SUSTAINING HUMAN ENERGY

by

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Inventors

Prepared to further the understanding of the effects of human standing

HUMAN BALANCE AND STABILITY SYSTEMS

HBS Systems - Established 2016

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November 19, 2016 (revised May 2022)

HBS SYSTEMS – UTILITY PATENT 10,368,651

ABSTRACT

Sustaining Human Energy

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The present document describes the origin, progression, and effects of standing for extended periods of time [meaning more than 8 minutes], beginning with evolution of mankind and the resulting symptoms of body pain, fatigue, and the detrimental health aspects of standing in gravity while identifying the causes and a solution resulting in improved health, safety, and productivity.

Standing individuals experience postural sway which results in fatigue and discomfort within minutes of standing. As this fatigue and discomfort occurs, cognitive focus becomes impaired, and the attention becomes more focused on relief of the associated fatigue and body pain, rather than the task being performed. The results are poor posture, degrading health, disengagement, unsafe acts, reduced productivity, lost time, and turnover. Furthermore, and because human workers *must* perform their tasks, individuals will lock the knees using their legs as pillars and essentially preventing proper hip hinge movement. This common condition results in excessive forces on the lower back, legs, and feet. When coupled with the redundancy and frequency of the task, even small repetitive movements are causing instances of musculoskeletal disorders (MSDs).

By controlling postural sway and providing a means for humans to stand comfortably with positive shin angle to enable proper hip hinge movement, fatigue and discomfort and body pain are prevented and cognitive focus is restored.

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ACKNOWLEDGEMENTS

The authors wish to express sincere appreciation to the entire human race for their assistance in the preparation of this document. We recognize their experiences in evolution, survival, human innovation, performing stationary standing tasks, developing chronic health issues throughout their lives and their suffering as they further endure debilitating effects of musculoskeletal disorder they have developed as they progress in old age. In addition, we extend special thanks to those standing mechanics whose ingenuity and craftsmanship, continually improves the human existence. It is in the spirit of their ingenuity that we were able to recognize the problem and engineer a sensible and timeless solution that will have a positive impact on humanity. We thank you.

"To leave the world a bit better, whether by a healthy child, a garden patch, or a redeemed social condition; to know that even one life has breathed easier because you have lived - that is to have succeeded." Ralph Waldo Emerson

GLOSSARY

Balance: An even distribution of weight enabling someone or something to remain upright and steady.

Bipedal: (Of an animal) using only two legs for walking.

Cognitive thinking: Refers to the use of mental activities and skills to perform tasks such as learning, reasoning, understanding, remembering, paying attention, and more.

Equilibrium: Physical, chemical, or social science equilibria, and wider contexts, the conditions of systems in which all competing influences are balanced.

Fascia: a band or sheet of connective tissue, primarily collagen, beneath the skin that attaches, stabilizes, encloses, and separates muscles and other internal organs.

Ligament: The fibrous connective tissue that connects bones to other bones and is also known as articular ligament, articular larua,[1] fibrous ligament, or true ligament

Metatarsal: A group of five long bones in the foot, located between the tarsal bones of the hind- and mid-foot and the phalanges of the toes.

Persistence hunting: Is a hunting technique in which hunters, who may be slower than their prey over short distances, use a combination of running, walking, and tracking to pursue prey until it is exhausted.

Postural: Pertaining to the posture or position of the body, the attitude or carriage of the body as a whole, or the position of the limbs (the arms and legs).

Posture: A position of a person's body when standing or sitting.

Prehensile: (Chiefly of an animal's limb or tail) capable of grasping

Sway: The horizontal movement of the center of gravity even when a person is standing still.

Tendon: a tough band of fibrous connective tissue that usually connects muscle to bone and is capable of withstanding tension.

Thoracic Cavity: The chamber of the body of vertebrates that is protected by the thoracic wall (rib cage and associated skin, muscle, and fascia).

PREFACE

The following document is based on previously published research, specific testing, and development of technology to benefit people who stand. Our findings do not reflect in whole or in part the intent of any one single reference made in this document but ventures to utilize each reference to support this understanding in its entirety. HBS Systems lacked the capitol required to perform extensive and costly university research and relied on published research to form this conclusion. Nevertheless, we have expended extensive time and effort on that research to form this conclusion and further research continues the evolution of standing.

