whole song (broad view) Symbols and notation have precise meaning Music has rules Nuances and details are important Players must play just-in-time Learn music mostly on-the-job (practice and performance) Sees overproduction (notes), movement (physical), defects (mistakes), waiting (for performance), and transportation as waste (to and from performance) Some room for adaptation and interpretation. You are never done; always more to learn Get complacent? Music sounds bad Keep trying; never give up	Must apply Lean principles and practices every day Requires a great deal of personal motivation and discipline Follows strict rules for timing, sequence, and synchronization with other people, departments, and organizations Cannot just “do” Lean. Managers must think and do Problems are broken down into minute parts, investigated thoroughly, and corrected Typically a small group activity, and requires real teamwork Establish the process, then work out remaining problems one-by-one over time Must adhere to standardized work (combination sheet) Must know both your part (the detail) and the whole process (broad view) Symbols and notation have precise meaning Lean management has rules Nuances and details are important Material and information must be just-in-time Learn Lean management mostly on-the-job (practice and performance) Recognize existence of seven wastes (Ohno, 1988), plus behavioral waste (Emiliani, 1998) Some room for adaptation and interpretation You are never done; always more to learn Get complacent? Make many costly mistakes Keep trying; never give up

Table I.
Similarity between learning music and learning lean

Music	Lean
Note (duration and pitch)	A part (part number or SKU)
Pitch (frequency of a note)	Pitch (frequency of a part or container of like parts)
Melody (sequence of single notes)	Sequence of parts (level AABAABC, not batch AAAAAA BBBB CCC)
Harmony (group of two or more notes)	Parts in an assembly
Rhythm (pattern of notes in time)	Pattern of parts in time
Tempo (speed of the notes)	Speed of the parts (takt time)

Table II.
Comparison of basic structure of music and lean

An orchestra and its various instrument sections can serve as a metaphor for a company, whereby each instrument section must work together to create harmony (musically). Likewise, the departments in a company must work together (teamwork) to create harmony. However, poor teamwork in a company is common, resulting in disharmony. In Lean as in music, discord occurs when the frequency of notes (parts) are off, meaning, items “A” and “B” are needed but items “A” and “C” appear instead. This causes delays or re-work.

Material and information processing in organizations is normally batch-and-queue, resulting in long lead-times, quality problems, and high costs. While some parts of a business may process material and information in ways that resemble flow, they are generally either an efficient batch-and-queue or hybrid batch-and-queue/flow processing method. Batch-and-queue material and information processing is prevalent in business, but rare in music. What does batch-and-queue processing look like in music? Figure 1a shows the musical equivalent of batch-and-queue processing.

In this music score, we see the same note played for varying numbers of measures (batches) followed by rests of varying durations (queues). This score would quickly frustrate listeners because they hear the same note repeated followed by silence of arbitrary duration, followed by a different note played repeatedly and another rest of arbitrary duration, and so on. People would not listen to or purchase this type of music because it does not flow. Interestingly, some avant-garde music seeks to deconstruct and disrupt flow in music, to make it more batch-and-queue. While perhaps technically interesting, such music sells only to a narrow audience. People’s conception of music is sounds (and silence) that flow.

Imagine someone who purchased a music instrument, such as a bass guitar, went home and began playing it for the first time. If you were a listener, Figure 1a is what you would likely hear. You would hear noise, which is why listeners prefer to be elsewhere when someone first learns to play music. The “music” sounds bad. If one practices diligently every day, then one will gain a better understanding of the instrument and the music, and the noise will soon become more listenable and sound like music (flow of notes in time). If one does not practice, or practice is infrequent, then the learning process is arrested and Figure 1a is about all that the player will ever be able to do. This skill level is the lowest it can be, which is convenient for the player but highly inconvenient for the listener.

Figure 1b is a current state value stream map depicting batch-and-queue material and information processing. This is how senior managers in most companies organize resources to perform value-creating work. Unfortunately, this push production system contains vast amounts of waste, unevenness, and unreasonableness (Ohno, 1988; Monden, 1998; Liker, 2004; Emiliani, 2008a), which results in long lead-times, high costs, and low quality. Organizing processes in this way requires little in the way of skill and is convenient for management because it is easy to do. However, it is highly inconvenient for customers, who will eventually look elsewhere to have their needs satisfied if they have a choice of suppliers. Thus, batch-and-queue processing may be acceptable for sellers’ markets, where customers have no choice, but it is unacceptable for companies that operate in competitive buyers’ markets. Unfortunately, few senior managers have realized this over the last 130 years.

