Research Journal of Physical Education Sciences ____
Vol. **1(1),** 13-20, March **(2013)** *Res. J. Physical Education Sci.*

Spaces for Sport Performances – A Systematic Approach

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Available online at: www.isca.in
Received 24th October 2012, revised 29th January 2013, accepted 5th February 2013

Abstract

This paper is devoted to spaces utilised in competitive sport and sport for all. Extra-mural sport spaces were taken into account. Several sporting disciplines need their own spaces, while others can use multi-sport spaces. There are spaces for ground sports (on the ground and under the ground), water sports (on and below the water surface) utilising water spaces (aquains), air sports utilising low and high air spaces (airains), and cosmic spaces (sub-cosmic and on the Earth orbit), especially at the space stations where astronauts train in order to have fit bodies. Almost every sport space is improved by engineering input.

Keywords: Sport, space, ground, water, air, cosmos.

Introduction

Since ancient times, non-military and non-labour competition between humans (also animals) has existed. Since the 19th century modern sport has appeared. Liponski[1] gathered information on eight thousand sports practiced all over the world, and published data on three thousand sports. Therefore, it can be stated that there are about 10 thousand sports across the world, and every sport needs a specific arena for competition. These arenas are situated on land surfaces with the possible use of the space above or below it, water surfaces with the possible use of the space below it, air spaces, and cosmic spaces.

Sport spaces take into account terrain arenas covered with earth, snow[2] or ice[3] and turf, both natural and artificial[4], water arenas for boat competitions and recreation (sport for all)[5] and air arenas for throwing competitions and games[6,7]. Today there are tens of different surfaces and spaces. Several sporting disciplines need their own spaces, e.g. water jumping, table tennis, speedway. Some others can use multi-sport spaces, e.g. javelin, discus, and hammer throwers use stadium fields and athletic runners use the same stadium tracks for different distances.

In many cases, natural resources are utilised; these can be unanimated, e.g. sand and stone, or animated, e.g. grass and moss. In other situations, especially in modern times, engineering constructions are needed, e.g. paved roads, artificial surfaces laid on tracks, wooden surfaces.

Sport spaces are utilised for training purposes and for competitions. There are also sport spaces utilised for reasons other than sport, e.g. entertainment, politics, religious services, etc. For these purposes especially, open stadiums are used where tens of thousands of participants can be gathered at the same time.

The aim of this paper is to show in a systematic way the different kinds of spaces that are utilised in sport, considering both sport for all and competitive sport (figure 1). Here, only extra-mural sport spaces were taken into account. The examples will be provided from many countries across the world.

Sport Spaces

Terrains: On the ground: Several sports are carried out on a plain, level or almost level terrain, e.g. race walking, long distance running, cross-country running and skiing, and road rallies (figure 2 A). Other sports take place in the mountains, which are very steep in some cases (figure 2 B). Since alpine skiers move at a very high velocity, i.e. 100 – 150 km/h (25 – 40 m/s) during downhill running and during record speed running they move over 240 km/h (over 60 m/s), special safety measures must be taken. There are painted markings on a course (figure 3 A), soft barriers near obstacles (Figure 3 B), and safety nets alongside a course in order to catch skiers if they run off the course (figure 3 C).

There are short sporting arenas, e.g. for shot-put in athletics (figure 4 A), long (e.g. in long distance running and walking – Figure 4 B), very long courses, like those used for bicycle tours, automobile rallies, or around the globe courses, like in ocean sailing.

There are sporting arenas that cover just a few square metres (e.g. in table tennis – figure 5 A), and those that use thousands of square metres, like in soccer (figure 5 B), cricket, American football, baseball, hockey, ice-hockey and other field games. There are also arenas that cover many square kilometres, e.g. orienteering, cross-country horse riding and other animal riding.