The patented StandRite-Pro effectively activates the body's natural core support system, making the core the center of balance, and spreading the work over the entire body. This is the basic principle in athletic strength and endurance training. The StandRite-Pro makes standing a full-body exercise, and therefore mitigates the destructive effects of static awkward postures on isolated muscle groups, that in turn undermine the integrity of the core and accelerate intervertebral disk degeneration.

INTRODUCTION

Precision grinding supports manufacturing companies in attaining the final tolerances required on tooling, gages, fixtures, and parts, often holding tolerances of .0001" and even .00005". This tedious and specialized process follows automated CNC machining and often involves the use of manually operated grinding machines. These machines require the operator to stand in a specific location allowing the individual to reach handles and switches comfortably and safely while at the same time allowing loading, unloading, adjustment and checking functions as the job progresses. Individuals will remain in this position for hours at a time during 8–12-hour shifts. Machinists who have been doing this work over the course of years develop chronic pain in the feet, ankles, legs, back and neck.

Recently, attention has shifted to jobs such as offices and ecommerce fulfillment where a dramatic increase has occurred in numbers of jobs performed by standing workers. Although all humans stand in the same manner, the task they perform have become more dangerous as experts have reduced movements and travel space [to make the task easier]. When coupled with mass volume of products, the result is less workers performing more output. Savvy product marketing depicts standing as being healthy, which leads standing workers to believe that timed movement is the key to MSD prevention. This is to spite decades of standing in every other sector where frequent movement does occur, but has made no such advance in reducing instances of MSDs. In fact, cases of MSDs are still rising. Finding the cause of the perils of standing, is where our research begins.

Chapter 1

EVOLUTION

Humans continue beneficial research from the smallest particles to the origin of the cosmos. We look for solutions to health, productivity and even happiness to ensure continuance of humankind. History often holds the key to our future and in the case of standing in gravity, evolution clearly identifies what we have all missed. The human body has obviously evolved to bipedal travel as we are able to efficiently transfer our body weight in a forward motion with only our feet to support us. The New York Times published an article titled "The Human Body Is Built For Distance" which provides insight as to why early humans evolved to be runners. We have evolved from a body covered in hair to resemble humans today more closely, who have very little hair on the body. The early humans practiced persistent hunting to outlast their prey. The lack of body hair enabled the cooling of the body through sweating while the mammals they hunted relied in panting to cool their hair covered bodies from exhaustion. The cooling aspect while developing the ability to run, provided humans with the ability to outlast prey. This development resulted in shorter toes than longer toed animals, alignment of our large toe with the other toes, and even a narrow waste to utilize our arms which all resulted in a higher degree of balance. Primate foot structure, [like humans] have five toes. The foot has a sole, a heel, a ball and five metatarsals.

However human feet have evolved away from the common primate foot anatomy to better allow bipedal walking. The arch of the chimp foot, therefore, is shallower than that of a human foot. Prehensile feet are lower limbs that possess prehensility, the ability to grasp like a hand. They are most observed in monkeys and apes, who similarly possess prehensile tails and this difference allows for efficient climbing, swinging and accelerated ground travel with balance and agility. Humans evolved with ligaments and tendons which are much more suitable for running. Unfortunately for standing workers, the mammals our ancestors hunted did not stand in one place for extended periods as we hunted them. Had they done so, we may have continued our evolution to develop more suitable means for balance and stability in that position.

The human body has not evolved to bipedal standing, yet most of us do it throughout the day. Due to the development of bipedalism in humans, the hands became the focus of prehensility and the feet adjusted to more of a stabilizing role. It may be possible, however, that the foot does not reach its limits of dexterity due to the constant muscle tension needed in stabilizing and balancing the foot to hold up the legs and the rest of the frame. Through movement of the feet in upright travel, we experience at least some movement of these ligaments and tendons which provides a reduction in the tension associated with stabilizing and balancing in a one-foot position. PBS aired a series called Your Inner Fish: "Episode 3: Your Inner Monkey" which provided specific explanations as to why standing has been so difficult for humans. Our early ancestor primates lived in trees foraging fruits and vegetation as well as escaping predators. It is not surprising that these primates developed incredible balance and stability in their movements. What is surprising is how they evolved to achieve them. Chimpanzees are capable of walking on their two legs, but they are only partially bipedal, as they typically tilt their body weight forward and use their long arms for balance. Humans evolve to stand upright which resulted in an "S" shaped spine to counter the weight of our thoracic cavity in an upright position. This causes serious issues for the human spine which results in compression of the vertebrae and in many cases, fractures due to prolonged improper posture and resulting weight balance.