It is critical to comprehend the meaning of Figure 1a and b. Like the beginner bass player processing notes (making noise) in Figure 1a and b represents how the beginner manager processes parts. But it is worse than that, because Figure 1b also represents how experienced senior managers process parts (meaning, as the ultimate process

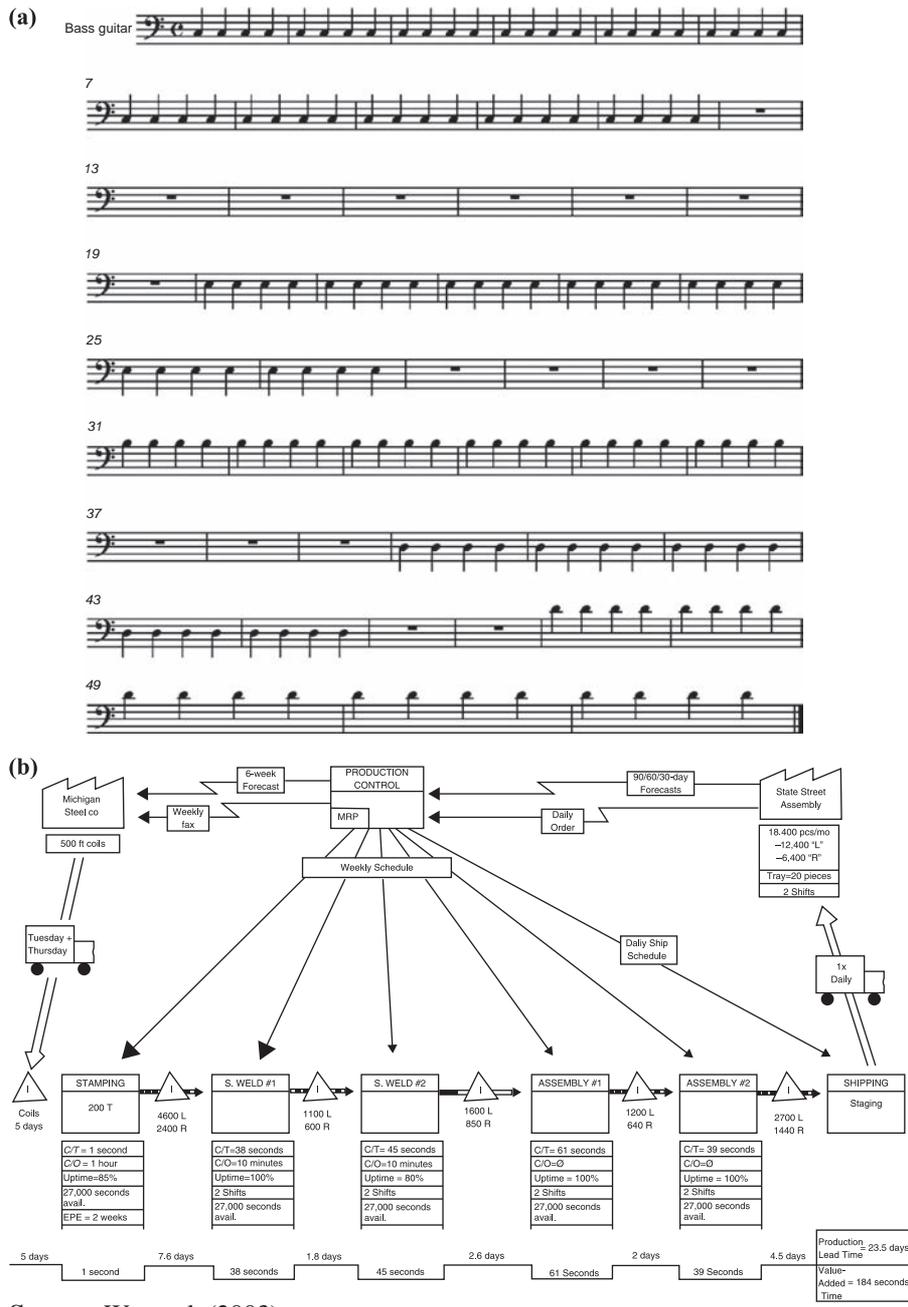


Figure 1.
 (a) A batch-and-queue music score (51 measures, $c = 4/4$ time); (b) current state value stream map depicting batch-and-queue processing

Source: Womack (2003)

owners), usually with significant effort made to optimize each individual process in isolation of the other processes. Optimizing batch-and-queue processing is akin to going from not knowing how to play a song (Figure 1a) to knowing, for decades, how to play only a few simple songs. Learning and development have stopped. Frederick Taylor and others subsequent to him established principles, practices, and methods to move batch-and-queue processing forward toward flow. It means to go from knowing a few simple songs to knowing how to play any song. That is what the pioneers of progressive management wanted senior managers to learn how to do, yet few have risen to the challenge.

