LAMPIRAN

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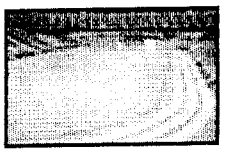
Training Facilities

Wall Aquatic Center

The Wall Aquatic Center is widely recognized as one of the finest altitude-base swimming facilities anywhere in the world. The aquatic center houses an Olymp size pool complete with eight 50-meter lanes, two 1-meter and two 3-meter divi boards, underwater viewing and filming windows, and state-of-the-art aquatics technology. The pool also features a modular bulkhead designed to effectively divide the pool into a 25-yard, 25-meter, and 50-meter facility all at one time. Swimming remains the single most popular sport at HASTC with national teams from Canada, Germany, the Netherlands, Italy, Jap Great Britain and many more utilizing the pool on a regular basis. Teams interested in exclusive lane encouraged to book lanes far in advance of desired training camp dates as our pool's capacity is limi and the demand continually high.

Facility Fee: $14.00 per lane per hour for exclusive lanes (Fees subject to change without notice)

Walkup Skydome



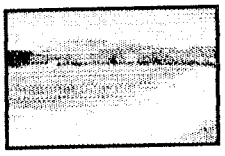
The Walkup Skydome, the second-largest clear-span timber dome in the world, major multi-purpose facility at HASTC. In addition to being the home of NAU's football, basketball and indoor track and field programs, athletes visiting HAST can utilize the Skydome for a wide variety of training objectives. New to the Skydome is a six-lane, 300-meter Mondo-surface track in 14, 10 and 6-millimet sizes. The track consists of a non-banked loop (with eight sprinting lanes) mad 14-millimeter Mondo Super X, the latest and most highly regarded surface in the world for competition. (It is the same surface that w used for the 2000 Summer Olympic Games in Sydney, Australia). The infield is a 10-milimeter surfac containing enough area for six NCAA-standard basketball and volleyball courts, as well as two regula tennis courts. Track and Field specific, the facility now has 12-month training capabilities. When cove for American football with artificial turf, the Skydome supports a practice pole vault pit and a long/tripl jump runway, as well as a lane for sprinting and hurdles. When the turf is up, the facility can be used intramural and camp sports, and has enough room for a varsity soccer practice.

Facility Fee: Dependent on sport, time of year, and requested usage

In addition to the above, the 15,000-person capacity Skydome also contains a Weightlifting Federation Regional Training Center for Olympic weightlifting. Fo more power and speed-oriented strength and conditioning, this Olympic Weightlifting Center has everything that you would expect from a world-class weightlifting facility. This weight room is entirely Olympic weightlifting-based an features a diverse complement of strength training equipment, along with the capacity to carry out advanced plyometric and speed conditioning drills. Some of the notable features of this weight room include 11 Training Platforms, Hardwood Lifting Surfaces, Eleiko and Uesaka bumpers and bars, Stop-Frame V for Lifting Analysis, Vertec Vertical Jump Analyzers, Glute-Ham Benches, 24 Squat Racks and much more.

Facility Fee: $5.00 per athlete per day (Fees subject to change without notice)

Lumberjack Stadium



Historic Lumberjack Stadium is home to our outdoor eight-lane 400-meter track world-class polyurethane all-weather track, perfect for year-round training in Flagstaff's ideal climate. This track facility also features long jump, high jump, tr jump, and pole vault runways and pits as well as a gravel-covered area for shot (hammer throw facilities are available at a nearby field). Lumberjack Stadium al contains the primary soccer training field at NAU, measuring approximately 98 meters x 60 meters. It is regulation size for NCAA soccer in the United States and provides an excellent training venue for international or domestic national teams.

Facility Fee: Dependent on sport, time of year, and requested usage

Recreation Center

Most teams and athletes, especially those whose primary sport is endurance-oriented, utilize the Recreation Center for their strength and conditioning needs This facility's fitness center is equipped with the latest in strength and condition equipment, including two full lines of variable resistance machines, numerous l presses and hip sleds, two cable cross-overs, two squat racks (all by Cybex) ar dumbbells from three pounds to 75 pounds. There are also a wide variety of ae machines, racquetball and squash courts, multi-purpose courts, and full locker rooms with showers and sauna.

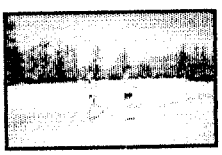
Facility Fees: $5.00 per athlete per day (Fees subject to change without notice)

Rolle Activity Center

Our Rolle Activity Center offers basketball courts, volleyball courts, and wrestling areas.