When we consider the process of standing for extended periods of time as opposed to the forward movement, the tension needed to stabilize and balance the feet to hold up the legs and the rest of the frame, becomes much more acute and spreads throughout the muscles, tendons, and fascia of the body. It has long been known that the fascia must remain flexible and relaxed to retain its elasticity to hold balance in conjunction with the muscles they surround. When standing for prolonged periods, individuals consciously and or subconsciously begin to shift from one foot to the other, lock their knees, lean on something or search for some other means of assistance for the relief of this tension, the fatigue that builds and the discomfort that results from it. It should be noted that shifting from one foot to the other the body simply shifts its entire weight from one foot to the other, further complicating the efforts to relive the discomfort. Hyperextending or locking the knees prevents proper hip hinge movement and significantly increase force on the lower back. Leaning backwards moves the center of gravity from a "centered" location supported by the feet to a sedentary, "off center" location supported by the feet. We can surmise that these conditions reflect an increase in imbalance and instability in a standing position.

Chapter 2

SYMPTOMS

As discussed in the previous chapter, humankind has obviously evolved to bipedal walking but standing for prolonged periods of time is something new to us, relatively speaking. One can easily see that humans developed this trait through our process of industrialization. As humans began to produce goods, we began to stand to perform these tasks, but it is not until we began to mass produce goods, that we begin to see standing in one location for prolonged periods become so prominent. The symptoms of pain, discomfort, and fatigue we experience today have a brief history. One of the most ingenious inventions has been the chair. Although the early Egyptians created sitting platforms, the Chinese were the first to utilized chairs, though be it mostly to mount horses. At the time, the chair provided the most sought-after solution to the discomfort and fatigue of standing. So much so, that it was later mass produced [by even more people standing to do so]. We have been reinventing "the most comfortable chair" ever since.

Today we have chairs everywhere; on mass transit systems, bus stops, waiting rooms, offices, and anywhere people are. It sounds obvious to us but consider that we spend so much time in chairs now that it is detrimental to our health at an alarming rate. The health benefits we see from walking and running are offset by sitting when we are not mobile. Inventors as well as employers are recognizing this and have set out to change it. In recent years, the focus has shifted from sitting at work to standing and providing apparatuses to assist standing such as stand-up desks, sit-stand workstations, and products such as copper lined socks, fatigue mats, braces and sole inserts have flooded the market. Science Direct published an article titled "A systematic review of standing" in which researchers report that workplace standing is beneficial to heart rate, cardio metabolic factors such as HDL cholesterol and even the mood of the individual.

But these products only treat the symptoms of standing for prolonged periods of time. Symptoms include conditions such as foot pain, fallen arches, ankle pain, leg pain, lower back pain, upper vertebrae pain, vertebrae degradation, neck and shoulder pain, poor circulation, and even poor posture. Although products manufactured to date may very well improve a person's threshold to these symptoms, they do not appear to be a solution to any cause. These symptoms would appear to begin as we reach adulthood and venture into the workplace.

As we become adults, time and responsibility no longer allow for simply sitting down in the cool grass to combat our fatigue and pain. As we further our careers where standing is required to perform our tasks, we develop chronic ailments related to these symptoms and begin addressing them by sitting down on a stool in our workstations, wearing braces to support our posture, taking unscheduled breaks, pharmaceuticals and now there is a push to replace our muscles and joints with exoskeletons [to prevent harm to our muscles and joints]. This solution may be useful in jobs where workers are reaching over their head and there is constant progression and movement like auto mechanics and construction.

As we continue our lives and reach the end of our careers, we have not only developed chronic health issues from extensive stand in place conditions, but we must also fight the joint degradation, muscle mass loss and frailty of aging. Our bodies simply cannot repair and rejuvenate as they once did. Biodex published an article titled "Recovering balance: Classes help seniors prevent falls" in which it is explained that loss of balance as we age, is largely preventable. In 1995, the late Dr. David A. Winter PhD [considered by many to be the father of Biomechanics] published an article titled "Human Balance and Posture Control During Standing and Walking" citing that in 1991 (Canada) there were more elderly (70+) deaths attributed to falls than were attributed to automobile accidents in those aged 15-29. As the current generation continues to experience the growing demands and increasing automated workplaces, they remain in the workforce longer and their health issues results in more personal misery and increased strain on healthcare. The need to address standing has become imperative not only for economic conditions, but for the effects being experienced in society.

