The Technology Applications of Balance Training

By Mr. Liu Yichun
Footwear and Recreation Technology Research Institute
Sports & Recreation Division

Preface

Over these years, people are more aware of health issues. And globally, more people have gradually known the benefits once they do sports regularly in their daily life. Moreover, stated in 2008 National Development Policy, the government setup the plan: to actively promote sports so as to increase sports and leisure population in multiple time and make fitness activities trendy. Consequently, fitness has become popular in Taiwan. New fitness clubs are opened one after another so that the fitness industry is also on the rise. The overall industrial value is increasing tremendously. It has become one of the important new industries. Taiwan's fitness manufacturers are capable of providing high-efficient and safe sports equipment.

In the fitness equipment industry, the product life cycle can only maintain one to two years. The main reason is that the fitness equipment industry is dominated by a few of large enterprises, fierce competition will change the nature of competition and the phenomenon of price polarization. When consumers buy fitness equipment, what they consider is not only their personal needs for sports but also product design as well as brand image. Therefore, in order to meet customer's demands, the manufacturers has to maintain brand image, the outlook of the product, specifications design and to renew functions consistently. Therefore, they can create advantages by setting product differentiations. However, this development has shorten product life cycles. Thus, to remain competitive in the fitness industry, innovative research and design capability is the key factor. Currently, the gap between the development speed of the fitness equipment industry and consumers demand is not large. New fitness products are closely renovations from the existing products.

Analysis on balance training

Balance for all human beings is an important capability. The capability to balance physical gestures is also extremely significant. According to the related researches, athletes who have good control of balancing their bodies can appropriately and efficiently perform their physical strength while doing sports; besides, they would have better sports performance because of their smooth actions. With good balance ability, they would able to do all kinds of dynamic and slow movement with elegance. More importantly, they won't get injured easily. The aged with good balance control of their body and movements also demonstrate that they have better living quality because they are able to actively take part in physical activities. Additionally, there is a lower chance of falling down and fatality.

The mechanism to control and balance body postures is mainly charged by the central nervous system (CNS) including the big brain, cerebellum and spinal cord. The sensory system, the central nervous system and the motor system are in interacting and coordinating with each other to maintain the stability of body postures. The sensory system is in charge of the body weight center vis-à-vis the supporting sides, the messages of the relevant positions and the effects of body weight center such as somatosensory, vestibular, and the neural signals of vision. The central nervous system is to integrate and coordinate body movement, muscle contraction strategies. As to the motor system, it can provide information of autonomous actions and the changing centers of body weight so as to make proper changes of body movements; that is, to stabilize the center of body weight and to maintain balanced. Human body rely on the proper coordination of the above-mentioned three systems, and together with motor neural muscle system, the body is able to do all kinds of movements without difficulty and show beautiful and elegant postures.

Based on the training measures, the collected literature or the related researches could be divided into two categories: the first category is the ordinary sports training like dancing, taichi, physical exercise, swimming, jogging, cycling, rope jumping, water sports, and eye and hand/foot coordination movements as well as stretching etc.; the second category is specific balance training such as ankle-joint platform training, balance board, jumping training like spring pad, body training such as yoga and vestibular system like rolling and so on.

Balance Training Literature List

Researcher(Year)	Experimental Subject	Research Conclusions
Li-Lan Fu (1998)	23 senior people, three times a week, 30-minutes specific balance training, continuous trainings for 4 weeks.	After training, the time of standing on one foot is increasing.
Jhih-Ping Cuei, Yi-He Yang, & Jie-Shan Jiang (1999)	30 navy soldiers, marching, rope jumping and rolling training, continuous trainings for 3 weeks.	Three kinds of training can increase vestibular balance function.
De-Jyun Yi, Li-Fen Wu & Chong-Song Jhou (2001)	281 senior students at the community university. 3 times of hula hoop training, continuous trainings for 12 weeks.	After training, the time of standing still on one foot is increasing.
Gauchard, Jeandel,Tessier, &Perrin (1999)	19 aged people do yoga twice a week, physical exercise, swimming, jogging, and cycling and other sports, continuous trainings for 3 weeks.	After training, dynamic equilibrium and muscle power have improved obviously!
Rozzi, Lepjart, Sterner, & Kuligowski (1999)	13 people with the problem of functionally unstable ankle joints and 13 normal people, 3 times a week dynamic and static equilibrium training, and continuous trainings for 4 weeks.	After training, the stability to stand on one foot is much better.
Suomi & Koceja (2000)	7 people with rheumatoid arthritis and 7 people with bone arthritis take water sports training courses for 6 weeks.	After training, the test proves that the body shaking index would improve.
Riemann & Lephart (2003)	13 young people, ankle platform training, 3 times a week, 20-minutes per training, continuous trainings for 4 weeks.	There is no obvious improvement while standing with one foot on the force plate.