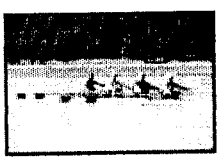
Facility Fee: Dependent on sport, time of year, and requested usage

Other Training Areas



Many distance runners training in Flagstaff make use of a wide variety of area training trails and roadway systems including: the Flagstaff Urban Trails Systen city trail network that currently offers over 20 miles / 32 kilometers of dirt runnin and biking trails around Flagstaff with 65 miles / 105 more kilometers planned f the near future), a vast amount of additional U.S. Forest Service Trails (90 mile 145 kilometers) at a wide variety of elevations, and numerous easily accessible Forest Service roads.
Maps of these various trail and road systems are available through the HASTC office.

Road cycling rides in the Flagstaff area are readily accessible, involving beautif and challenging riding. Many rides, from the Mormon Lake Loop (102 kilometers the Flintstone Loop (190 kilometers) are continuous in elevation, offering long ri at consistent altitudes of 2,130 to 2,430 meters. Others, like the Snowbowl Roa ride (55 kilometers), are shorter and more varied, presenting opportunities to experience elevation gains from 2,130 to 2,900 meters. Other lower elevation ri are also easily accessible in areas like Sedona, a mere 40 minutes away by automobile at an average elevation of 1 meters.



Flagstaff's Lake Mary has proven to be an ideal training site for rowers, and se as a regular training site for Olympic rowing teams from such countries as Norw Russia, Lithuania, and the United States. The long, narrow layout of the lake sa rowers and kayakers from having to row short courses with frequent rotations, a the passage is shielded from harsh elements by the surrounding dense pine for The lake is also an excellent site for open water swimming and is used every ye as the swimming site for the Mountain Man Series, Arizona's renowned series of triathlons.

http://www.tjced.org/PDF%20files/wherechildrenlearn.pdfDOES

T MATTER WHERE OUR CHILDREN LEARN?

Daniel L. Duke
Professor of Educational Leadership and
)irector of .he Thomas Jefferson Center for Educational Des.gn
Jniversity of Virginia 1998

Size and Capacity

he preceding paragraph introduced the issues of school size and capacity, aspects of PLEs that are attracting onsiderable attention in rapidly growing parts of the United States as well as localities where budget problems have ompelled educators to increase school and class sizes. The issue of size turns out to be multi-dimensional and omplex. Size, for instance, can refer to square footage as well as number of students. The focus of attention may be chool size or classroom size. Actual size, in terms of either square footage or enrollment, may differ from perceived ze. Most research related to size has concentrated on student enrollment rather than square footage. Interestingly, chool enrollment and class enrollment, while obviously dependent to some extent on the physical capacity of the pace (square footage), are not closely related to each other (Jones, 1995, p.83). Schools with relatively large umbers of students often are better able to offer small classes than small schools, which, because of staffing mitations, may be compelled to operate large classes. 15 A recent investigation of school size and student chievement found a curvilinear relationship between the two (Lee and Smith, 1997).
he researchers examined student performance in reading and mathematics using data from the National ducational Longitudinal Study of 1988. They found that student achievement over the high school years was lated to school size, with the ideal high school ranging form 600 to 900 students. Students tended to learn less in naller schools and considerably less in larger schools. The adverse effects of size were particularly great for poor id minority students. The greatest negative effects of school size were found in high schools enrolling more than 100 students. The discovery of an optimal size for high schools does not explain how size affects student learning. ne need exists for research in the tradition of Barker and Gump's classic Big School, Small School (1964), which mpared the experiences of being a student in a sample of large and small high schools in the Midwest. Do xtremely small schools lack sufficient opportunities for student participation in enriching activities and specialty asses?
o extremely large high schools foster feelings of anonymity and lead to greater instances of disruption? One of the rgest studies ever conducted of American adolescents recently found that the strongest school-based correlate of althy adolescent behavior was close relationships with teachers (Resnick, et.al., 1997).
oes the formation of such relationships become more difficult in very large high schools? In a recent review of 103 udies of the relationship of school size to various aspects of schooling,
otton (1996) found that in small schools academic achievement was at least comparable to—and often better, an—that of large schools. In addition,
tudent views of school life in general and toward particular subjects were more positive.
tudent behavior—including truancy, discipline problems, violence, theft, substance abuse, and gang rticipation—was more positive. 16
evels of extra-curricular participation were higher, and students described their involvement as more fulfilling.
ttendance was better and drop-out rates were lower
elationships among students, teachers, and administrators were more positive.
tudents performed as well as those from large schools in such areas as college board scores, grade point averages, d college completion rates.