Figure 2a shows the musical equivalent of flow processing. In this music score, we do not see the same note played for varying numbers of measures followed by rests of varying durations. We instead see notes played in combination with short rests that fit appropriately to maintain the flow of music. This would make listeners happy because they hear music, not noise.

The person who can play Figure 2a well does so because of years of experience studying and playing music. They were once a beginner, but dedicated themselves to moving far beyond that to develop capabilities that few people possess. They learned the new language and associated skills, which was difficult and inconvenient for the musician, but is convenient for the listener. Music that flows sells much better than music that does not flow, and the former requires real skill and reflects what customers value while the latter do not.

This pull production system is more responsive to buyers' markets and contains far less waste, unevenness, and unreasonableness which results in shorter lead-times, lower costs, and higher quality. Organizing processes in this way requires great skill and is very inconvenient for management because they must study and practice new things. However, it is highly convenient for customers, particularly if they have a choice of suppliers. Flow processing should be the norm in sellers' markets as well because sellers' markets do not last forever, and also because batch-and-queue processing develops bad habits in senior managers that are difficult to break when the need for flow eventually arises due to increased competition. Unfortunately, few senior managers have realized this as well over the last 130 years, and thus experience great difficulty transitioning from batch-and-queue to flow.

Once again, it is critical to comprehend the meaning of Figure 2a and b. Like the advanced bass player processing notes (making music) in Figure 2a and b represents how the advanced senior manager would process parts. They have gone from knowing only a few simple songs to knowing how to play any song. That is why experienced sensei (kaizen teachers) can help any organization in any industry achieve flow, regardless of the product or service produced. They can play any song. Unfortunately, few senior managers have risen to this challenge. To them, it is sufficient to know, at most, a few simple songs. It also explains why, for so many years, Lean has remained stuck in operations, while its principles and practices apply to all processes in an organization.

Table III lists additional similarities between Lean and music. Teamwork in organizations is often forced and ineffective, which is no surprise when processing is batch-and-queue because processes operate in isolation. In order for material and information to flow, the level of teamwork must be far greater because processes are connected instead of independent of one another. Sharing is also a common characteristic in both music and Lean; the former centering upon performance time and sonic space, while the latter pertains to sharing ideas (Yasuda, 1991), profits

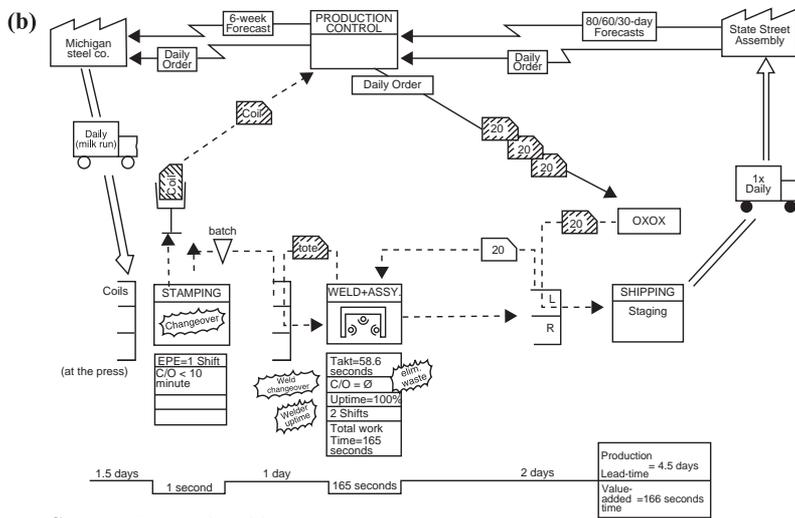
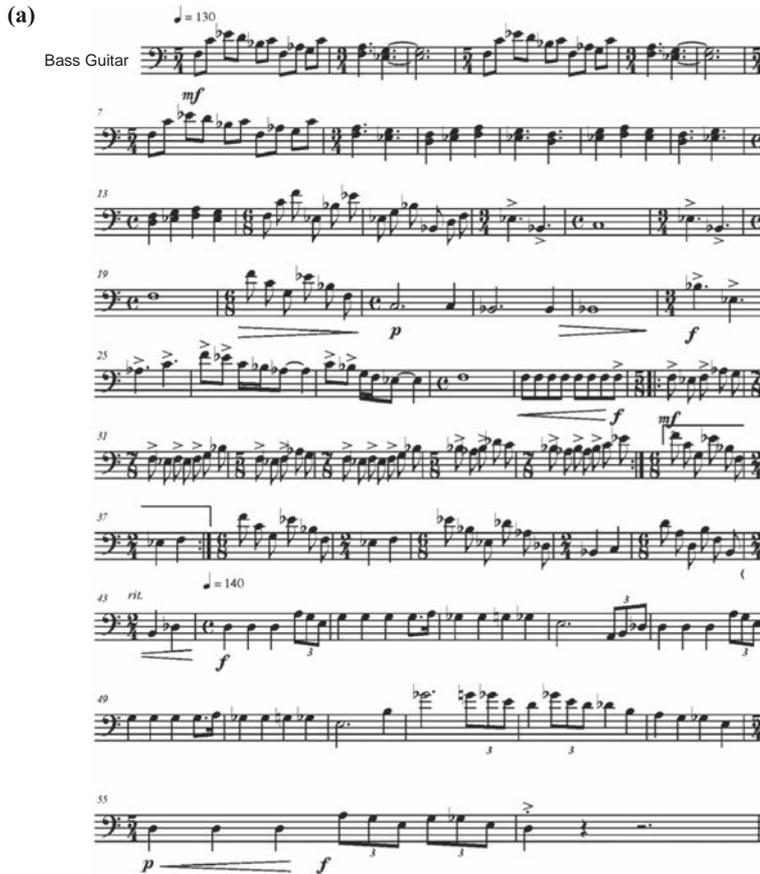