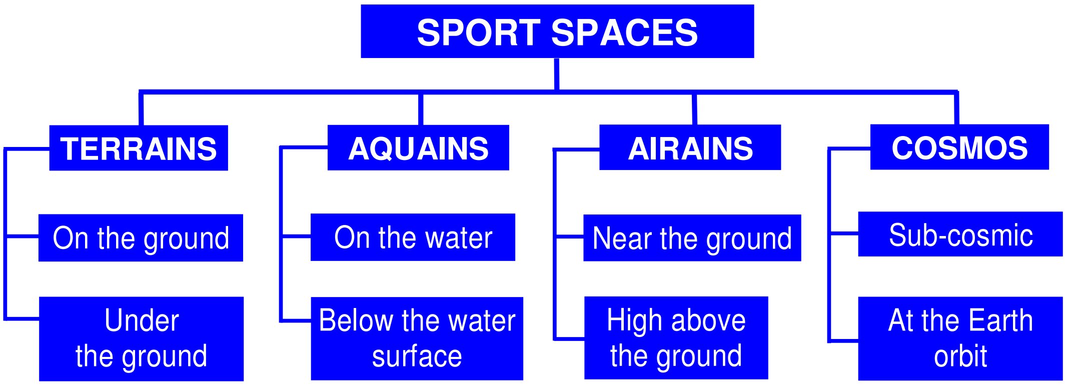


Figure-1
Systematic approach to spaces utilized in many sport disciplines[8]

A **B**

Figure-2
Examples of flat and mountainous sport arenas [photo: author]: A – bicycle riding of disabled sportspersons at marathon distance (Berlin, Germany, EU); B – alpine skiing, downhill – view of the final steep fragment of the distance (Val Gardena, Italy, EU).

A **B** **C**

Figure-3
Safety precautions in alpine skiing [photo: author]: A – paint markings of the course (Garmisch-Partenkirchen, Germany, EU); B – soft barrier near rock danger obstacle (Val Gardena, Italy, EU); C – up to three rows of nets at the side of a course (Val Gardena, Italy, EU)

A

B

Figure-4
Examples of short and long sport arenas: A – 30 m shot put field (Gdansk, Poland, EU) [photo: author]; B – 2 km of streets for race walking of 20 and 50 km (Olympic Games 2004, Athens, Greece, EU) [Photo courtesy: Lipinska]

A

B

Figure-5
Examples of small and large area of surface of sport arena [photo: author]: A – table tennis (Gdansk, Poland, EU); B – soccer pitch (Filho Stadium, Maracana, Rio de Janeiro, RJ, Brazil)

For some sports, large terrains are specially prepared. For example, mountain slopes are sometimes remodelled with the help of a bulldozer. In contrast, golf courses are flattened in some places.

Some sports use terrain with natural cover. Cross-country runners run and cyclists ride on earth, grass and stones. Some people run on beach sand and some cars and motorbikes ride on desert sand. Golfers use grass land. Winter skiers run on a terrain covered with snow, while summer roller skiers and skaters run/ride on a terrain covered with artificial grass and cement or asphalt concrete.

Under the ground: Underground exploration is as old as human beings. Caves were settlements for animals and the first humans. Later on, especially in the 19th and 20th centuries, sportspeople started to go further and deeper to establish new records of cavern exploration, to establish cavern systems, and to describe cavern features. In order to make exploration more efficient, people engaged in cave exploration became acquainted with chemistry, hydrology, and earth mechanics.

Sporting activities underground deal with: 1) practicing sport disciplines, which can be found at first at the ground level; and 2) an activity called speleology, which is aimed at going as far as possible or as deep as possible through caves, tunnels and water basins, in order to explore new underground spaces[9]. Caves can be very long, sometimes more than 600 km (Mammoth Cave, Kentucky, USA) and very deep, often more than 2 km (Voronya Cave, Georgia)[10].

In a Polish salt mine in Wieliczka (near Krakow) there are sport arenas where sportspeople can play tennis and futsal (five-aside football), can run long distances, and practice windsurfing. There have also been boxing galas and dancing competitions. Breathing in a salt atmosphere is healthy, and there are also rehabilitation areas with beds for patients.

Aquains

On the water: There are several sporting disciplines that utilise water spaces (aquains), both unfrozen and frozen, as well as both flat and with wild water. There are sports practiced on inland waters and those in open (sea, ocean) waters.