After reading the above-mentioned literature, we could conclude that regular sports training can strengthen body muscles, tenants, as well as the pressure-accepting level of joint capsules; moreover, it can speed the neural transmission and develop better neural control function and faster sensory input and the central spinal coordinating function. Through the integrating process to improve sensory messages, body has better equilibrium to enhance physical performances. The effects of regular physical training is particularly remarkable for the old people who gradually lost physical strength and the balance power of their own bodies.

C The importance of keeping balanced

Keeping balance is very important no matter people use muscle training equipment or stretching equipment or cardiovascular training equipment or other equipment. Balance is the major power to maintain body's stability in all kinds of actions or postures. Without any doubt, it is the basic ability that human beings can do all sorts of movement. In the daily life, most of physical activities bears close relationship with balance which plays a significant role particularly in motor coordination, sports performance and prevention from sport injuries. The importance of balance capability is detailed in the following indicators:

Enhancing children's balance ability

The researches related to enhancing children balance points out that training better balance at children's early stage will not only improve their learning efficiency of all kinds of sports skills but also reduce the sports injuries. Accordingly, if children can receive balance training at the early stage, there will be a great room for them to make progress. Based on related studies, children at about 7-10 years old, their balance ability is almost the same as adults. If they can receive balance training, their balance ability shall be lifted to a great extent. As believed, the way of balance training shall be also effective for adults. Because people's balance ability will degrade while getting old. Finding an effectively way to train balance, though it may can't improve the balance capability of adults or seniors, at least, can slow down the degrading balance ability. As known, it shall be an important issue.

Slowing down seniors' degrading balance ability

The aging geographic structure has become a global issue. Seniors' muscle performance and balance ability will degrade with time's passing. How to help the older people to slow down the degrading curve or how to maintain living quality and physical fitness shall be the major future development of preventive medicine. And also based on the related studies, balance training can strengthen seniors' muscles, better the coordination of the lower-limb neuromuscular as well as body's balance ability. Furthermore, it can improve the way of walking and sports performance. Besides, the dangerous elements of fallowing down and bone fracture will be decreased. Consequently, this training can slow down the degrading balance function.

Bettering proprioception (individual perception) and reducing medical cost

Balance training can improve the vestibular system, muscular proprioception and the functions of brain cortex. Furthermore, it also can improve balance capability as well as the coordination balancing ability while changing gestures. Therefore during the process of doing sports, there's always stimulus to the vestibular system, proprioception and brain cortex and this is helpful to improve the control ability to keep balanced. If the items of balance training could effectively stimulate the above-mentioned systems, it will definite better the control ability of body balance. Logically, this also brings a lot of benefits such as reducing the social problems of the aging population as well as the social cost, and so on.

With regard to the above-mentioned importance of balance ability, at present the balance training products are rarely seen in the domestic or foreign markets. Even though, it is necessary to train the balance ability of old people and children. Especially

nowadays children lack of outdoor activities; thus, averagely their balance is poor. And lacking of balance brings the results like easily falling down, poor body coordination and reaction. In view of these phenomenon, the future of balance training products shall put unique, innovative and creative ideas into the design concepts. Moreover, the important researches and studies related to balance training shall be materialized in the sports and leisure industry. Plus the entertainment technology in the daily life, the balance training products can combine interactive electronic monitoring device and finger-touch screen so as to increase entertaining features into the fitness equipment. Not only can balance products be one of the important index of domestic sporting goods but also they can help the development of the related fitness industry. More importantly, the applications of body balance products and Taiwan's related industry can be elevated.