Figure 2.
 (a) A music score that flows (56 measures, time signature varies); (b) future state value stream map depicting a pull production system

Source: Womack (2003)

Table III.
Additional similarities
between music and lean

Music	Lean
Teamwork (band, orchestra)	Teamwork (intra- and inter-departmental/organizational)
Sharing ideas and sonic space	Sharing ideas, rewards, and benefits
Creativity to innovate and improve (jam session)	Creativity to innovate and improve (kaizen)
Time and counting (time signature, tempo)	Time and counting (takt time, cycle time)
Balance (melody and harmony)	Balance (percent loading, heijunka, job rotation, etc.)
Observation (mainly by ear)	Observation (mainly by eye)
Patterns and relations (circle of fifths)	Patterns and relations (part families, heijunka, milk runs, etc.)
Steps (music scales)	Steps (continuous improvement)
Must be in tune (sound, e.g. A440 Hz)	Must be in tune (with marketplace, e.g. takt time)
Standardized work (sheet music)	Standardized work (standard work and SWCS)
Visual controls (sheet music, conductor)	Visual controls (andon light, production display board)
Audio signals (the music itself)	Audio signals (music and tones used as signals)
Continuous flow (notes and rests)	Continuous flow (material and information)
Non-zero-sum (good for both musician and listener)	Non-zero-sum (win-win outcomes among key stakeholders)

(Emiliani *et al.*, 2007), etc., among key stakeholders (employees, suppliers, customers, investors, and communities). Both music and Lean are creative activities, while batch-and-queue processing is not. Time and counting are extremely important for both music and Lean, as is the concept of balance. Observation is of great importance as a means of identifying abnormal conditions to initiate problem solving, as are patterns and relations.

Musical pitches can be arranged into various scales, major or minor, for example. A scale is a collection of notes with designated pitches that, when arranged a certain way, provide the foundation for a desired harmony or melody. Each scale is composed of a series of small steps called intervals, which is the distance between one note and another. Lean also advances in small steps (continuous improvement). The music must be in tune, and Lean, through takt time, heijunka (level loading), standardized work, visual management, and total productive maintenance, ensures production is in tune with the marketplace. Finally, activities must be performed according to standardized work, continuous flow is the goal, and outcomes must be non-zero-sum.

Physics of sound and lean

The common denominator between music and Lean is time, which means the two share even deeper similarities than those presented thus far. Note, in contrast, that there is essentially no time relationship between music and batch-and-queue processing because of large cycle time mismatches and huge variations in queue time (hours to months or years) between operations. The decoupling of processing and time makes senior managers insensitive to time (Figure 1b) despite their exhortations to reduce lead-times, for example, which usually only results in speeding up the workers doing value-creating work – which Taylor (1947) explicitly warned against (1912 testimony to Congress) – and leaving queue times largely untouched.