Open water swimming takes place on lakes, bays, and straits. The length of the water distance is up to tens of kilometres. For example, the width of the English Channel (La Manche) at its narrowest point (the Strait of Dover/Pas de Calais) is 33.8 km. Swimmers from several countries swim this Strait through the whole day, sometimes battling high waves, whilst accompanied by a team in boats[11].

The first utilisation of water surfaces with special equipment started with tree trunks on rivers, in addition to the use of primitive paddles and, later, primitive sails; this was also seen on the lakes and sea surfaces near the coast with kayaks in Greenland and Eskimo regions in the farthest parts of the Northern Hemisphere. The next step was utilising the mechanical idea of a lever, at which point rowing boats appeared. They were originally for one or a few persons, but eventually they grew to become huge ships using tens of rowers on both sides of a ship – on the Nile and on the high seas. These rowing boats were very efficient in transporting people and goods, so they were built all over the world. Even more efficient were sailing boats (yachts), which are dependent on wind. They are utilised on small lakes, rivers, and seas up to global circumnavigation. Together with the introduction of engines for land transport, they were also utilised for flat water vehicles – boats, yachts and ships.

For the proper organisation of regattas, special courses were built. For rowing distances of 2000 m, such a course is about 200 m longer (hence being about 2200 m long) in order to have an additional distance for braking movements. There is also a part of the aquain where boats are put on the water from platforms by competition crews. Then, there is also an additional fragment of the aquain, parallel to the main course, where crews go to the starting point (Figure 6).

If large water areas have to be used for training and competitions, they have to be checked beforehand from the point of view of security. Sport organisers have to check the depth of the water space, currents, temperature and the winds acting over the aquain. If an aquain has to be prepared for long distance swimmers, it should be checked for the presence of dangerous live species. For both swimmers and water vehicles, an aquain has to be checked for the presence of wrecked vehicles, poles positioned in the water, nets, lines and other objects.