Today we see a radical change in thinking regarding the workplace and as stated previously, standing is heathier than sitting if there is sufficient movement [every 30 minutes at a minimum]. Published and ongoing research such as an article in The Seattle Times "Stand-up-desk trend also carries health risk" suggests that although standing is beneficial to health, such activity should be limited to only part of the time and that movement (including bipedal walking) must accompany the effort. Behavior Fit published an article titled "Please Leave Your Office: The Danger of a Standing Desk" in which the excessive duration of standing is addressed and points out that it is important to move periodically regardless of sitting at work or using a standing desk.

Modern designs entering the market are developed by people who sit at desks, to allow people who sit at desks, to stand. Workers who already stand all day and have done so for decades, are not part of the equation. The reason for this is simple. People who stand to perform tasks have little time, accessibility to technology or capitol to allow for personal research to solve this problem, let alone identify the cause and engineer a solution. They might have time to find a stool for their workstation, build a more accessible shelf to assist reach or simply perform the task a little slower to avoid complete fatigue and exhaustion, but the people who desperately need a solution cannot take the time to find one while meeting the demands of their job. Hazards Magazine published an article titled "Humans are not made just to stand and work" and poignantly addresses ailments, at risk jobs, little used regulation for standing workers, reluctance of employers to engage in the issue, health issues from standing and even the reluctance of the occupational health and safety authorities to take this issue seriously. The Canadian Centre for Occupational Health and Safety published an article on their website titled "Foot Comfort and Safety at Work" which identifies some causes of foot problems due to standing and advises on the need to consider what type of shoes are appropriate for the specific type of floor .Very little useful corrections are mentioned and the article simply states that we should relax our calf muscles, and straighten ankles and knees. Perhaps the most impressive description of debilitating standing conditions was presented as a TED Talk titled "Sitting Kills, support Standing" in which we find indisputable arguments of how vast the problem of standing is and how critical it is to find a solution.

Individuals who perform standing tasks all day are simply trying to get though the day as productively as they can and the last thing they want to do, is appear weak or less valuable by asking for assistance to stand and work. Managers are often older and still consider younger works as soft so there is little chance they will offer any assistance. We owned and operated a machining business and not only stood to perform the work, but we also allowed ourselves accessibility to technology during the day and expendeded personal capital to fund research on a solution. Between those factors and over thirty years of experience with chronic symptoms of standing, we have put ingenuity to this problem to fix our own bodies, our most valuable machine.

Chapter 3

CAUSES

To understand the cause of pain, discomfort and fatigue while standing, one need only look at the activities they perform while standing. Machines are engineered to keep workers in one stationary, safe, and comfortably reachable position throughout the entire process of performing their tasks. In fact, we place adjacent tables directly opposite the machines [or behind the worker] for minimal changes to their position as they access objects required for the task. The same is true in the new ecommerce fulfillment jobs where workers stand, package, and reach out to place the finished shipment on the assembly line. Although they do have to turn and move to the shelf behind them for the next item(s), they spend the largest amount of their working time statically standing and reaching. So, the option of bipedal movement recommended to offset standing is not an option in either case, especially every 30 minutes. This leads to hours and hours of standing in one place for days, weeks, months, and years on end. Because these movements are not considered hazardous or fatigue causing in themselves, the effects of the repetitious movements and fatigue grow over time and remain unnoticed until actual debilities and injuries become noticeable. That is where we are today in standing workplaces.

We have all heard the adage that to prevent back injury, we are supposed to lift with the knees and use our legs [rather than our backs] to leverage the weight. This is because we must adjust our center of gravity to balance as we perform this task to prevent injury. Lumen Physics provides a valuable tutorial titled "Stability" to explain the relationship of equilibrium, balance and the center of gravity. Even more appropriately, a source for understanding these conditions was published by Slide Share titled "Physiology of Equilibrium & Balance". Athletic conditioning principles identify it best when professing that positive shin angle encourages proper hip hinge movement to increase stability and decrease force in the lower back. The body is constantly tensing various muscles to hold balance while standing to control body sway. Biomechanical research continues to advance valuable knowledge on these conditions and effects. The Journal of Neurophysiology published an article on Postural Sway which describes that placing one finger on a surface has a stabilizing effect on sway. When you understand the role postural sway plays, it is easy to understand what makes chairs, beds and doorways comfortable.