Figure 3 shows the basic time functions in music and in Lean, which will be used to illustrate their relationship for a few production activities. In music, wavelength is reduced by half for each doubling in frequency, as shown in Table IV and Figure 4.

Domain	Time function	Measure
Music	$\text{time} = \frac{1}{\text{frequency}}$	seconds / cycle
	$\text{frequency} = \frac{1}{\text{time}}$	cycles / second (Hz)
Music		beats / measure
Lean	$\text{cycle time} = \frac{1}{\text{frequency}}$	seconds / operation
	$\text{frequency} = \frac{1}{\text{cycle time}}$	operations / second
Lean	$\text{takt time} = \frac{\text{available operating time}}{\text{customer demand per day}}$	seconds / unit
	$\text{frequency} = \frac{1}{\text{takt time}}$	units / second

Figure 3.
Basic time functions in music and in Lean management

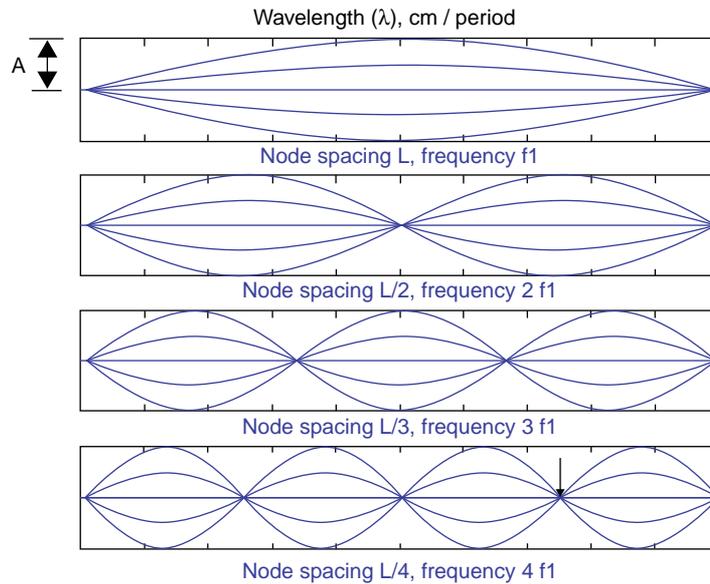
Thus, proceeding from middle C (C4) to the next higher octave (C5) results in a doubling of the frequency and a wavelength that is shorter by half, with no change in amplitude (A), and so on, as illustrated in Figure 4.

Time signature is a music notation that specifies the number of beats per measure, as well as the specific note value (e.g. eighth, quarter, whole) that constitutes one beat. Music is performed at a specified velocity, termed the tempo, measured in beats per minute, while part of the music score is often cyclic whereby all or part of the song repeats at various points (by same or other instruments) while still maintaining flow.

In Lean, the person or persons operating a production cell must cycle through their series of operations in some period of time, *T*. Their work performed through each cycle can be drawn as a sinusoid, phase shifted to eliminate negative values which

Note	Frequency (Hz)	Wavelength (cm)
C4	262	132
C#	277	124
D	294	117
D#	311	111
E	330	105
F	349	99
F#	370	93
G	392	88
G#	415	83
A	440	78
A#	466	74
B	494	70
C5	523	66

Table IV.
One octave range starting at middle C



Source: Peterson (2011)

Figure 4.
Relationship between
wavelength and frequency

would represent delays. In a moving assembly line, the floor typically has markings to signify the beginning and end of the cycle by which an operator must complete an operation, with additional markings between these to indicate the duration of specific tasks. This wavelength is a form of visual control to inform the worker of activities that have been completed and those that remain to be completed within the cycle time.

The velocity, v , of the assembly line is described by the equation, $v = f \lambda$, where f is the frequency and λ is the wavelength. A takt time of 56 seconds per unit yields a frequency of 0.0179 units per second. For a wavelength of 5.6 meters, the assembly line velocity is 0.1 meters per second, which is typical for an automobile assembly line. Thus, there is a direct analog between the speed of music (tempo) and the speed of a moving assembly line.

All businesses are subject to the macroeconomic business cycle – peak, recession, trough, expansion – every five to six years (NBER, 2012). Despite these ups and downs, healthy macro-economies typically grow at an average rate of 3 or 4 percent per year. The fluctuations in ordering patterns by customers within the business cycle can be represented by a sine wave whose amplitude is determined by the diameter of the circle that traces the sine wave. A circle whose diameter changes continuously over time (order fluctuation) is not good because it makes it very difficult to achieve consistently favorable results in operations; e.g. on-time delivery, low cost, and high quality. The purpose of takt time is to dampen the wave amplitude for a period of time – day, week, or month – using a simple averaging function to avoid over- and under-production. So instead of experiencing large peak-to-valley fluctuations in customer’s ordering patterns, takt time helps create low rolling waves representing customer demand. This, coupled with heijunka, standardized work, visual management, and total productive maintenance, helps assure basic stability, which enables Lean companies to succeed on a more consistent basis.