Analysis on balance training equipment

In terms of marketing competition, American high-end products and China's low-priced products impose certain threats to Taiwan's fitness industry. The competitiveness of Taiwan's fitness equipment industry will have to rely on related researches and technologies so as to increase product quality and values. The domestic advantages include steel pipes, plastic accessories, and electronic hardware and other resourceful components. Plus mature technology, and efficient order and delivery, Taiwan is highly capable to develop balance training products. Besides, Taiwan's manufacturers are flexible and responsive to the changing markets. Therefore, they do have high competitiveness in the future. Now the balance equipment is classified as followed:

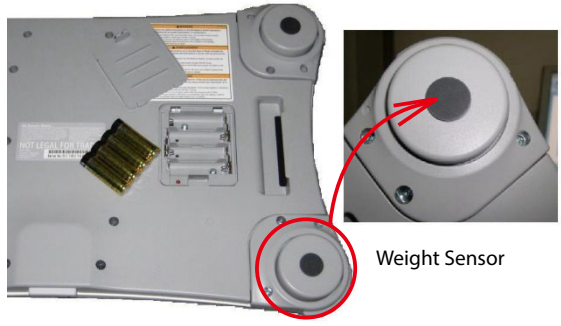
The balance training equipment are diverse. According to the power-driven types, they could be divided into the passive type and the user-and-equipment interactive type as followed:

1. The passive-type equipment: the equipment has no power design. It depends on the user to move body to stabilize the equipment. The advantages are small sizes, low cost, simple structure and easy designs. This type equipment is often the training products to stimulate children's vestibular of the big brain. However, the training is over simplified and monotonous. In the long run, the user lost pleasure and in the end, it'll be placed in the storage.
2. User-and-equipment interactive type:

   The equipment is in combination with the interface screen to provide balance training with regard to vision, vestibular, and proprioception balance systems, plus digital entertaining interface to stimulate higher usage. Indeed, this is a whole new design which overturns the traditional fitness concept particularly for office workers. The user-and-equipment interactive balance equipment provide rare chances which common fitness clubs do not provide. Most of the fitness clubs are mainly equipped with cardiovascular and weight training equipment. Interactive balance training equipment offers interactive games so that users can play games and simultaneously make body parts do various levels of exercise.

Comparison of Balance Training Equipment

Product	Picture	Type of Power	Required movements	Inclination Angle
Interactive Balance Training Equipment		User-and-equipment interactive type	The equipment is in combination with the entertainment interface. The user can slide back and forth as well as swing left and right	No inclination
Dancing and Stepper Equipment		Passive Type	Twisting the waist so as to reach the effects of turning	No inclination
Swing Stepper Equipment		Passive Type	Step up and down and twist the waist	No inclination
Surfing Stepper Balance Equipment		Passive Type	Step up and down and twist the waist	No inclination
Wii Fit		User-and-equipment Type	The equipment combines with entertainment interface, messages are sent by the sensor	Weight sensor



Weight Sensor

At present, the most influential product on the market is Wii. It provides many ways of playing. One way is to take balance training with Wii Fit which functions with Balance Board. The design concept comes from the rectangle-shaped weight scale. Its length and width are the averages of people's feet length and shoulders' width. Unless the player has unique figure, the size of the balance board can fit most of the people usually. The four corners of the balance board are installed with weight sensors. When the player stand on the balance board, Wii Fit can inspect the player's body weight center and then control the game's directions. This product sells very well. Many people like to play Wii Fit. Nevertheless, it's still a game. The way of balance shall change with body weight center. Strictly speaking, it cannot effectively improve feet muscles and balance control.

E. Balance training equipment will be the major demands and development among fitness products

In face of the current market demands and the approaching global aging population era, to bring high technology into the sports and leisure industry shall be the major targets of researches and brighten the future of the sports and leisure industry. In the future, it is necessary to lead the developing cloud technology into the products and establish the mass production of overall leisure sporting goods. New products' R&D shall step towards to these four directions: sports, health, novel, and innovative and further develop comfortable, safe and human-centered sporting goods. In addition, the futuristic products shall be suitable for all ages. Moreover, the usage scope shall be also broaden and the functions shall be variable.