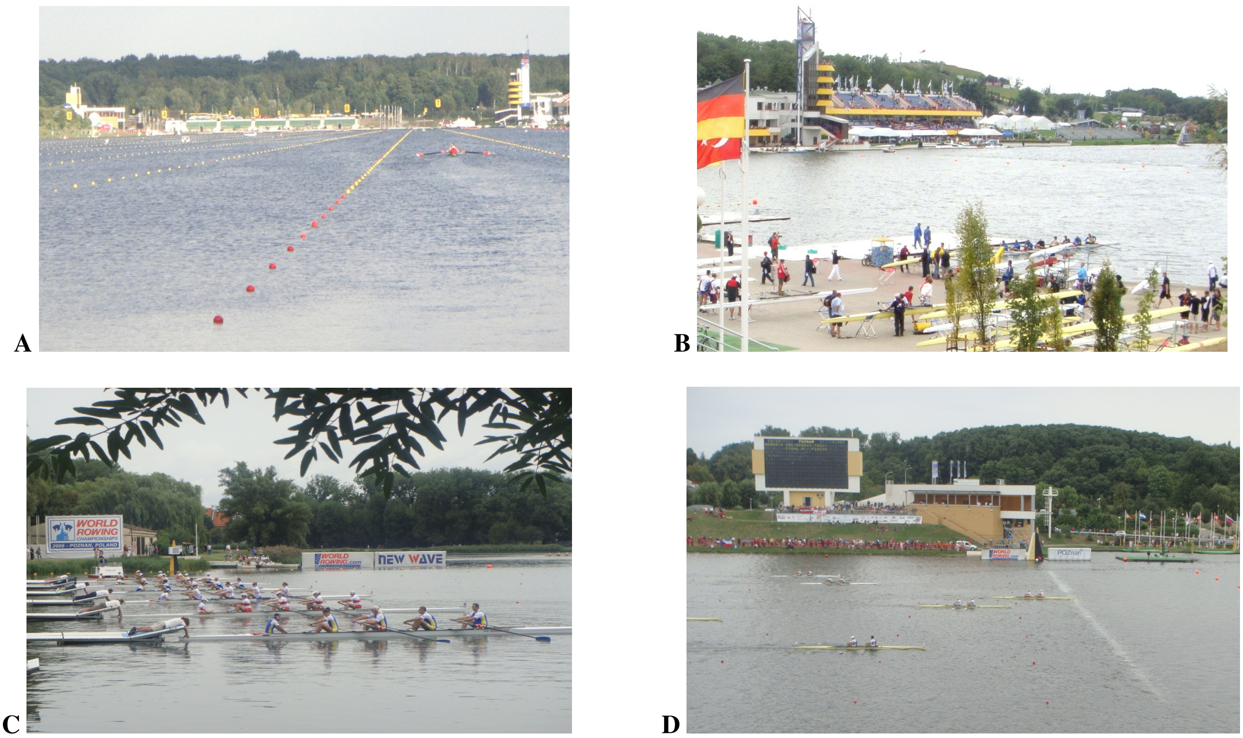


Figure-6

Facilities on a flat water for rowing regattas (World Championships, Poznan, Poland, EU, 2008) [photo: author]: A – general view of 2000 m course with buoys for dividing of tracks, B – at the foreground are boat stands and water platforms, at the background are deceleration part of a course and spectators' stands; C – start part of the course; D – finish line of the course with bubbles released from the tube with holes laid down on the lake's floor

Aquains have to be prepared according to discipline rules. Buoys must always be deployed on the water in order to show water tracks, or to show dangerous locations. Engineering projects are sometimes deployed by the waterside.

Below the water surface: Some swimmers use a water space just below water surface in order to show how far they can swim underwater without breathing. Some swimmers can swim more than 100 m for one or more minutes.

Other swimmers may swim or dive (skin diving) just below the water surface using a special tube called a snorkel. This is fitted to a swimmer's mask and permits ventilation while having its open end just above the water surface. Such swimmers can use also flippers, or foot fins. A wet suit or dry suit may be used in cold waters or in the presence of unwanted water animals (Figure 7 A). Skin diving was popularised in the 1920s and 1930s in the Mediterranean and off the coast of California [11].

Deep water (underwater) swimming began with pearl and sponge gatherers. Those individuals were able to swim underwater for a few minutes without ventilation. Unfortunately, if they dive in succession many times (up to 50 m and up to 100 m a day) without sufficient intervals (up to few minutes) they can suffer from decompression sickness (taravana syndrome). The sport of scuba (self-contained underwater breathing apparatus, or Aqua-Lung – figure 7 B) started in 1943 when Frenchmen Cousteau and Gagnan developed the first fully automatic compressed air Aqua-Lung[11]. Today, scuba diving is very popular in many sporting and recreation places (figure 7 C).

Airains

Low airains: Knowledge on low airspaces (near the ground) is important for sailing, ski jumping, all track and field events and also for open-air shooting. It is important to check air streams, their direction, velocity, and pressure, as they might influence sporting accomplishments.

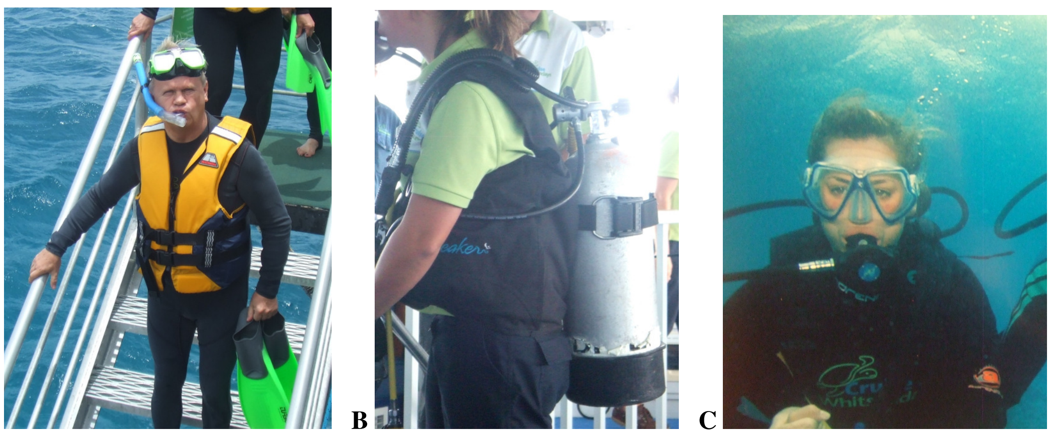
Data on wind are the most important for sailing. Competitors choose the direction of sailing according to the direction and velocity of the wind. They use proper sails to achieve proper sailing areas, e.g. if the wind is from the stern they use spinnaker (despite other sails).