Kanban in Lean management is a signaling system that tells people what to make, when to make it, how many to make, and where to deliver their product in a pull system. There are different types of kanbans (Monden, 1998), but the production kanban illustrates the cyclic nature of replenishment under steady state conditions created by using takt time, heijunka, etc. The kanban cycle time is expressed as (Monden, 1998, p. 284):

$$K_{ct} = \frac{CN}{D} - L_T S_P$$

where C is the order cycle, N is the number of kanban, D is the daily demand, L_T is the lead-time, and S_P is the safety period.

These simple examples illustrate the reason why Gary Convis and others describe what they see in a precisely timed and synchronized flow production system as musical. It flows – unlike batch-and-queue or hybrid batch-and-queue/flow processing where all or most of the queues remain, thereby preventing flow.

Discussion

Let us return to the question posed earlier: why is it so difficult for senior managers, and others, to correctly understand and practice progressive Lean management? Using music as an analogy for Lean management helps one better understand the magnitude of the challenge. Music takes years to understand, as does the Lean management system and, in particular, its two principles: “continuous improvement” and “respect for people.” Learning, in both cases, is achieved by a combination of thinking (studying) and doing (practice), sustained over time by personal motivation and commitment (Emiliani, 2005).

The implications for management practice are profound in that effective Lean leadership is the result of long-term daily application of Lean principles and practice by managers at all levels. Empirically, we find that the organizations that experience the greatest success with Lean management are those where leaders at all levels engage in the daily application of Lean principles and practices (Person, 1929; Ohno, 1988; Emiliani *et al.*, 2007; Kenney, 2011). They engage in specific daily routines to develop their knowledge and capabilities of Lean principles and practices (Emiliani, 2008b; Rother, 2010). These leaders are able to lead their organization’s practice of Lean management because they know Lean, just as conductors are able to lead musicians because they know music.

In contrast, we find that the organizations that experience the least success with Lean management are those whose leaders do nothing more than support Lean management (Schmidt, 2007; Roth, 2010; Aeppel, 2011; Carter *et al.*, 2011). This is often accompanied by a belief that knowing about something (Lean) is a viable substitute for actually doing it (Pfeffer and Sutton, 2000). Leaders continue their conventional management routines, which further entrenches batch-and-queue information processing and renders it impossible to achieve flow throughout the enterprise.

To further elaborate on the importance of doing in order to know Lean management, let us associate the “continuous improvement” principle to the treble clef and the “respect for people” principle to the bass clef of the grand staff of music for piano (Figure 5). Senior managers who want to “play” Lean must use both their right and left hands. Playing with their right hand alone, the “continuous improvement” principle, is not sufficient.

The “continuous improvement” principle may seem easy enough to master, but it is not. Most senior managers seek short-term improvements that have direct bottom-line

impact (Roth, 2010; Carter *et al.*, 2011). To achieve this outcome they take shortcuts. They, or their delegate (often, a consultant), will cherry-pick Lean tools and methods (Emiliani *et al.*, 2007; Johnson, 2008; Jargon, 2009; Carter *et al.*, 2011), invariably without understanding their purpose – either individually or how they relate to each other. The organization then receives a top-down directive to use Lean tools to improve the work done at lower levels, while senior managers continue working as they always have. One group of people is required to use certain Lean tools and methods every day, while the other – senior managers – is not. Short, classroom-based executive training programs on the use of Lean methods and tools lead managers to become overconfident in their knowledge of them, which results in misunderstandings and incorrect application (Roth, 2010).

As a result, senior managers cannot lead a Lean transformation because they do not know the subject matter well enough to lead. It is like asking a person who loves listening to piano, but who knows nothing about playing a piano, to teach others to play piano. Senior managers like “hearing” Lean “played” by others (usually right hand only), but are in no position to teach it because they do not know it (due to the absence of study and practice). In most cases, senior managers cannot even play a few easy notes with their right hand, but they can always hum the tune – i.e., say the buzzwords and feign support for Lean.