Before developing training products, it is necessary to better know the impacts of balance training upon human body and further give analysis. With regard to balancing time, the shaking range of body weight center, control center position, the ability to control left and right feet, the body-inclination angles, as well as the controlling reaction time of visual interference, etc., all these factors shall be taken into considerations of the product design concepts. At present, it is known that most of the domestic and international patented products are in need of high cost and a great number of original cases; they still cannot effectively reach the physical and mental consensus. The design of balance products aims to strengthen nerve reflex and

the coordination of body limbs. It shall be a new-typed indoor sports equipment which is suitable for all ages. Besides, the small size of the equipment can be placed at any places. Users can easily achieve the sports effects and boost the blood circulation. The product will be in need of the least parts and achieve the best sports effects. Thus the basic design conditions of balance training equipment is described as followed:

1. The design focuses on the least parts and achieve multiple ways of sports capability so as to reach the target of low-material cost.
2. The design shall be interactive; that is, for the user to interact with the equipment. Besides, the equipment could make users do different body angles so that they can do physical therapy on their own and strengthen their health conditions.
3. The design shall be strong enough to support those who has poor balance ability. Thus, the height shall be as low as possible and the system shall be as stable as possible.
4. The stepping plate is movable with changing weight centers of the user and increase the features of reality as well as challenges.
5. The design shall provide safety and comfort with simple structure, light material; meanwhile, it has efficient mechanical strength.

From the above-mentioned design concepts, they are different from traditional sporting goods. The balance training products are in combination with interactive games. Users can received the images from their visual nerve system and then pass to vestibular system of the big brain. Furthermore, these products can train and improve the coordination between nervous systems and body's feelings; one more step is to train the whole body's balance. The whole-body balance training could be complete. For the young users, balance product could be entertaining so that they will continue doing sports and even increase sports activities. For the seniors, the training should focus on their lower body/limbs so as to enhance their balance coordination. The training will bring great benefits to prevent them from falling. In conclusion, Proper increasing sports provides the seniors great benefits such as prevention from dementia and enhancement of balance. Besides, because environmentalism has been on the rise, not only does green technology but also green consumption become a momentum of economic development. And viewing such a global trend, it is also an important factor for R&D to develop solutions and make contributions to the sporting goods industry, that is, to develop balance training equipment with interactive electronic controlling system. There shall be a breakthrough that balance training equipment will be installed with an innovative and interactive platform for the user which is different from other fitness equipment with PC interface operation system. Consumers can easily and continuously update information via the internet. There shall be innovative thoughts and create the clouds technology industry. As predicted, this balance training equipment will be a great potential for the sporting goods industry.

F. Conclusion

Based on the researches on the importance of balance training, the relevant equipment could be designed with games software. Starting from improving quality and integrating development, the balance-training related organization

and electronic module shall be upgraded and integrated with video sound system as well as interactive controlling system and other technologies. Focus on the demands of the user, ergonomics, security design and son on, all these shall be re-evaluated and designed. Thus, new balance training equipment could distinguish itself from others at the market. If so, there shall be promising future at the market. More importantly, in the aging global population, this new product will be much welcome and favored by the sliver-hair people.

Taking balance training course is a necessary credit for all people. The future development, no matter at the schools, hospital, nursing houses or homes, will be much broader. The demands and usage will be increased and become much popular. And this shall be a good news for seniors. And the competitive advantages of balance training equipment are listed in the following:

To increase entertainment with interactive interface

To design an innovative structure as so to achieve the effect of balance training

To install high-end embedded system so as to replace high-cost PC system

To install multimedia system so as to reach training effects: better connection between sight and vestibular balance system

References

- Pou-Ling Dong, With Regard to Balance Training from Sitting to Standing, Its Medical Effects on Balance Performances of the Patients Suffering from Strokes.
- Health China Times, http://health.chinatimes.com/contents.aspx?cid=1,13&id=2854
- Health Hotline, http://tw.myblog.yahoo.com/mygymtw/article?mid=284
- Bao-Huei Huang, Researches on Taiwan's Fitness Industry, Its Core Competitiveness and Competitive Strategies.
- Gin-Yu Lee, Control System and Design of Balance Training Platform.
- Wei-Siou Lin, Guan-Lun Lin, Zong-Li Zeng, Jhih-Yuan Lin and Jyun-Yan Li, Comparison of Balance Control Ability between Healthy People and Aged Seniors.

If there's any question or interest in cooperation, welcome to contact Footwear and Recreation Technology Research Institute

TEL: 886+4+2359-0112 ext. 652

Contact Person: Mr. Liu

Email: 0481@bestmotion.com