During athletic running events, in order to acknowledge a record, the velocity of the wind should not exceed a value of 2.0 m/s if the wind blows in the same direction as the running event. This takes into account sprint dash runs 60–200 m, 100 m (for women) and 110 m (for men) hurdle events, long jump and triple jump (figure 8). Also, competitors for vertical (high and pole vault) jumps and throwers (discus, javelin and hammer) take into account the direction and velocity of the wind.

In ski jumping, the velocity and direction of the wind is transferred to the points system, with points being added or subtracted from the points obtained for the length and style of a jump (figure 9).

In open-air shooting, air has a significant influence on target shooting. Since shooting is performed with great accuracy, every wind change can displace the arrow or bullet. Therefore, aiming equipment needs to take into account air movement.

High airains: For sports using airplanes, gliders, moto-gliders, balloons, kites and parachutes, one has to take into account high above the ground air spaces (high airains). These airains should be free of obstacles – natural and technical, both stationary and moving. Natural obstacles are: mountains, high trees, storms, tornados, and night time. Technical obstacles are: high buildings, chimneys, bridges, electricity masts and cables, radio masts and antennas, cable cabin routes and others.



A B C

Figure-7

Underwater swimming (Great Reef Barrier off the Australian coast) [photo: author]: A – a swimmer prepared for snorkeling; B – a container with compressed air on the back of scuba diver; C – scuba diver in deep water.

A B C


Figure-8
Tachometer measures velocity of the wind near the ground surface – about 1.5 m above the ground (Gdansk, Poland, EU) [photo: author]: A –general view; B – steering / reading panel; C – reading stand for spectators.

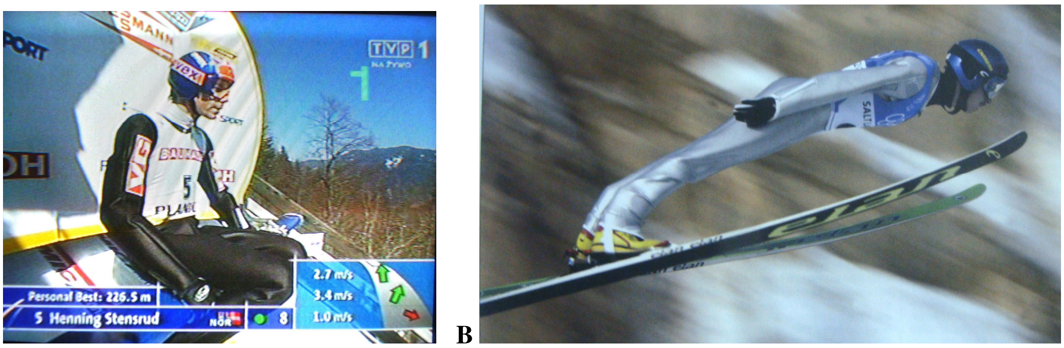
A B


Figure-9
Ski jumping – a sport discipline depending mostly on air condition: A – speed and direction of the wind is shown below at the right hand corner [photo courtesy: TVP[12]]; B – a ski jumper should be like a javelin in forward direction and like a parachute in downward direction [photo courtesy: Liponski[1]]

Airains used by air vehicles (aircrafts) are not unbounded. Air corridors exist for commercial (passenger and cargo), Air Force, medical, agricultural, and sport airplanes. Air traffic controllers maintain air routes and their security (figure 10 A).

Organisers of many sporting events include air shows in order to provide attractions for spectators. In this case, they need to coordinate the use of air routes with air traffic controllers (Figure 10 B and 10 C). There are several specific weather conditions that prevent the use of airains for sporting purposes – strong wind (movement of air masses), usually due to the difference of air pressure in the vicinity of air routes, fog, strong precipitation and darkness. Turbulence of the air can also cause difficulties with operating air vehicles.