In their rush to cut costs, most senior managers lay off workers as a result of process improvement. This action reflects a fundamental misunderstanding of Lean management, whose actual purpose is to grow and improve a business operating in competitive markets (Taylor, 1947 (1912 testimony to Congress); Ohno, 1988; Basu, 1999; Emiliani *et al.*, 2007). Further, senior managers commonly treat as optional the “respect for people” principle. This principle is an expression of the requirement that management decisions and outcomes among key business stakeholders must be non-zero-sum (win-win), not zero-sum (win-lose). In this context, non-zero-sum does not mean perfect win-win outcomes. It means that stakeholders may not win as much as they would like, but they will not lose as much as they could. In other words, it is critical that management consistently achieves balanced outcomes.

Continuous improvement will rapidly degenerate into discontinuous improvement if people are harmed. This was well-known long ago by progressive management’s pioneers (Cooke-Taylor, 1891; Person, 1929; Taylor, 1947 (1912 testimony to Congress); Woollard, 1954; Ohno, 1988). This cause-and-effect should be obvious to senior managers but it normally is not. Thus, a company winning at its employees’ or suppliers’ expense reflects a senior management that is unaware of or does not care about the “respect for people” principle. The left hand, therefore, is not even used, thus assuring management decisions and outcomes are always zero-sum. One must use both hands to play piano and to practice Lean management.

The absence of the “respect for people” principle means that senior managers are not actually practicing Lean management. Instead they are continuing their long-

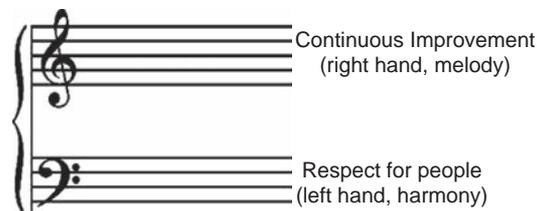


Figure 5.
Grand staff of a music
score for piano

established conventional management practices with the addition of selected Lean tools and methods. This has been dubbed “fake Lean” (Emiliani, 2001) or “imitation Lean” (Emiliani, 2005), and “L.A.M.E.” (Lean as misguidedly executed) (Grabau, 2007), to distinguish it from those who make sincere efforts to understand and correctly practice Lean management. The widespread existence of “fake Lean” in organizations causes great confusion, and may also explain why there has been little in the way of new Lean practices since the early 1980s (Emiliani, 1998, 2004).

The fact that the “respect for people” principle is widely ignored by senior managers is a weakness in need of correction. Most people are right handed and have at least some level of capability in applying the “continuous improvement” principle, faulty though it may be. The left hand, representing the “respect for people” principle, is clearly weak and needs work. So how do you correct weaknesses? When a serious musician recognizes a weakness, they immediately correct it by breaking down the problem into its component parts and studying the problem carefully. Weaknesses are corrected one-by-one as part of one’s daily music practice, and include specific exercises to improve performance. Practice, in this context, is deliberate in order to achieve an objective such as improved technical playing ability. Practice is not haphazard in the hope of improving one’s technical playing ability, as nuances and details in music cannot be mastered in this way. Likewise, managers must deliberately practice specific numerous aspects of Lean to steadily improve their leadership and management capabilities.

Serious musicians will practice some 10,000 hours over the course of many years to become credible and proficient (Levitin, 2006, p. 197). Senior managers must do the same. They too must practice Lean management, both principles simultaneously, for 10,000 hours (Emiliani, 2008b, c) – not each principle as a separate activity. They must do this as an integral part of their daily work, and emphasize the “respect for people” principle because that is their primary weakness. If they do this, then senior managers will become credible and somewhat proficient in four to five years (Emiliani *et al.*, 2007; Liker and Hoseus, 2008, p. 19), and will have accomplished many positive things along the way. In addition to the “respect for people” principle, most senior managers have weaknesses related to specific practices in Lean management including: observation, root cause analysis, “go see,” kaizen participation, visual workplace, teaching others, and making fact-based decisions (Liker, 2004; Emiliani, 2008a).

While the expectation for all classical pianists is to possess virtuoso capabilities (Tommasini, 2011), it is not a realistic expectation for all senior managers to become virtuoso Lean management practitioners. While many will hopefully become that, we should expect at least a very high level of understanding and capability among the men and women whose chosen profession is management. They should, at minimum, develop progressive Lean management capabilities that are at least equal to that of serious amateur musicians.