Therefore, we can surmise that our balance and stability directly impact sway and controlling sway can have a positive impact on the symptoms of prolonged standing. From biomechanical research one can assume that when humans add auxiliary tasks to the complex activity of standing in place, humans depend on the body's support structure even more to perform complicated movements of the task. The conclusion is that we are expending valuable energy on balance and stability which can lead to fatigue and pain while our degrading our posture.

Chapter 4
FOCUS

All of us attempt and perform complicated tasks on our feet and often, these tasks require more than our hands and feet to accomplish them. We perform these tasks so effectively yet lack the simple knowledge to allow our personal machine (the body) to endure it. Our research led us to the article published by The Emotion Machine titled "Expanded Awareness And The "Car Body" Phenomenon" in which the similarities are described between the brains ability to treat the automobile as an extension of the brain and the brains ability to do the same with our body. We can control our movements and effects from those movements on our bodies through awareness and cognitive thinking. Similarly, Discover Magazine published "Brain treats tools as temporary body parts" in which we learn that the tool itself becomes an extension of our arms. This understanding of cognitive thinking is critical in defining what we are doing when we are standing and performing tasks. More importantly, it can explain what goes wrong when focus is interrupted.

Any given task requires a multitude of decisions, preemptive thinking and learning we summarize as cognitive thinking. As we load parts into our machines, adjust the tooling controls, check the speed, bring the cutter into contact while ensuring safety proximity and balance we are performing cognitive thinking. The same is true for most every standing job from cashiers to surgeons and if we experience body fatigue and pain, we at least expend part of our cognitive thinking on that as well. Perhaps that is why orthopedic surgeons still stand for 6-12 consecutive hours with locked knees as they operate on spines. Take for instance the new generation of "Gamers" as shown in the YouTube post titled "Oculus SEXY Rift: The Best and Funniest OR Reactions Ever" in which we see the cognitive thinking being performed by gamers and the resulting reactions. The loss of balance and stability experienced as they engage in this technology was of particular interest. If we can balance and stabilize our bodies to reduce the cognitive thinking required to address the fatigue and pain, we can direct adequate focus on working safely and more productively.

Chapter 5

FIXING THE MACHINE

Humans continue to develop more complicated and efficient machinery to improve production whether that be for manufacturing, medical technology, assembly or countless other sectors and purposes yet we continue to ignore the people who operate those machines. Of course, one could argue that automation is advancing to eliminate the person who stands at the machine all together, but the reality is that it will be many decades before humans are no longer needed to stand on their feet to perform tasks.

Mechanical aptitude is a unique trait in the sense that those of us who have it, seem to have a predisposition to recognizing problems and addressing them. Most mechanics can remember the tools they received as gifts much more readily than the toys they received. Their minds work differently in that respect, and it seems to drive them to not only think about how the tool is used but how the tool can be used. In manufacturing, especially in tool and die work, machinists determine ways of holding parts, organizing the tasks, and even repairing machines to be as accurate and productive as we can. The ability to successfully perform these processes results in them becoming a craftsman. Repairing a machine begins with determining what the issue is, locating the manual, engineering a solution, reworking parts, and recalibrating the machine. If we look at our body as a machine, we can employ the same approach. By determining that our feet, ankles, legs, back and neck feel fatigue and pain, simply consult the human manual beginning with evolution and engineer a solution to restrengthen the body to the task.

The development of the StandRite-Pro balance support came about as a necessity in a machine shop where volume was growing, and it became quite concerning that the physical demands would not be met. Each day the pain and fatigue seemed to become worse, due in large part to knowing it would all happen again the next day. In late August 2015 we began working on a support to stand that would allow resting one knee at a time.

Figure 1

We used a shower seat (figure 1) and reconfigured it so that what was normally the back rest of the seat, now dropped from the seat towards the floor. But because the prototype was placed against a machine and positioned so the feet could be placed just under it and the shins, when standing with both feet on the ground, it could serve as a shin rest. Within seconds, the benefits of this discovery became apparent, and we had [at that time] unknowingly controlled postural sway to reduce the work our body was performing to hold balance. That is when padding was added to create a comfortable surface for the shins. Although this device completely and had support legs that impaired travel, it was functional and the need to develop this idea was born. Research began as we had previously described here. After using the initial prototype for two weeks, energy was increasing, and fatigue was decreasing.