Cosmos

Sub-cosmos: The composition of the atmosphere, as measured by its mean density (the average mass per unit volume), is more or less constant with height to altitudes of about 100 km. Very high altitudes of the atmosphere are used as sub-cosmos spaces. It is agreed that all below 100 km is the sub-cosmos space (homosphere) and that above this is the cosmos sphere (heterosphere). Air atmosphere is still spotted thousands km above the Earth, although with very small density[11].

High altitude of the homosphere (above 10 km) is used by airplanes in order to experience small air resistance. One such airplane circumnavigated the globe without landing. The area several kilometres above the Earth surface is also used by balloons. After several attempts, a balloon crew also circumnavigated the globe without landing. Another balloon achievement was that accomplished by Austrian explorer Baumgartner; he jumped from a balloon at the height of 39 km with his parachute (he opened the parachute at much lower altitude) and landed safely (figure 11 A).

High altitude is used by people trained as astronauts. They fly in an airplane through the trajectory of parabola-shape (Kepler's trajectory). At the top curved fragment of the trajectory, centrifugal force equals gravity force and, for about 30 seconds, passengers of the plane are in a state of weightlessness. This is repeated several times and is good training for future cosmos flights (figure 11 B).

There are also private enterprises exploring borders of sub-cosmic and cosmic spaces (100 km). For now, their goal is to begin tourist flights (figure 11 C), but in the future, sports-like events could also be possible.

Figure-10

Utilizing of an air by air vehicles [photo: author]: A – airplane tows a glider (Leszno, Poland, EU); B – airship used at the occasion of a sport event (Garmisch-Partenkirchen, Germany, EU); C – airplane during air show at the occasion of a sport event (Kranjska Gora, Slovenia, EU)

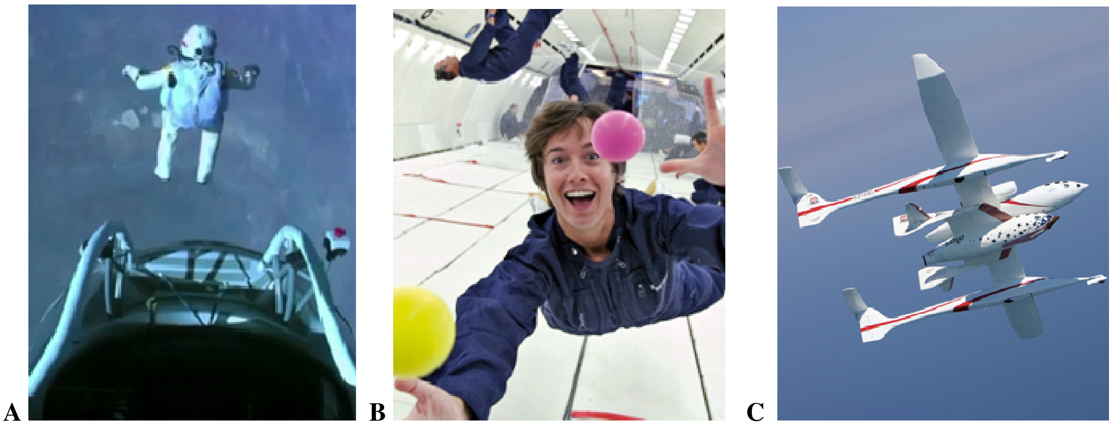


Figure-11

Sub-cosmos travels: A – a parachute jumper from Austria (UE) jumped from the balloon [photo courtesy: space.com[13]]; B – airplane passenger during exercise at the state of weightlessness flying parabola-like trajectory [photo courtesy: airzerog[14]]; C – private enterprise airplane SpaceShipTwo for sub-cosmos flights [photo courtesy: s1.aecdn[15]]