Unlike piano virtuosos who compete on the basis of sound – both technical and artistic capabilities – senior managers of publicly owned corporations often compete against each other on the basis of stock price appreciation during their tenure. This is akin to professional musicians competing on the basis of income rather than on making good music. Were senior managers to instead compete on the basis of management capabilities, practitioners of progressive management would no doubt put great pressure on practitioners of conventional management to improve their performance. Efforts to improve the value proposition for customers, improve processes, etc., would almost surely be followed by the increases in stock price that senior managers and investors covet (Maskell and Baggaley, 2003; Johnson, 2008).

It is difficult to characterize senior managers as professionals if they do not continuously improve their capabilities and compete on the fundamental basis of their profession: management. Continued use of the grim, unchallenging, and worn-out playbook of laying off people, closing plants and offices, squeezing suppliers' profit margin, etc., as methods for improvement illustrates how far management has yet to go to become a profession. Unfortunately, in most cases, management today more closely resembles Figure 1a and b, just as it did over 100 years ago.

Summary

This paper has shown the existence of many similarities between Lean management and music at depths ranging from shallow to deep. It compares the challenge of learning Lean management to the challenge of learning music and illustrates how Lean is a more precise way to manage (objective and scientific) compared to conventional management (subjective and artistic). It helps explain why so few companies possess a high-functioning Lean management system, inclusive of both the "continuous improvement" and "respect for people" principles, in the same way that few people can play music well. The daily practice that is required to achieve competency in music is typically missing in the practice of Lean management. This suggests that senior managers, unlike serious musicians, lack the motivation to persevere and learn Lean management over the course of many years – despite its potential for greatly improving customer satisfaction and achieving business objectives (Liker, 2004; Emiliani *et al.*, 2007).

This also suggests that it is very difficult for senior managers to recognize their own weaknesses in management practice, even when they are explicitly pointed out to them. It is common to hear senior managers with little actual Lean experience say "I'm beyond that" in reference to some aspect pertaining to Lean. For example, many senior managers will say they know all about 5S (sort, sweep, straighten, shine, and sustain), yet they have no idea how 5S relates to Lean principles, other Lean tools and methods, the interests of each stakeholder, and to financial performance (income statement and balance sheet). Most senior managers are vastly overconfident and confuse superficial knowledge with the deep knowledge that comes from daily practice. In contrast, weaknesses in one's understanding of music and playing skills would generally be obvious to a musician. Further, few musicians would be so bold as to say "I'm beyond that," knowing well that their knowledge of music and playing skills quickly erode when daily practice becomes infrequent or ceases.

It seems that the demands of both music and Lean management weed out the uninterested, the unwilling, the incapable, and the incompetent. Both disciplines seek people who are curious, studious, practical, motivated, and committed. Fortunately, one need not be an engineer to experience success with Lean. Exceptional Lean leaders have begun their career with backgrounds far removed from engineering, such as finance, accounting, economics, law, and science. The question, then, is what, if anything, can be done to increase the number of senior managers who are interested in becoming capable Lean leaders?

The comparison made in this paper between music and Lean management is meant, above all, to highlight the importance of daily practice by senior managers to learn and understand Lean management, to capably lead Lean transformations, and to recognize and correct problems in Lean thinking and practice among themselves and others. It also hopes to inspire current and future senior managers to personally engage in advancing the practice of management, which for over 100 years has largely remained the same.

Finally, while music and Lean management are similar in many ways, they do not share one important characteristic: Bad music does not harm people, while harm does come to people (stakeholders) when senior managers misunderstand and misapply Lean management. Therefore, it is important for managers to know what they are doing. In Taylor's 1912 testimony before the Special House Committee of Congress, in which he defended Scientific Management, he said (Taylor, 1947, p. 191):

It ceases to be scientific management the moment it is used for bad.
The same is true for Lean management today. Do no harm.

Future research

The findings of this paper suggest different paths for future research with respect to the challenges that leaders face when confronted with the need to develop new daily practice routines. One possible line of future research includes interviewing leaders skilled in the practice of Lean management to determine the type and duration of daily practice, as well as the specific motivations and routines that enabled successful outcomes. These results can be compared to organizations whose leadership opted-out of daily practice and instead delegated continuous improvement efforts to lower levels. While comparison of economic outcomes between such organizations is tempting, it is not a good basis for comparison because financial metrics can be easily manipulated to show success. A better basis for comparison is the social outcomes in organizations among both leaders and followers. This can include employee engagement, employee satisfaction, learning, innovation, motivation, morale, employee suggestions, efficacy of problem solving, etc. Another possible line of research could be to determine the ways in which the "respect for people" principle is recognized and applied by leaders in organizations whose Lean transformation has been successful compared to those who have not, and specific practice routines that enabled successful outcomes.

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