Figure 2

Figure 3

Prototype development continued through numerous iterations (figures 2 & 3) made up of readily available materials, as we worked to restore unrestricted travel. Research continued leading to a more complete understanding of balance, stability, and the effects those have on cognitive thinking. Tension was reduced throughout the body and improvements were apparent in overall posture and mood. Most surprising was the reduction of tension and pain in the feet, ankles, and lower back. This led to research on positive shin angle and proper hip hinge movement. The prototype process determined the best angle for support of the shin while standing as to control sway and reduce force on the lower back without creating excessive weight on the shins like kneeling would. As the process continued, we eliminated any impairments of ingress or egress to or away from the workstation by ensuring the feet could move freely under the shin support, it developed an adequate way of allowing force against the support in numerous configurations and attachment types and we determined the appropriate height as to allow the greatest comfort. In late October 2015, it became obvious to us that balance and stability at would positively impact standing and in November 2015, we submitted our provisional patent.

Figure 4

Figure 5

In March of 2016, prototypes were in use throughout our machining company on nearly every machine we owned (figures 4, 5) and the natural corrections to the poor posture we once had were unmistakable from the initial start of use (baseline figure 6), four months of use (figure 7) and ten months of use (figure 8). We found ourselves working more accurately, working longer hours, and we even used a stand-alone prototype home to continue our research.

Figure 6
Baseline

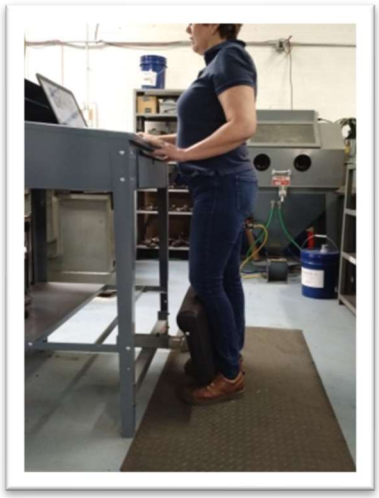

Figure 7
4 months

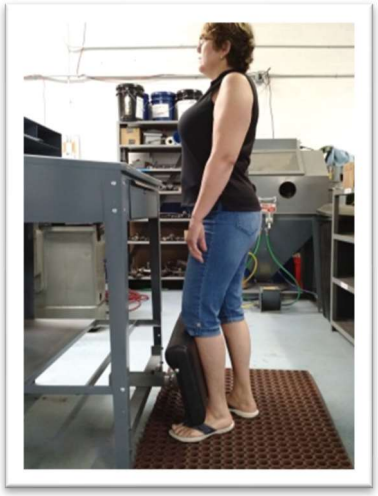

Figure 8
10 months

The use of the StandRite-Pro by nearly every person who performs sanding tasks in nearly every sector will soon become as common as a stool. Just a few examples are listed in Table 1.

Table 1

Manufacturing	Education	Transportation
Machining	Auditorium Speaking Podium	Baggage Claim
Machine operation	Classroom Teaching Standing Desk	Ticket Sales
Assembly	Student Desk	Boarding
Quality Control station	Library	Passenger Waiting Areas
Plant Work Desk	Retail Sales	Security Check Point line
Shipping & Receiving Desk	Cashier	Government
Industrial	Bagger	Public Service Employee Station
Welding	Stocking Carts	Public
Shipping & Receiving	Customer Service	Public Use Railings
Assembly	Sales Window	Agricultural
Print Table	Food & Drink	Feed Stations
Meeting Room Podium	Drive Through Station	Observation Stations
Health Care	Bartender	Sports and Entertainment
Patient Rehabilitation	Cashier	Ticket Station
Surgery OR	Hostess	Vendor Service Station
Patience Beds	Kitchen Stations	Gamers and Gamer Stations
Nursing Station	Research & Development	Residential Applications
Nursing Carts	Laboratory Stations	Kitchen Sink
Patient Examination Room	Auditorium Speaking Podium	Kitchen Island
Dentistry	Office	Counter Prep Area
Anesthesiology	Standing Desk	Laundry Room

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