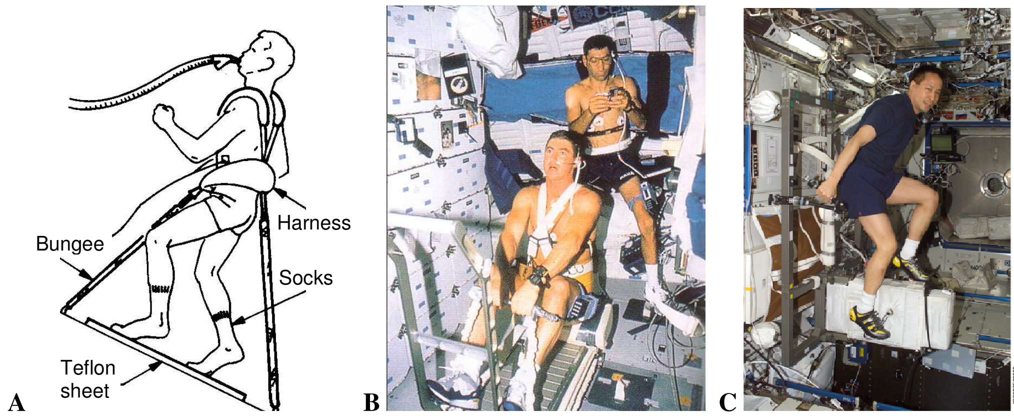


Figure-12

Cosmic space; astronauts during training at a space station (ca. 400 km above the Earth) [courtesy: NASA]: A – on a sheet of teflon with harness (1970s)[16]; B – on a rowing ergometer (1990s)[17]; C – on a bicycle ergometer (2003)[18].

At the Earth orbit: The space situated beyond the Earth is vast and endless. For contemporary humans, only the space closest to our planet and that of the Moon, and perhaps additionally on Mars, might be considered usable. The most important characteristics of outer space are the lack of air, weightlessness, and the enormous difference in temperature of the space opened to sunshine and that in the shadow (during cosmic circumnavigation of Earth or other planets). Unfortunately, this space is also a place of cosmic rays, planetoids, meteors, and cosmic trash of anthropogenic origin, all of which are very dangerous to humans. Space vehicles and space stations are protected against those hazards, but in some cases this protection does not work.

Astronauts who are at a space station are specially prepared for overloading during rocket take-off and then for the state of weightlessness. In order to overcome hypodynamic and hypokinetic situations during their stay at the space station, every astronaut is obliged to exercise for at least two hours per day – figure 12.

Conclusion

At the beginning of sports development, sporting spaces were natural grounds and waters. Later on, man-made facilities appeared where sportspersons could achieve better results or have better, safer environments. This took into account e.g. swimming pools, ice rinks, and bicycle arenas. Also, new sporting disciplines were utilising those facilities, e.g. all roller sports utilise flat or almost flat, even grounds covered with man-made or artificial surfaces (wood, cement or asphalt concrete).

It should be noted that there is a high presence of engineering ideas, designs, constructions, and maintenance in many sporting disciplines. Today, there are no sports that do not use the help of engineers and technicians. This takes into account products for the body, movable and immovable products, IT and other products[8]. Also, almost all spaces devoted to sports have some input of engineering. This takes into account especially problems of safety and comfort for sportspersons, accuracy of refereeing, and better possibilities for media coverage.

Sportspeople are involved in incidents and accidents. There are many injuries and even deaths, where the causes are improper preparation of the sporting arenas. Better knowledge of sport spaces would allow safer approaches to sporting activities and the better preparation of terrains, aquains, airains, and cosmic spaces.

Sport spaces should be properly prepared, not only for those directly involved in the sporting activity, but also for those indirectly involved, i.e. spectators, journalists, servicemen. Unfortunately, sometimes there are too many emotions met during sporting spectacles. Representatives of spectators who belong to opposing teams are attacked by home spectators, or vice versa, and they want to run out from the stands. Designers of sports facilities should foresee these situations, and ensure that adequate emergency exits exist. After several bad experiences, it is well known that fences between stand sections should be removed.

A systematic approach to sport spaces would allow teachers to present these didactic problems in a better way. Students of sports sciences would learn better if presentations of the problem are given in a systematic way with many illustrated examples.

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