ne set of issues concerns the overall design of a school and the extent to which the configuration of separate rning spaces contributes to its mission and supports its organizational philosophy. One elementary school, for ample, may be organized around departmentalized classes for the intermediate grades, while another elementary hool may embrace the notion of family-style organization, where students of varying ages remain within the same ster of classrooms for the duration of their primary and intermediate instruction.
. the secondary level, some schools adopt team-based or interdisciplinary approaches in order to facilitate more tegrated learning experiences. Schools designed to segregate different disciplines by department might be ill-ited to this purpose. As more PLEs are designed to advance particular missions, post-occupancy evaluations, vironmental assessments, and 19 comparative case studies will be needed to determine whether particular designs e more effective than others.

second set of issues concerns the purposes and designs of individual classrooms. The curriculum, intended rning outcomes, teaching methods, and resources of the reading teacher are not identical to those of the algebra acher or the Spanish teacher.

Yet each is compelled in many schools to work in the same type of space. Years ago only teachers of music, physical education, vocational education, home economics, and laboratory sciences were likely to be assigned to specially designed classrooms at the secondary level. As foreign language and mathematics teachers shift their instructional focus to "laboratory" activities and teachers of other subjects differentiate their approaches to accommodate new instructional methods and technology, the traditional one-size-fits-all classroom is becoming obsolete.

Desks for individual students are being replaced by work stations and furniture appropriate for cooperative learning groups. Space is needed to build, test, and store projects that have replaced paper-and-pencil tests in the wake of performance-based assessment. Classrooms are being redesigned to accommodate the needs of mainstreamed students with disabilities (Sydoriak, 1993).

Taking into account new thinking about how students learn, Halsted (1992, p. 47) envisioned the classroom of tomorrow thusly:

- Classrooms will be like studios.
- Each student will have his or her own work station and research space.
- In addition, there will need to be an array of spaces of various sizes, including: -central gathering places, -presentation arenas for the school community; -work spaces for cooperative learning by groups of different sizes; -quiet, private areas for one-to-one sessions with a teacher, mentor, or fellow student; -nooks where students can think and work independently; -offices for teachers where than can do individual testing and counseling, organize individualized study programs, phone parents, etc.

While teachers and students acknowledge the need for differentiated learning space, research to guide the customization of classrooms is scarce. Answers are needed to a variety of questions. For example—Are there better and worse ways to design classrooms to accommodate computers and other forms of technology? What designs are best suited to project or problem-based learning? Should classrooms have annexes where individual students can work while group instruction is taking place? Moore (1986) has paved the way to answering questions related to functional adequacy by developing and studying the concept of "architecturally well-defined behavior settings." Such settings contribute to longer student attention spans and decreased interruptions by providing clear boundaries and at least partial acoustic and visual separation.

A third set of issues relates to non-classroom space, including special areas like auditoriums and media centers. Educators and architects are rethinking designs for these areas in light of changing needs and technology. The advent of computer access to print media, for example, reduces the need for large libraries and increases the importance of immediate computer access in classrooms or satellite computer labs. The move to create full-service schools for at-risk students is necessitating the redesign of PLEs to accommodate offices for social services workers, clinics, and community centers. Community-minded educators want to open school-based libraries and computer labs to adults. Day-care centers, parent education facilities, and special reception areas are being added to schools in an effort to encourage parental involvement and volunteerism.

Some schools are even experimenting with creating museum-like exhibit areas and miniature neighborhoods with scaled-down versions of post offices, banks, and stores in order to stimulate student engagement in learning. Unfortunately, the implementation of these innovative designs is rarely accompanied by the systematic collection of data to permit subsequent assessment of their impact on teaching and learning. Cutting across the various "domains" of functional adequacy are the issues of equity and expense. To what extent should educators be allowed to "customize" their PLEs?

Prototypes and standardized learning spaces not only are cheaper in many cases, but they limit between-school and inter-department disparities in the quality of facilities. Is the value added to teaching and learning as a result of customization of schools and classrooms sufficiently great to offset concerns for higher costs and minimize objections to inequities across sites? Some architects contend that it is possible to obtain the benefits of prototypes, including reduced costs and quicker completion times, without sacrificing customization (Ehrenkrantz and Eckstut,1994).

Ultimately, the central issue concerns the importance of variation. Research is needed to determine how much variation in the design and organization of PLEs is necessary to produce a demonstrable difference in the achievement of desired student outcomes. Environmental Quality Environmental quality refers to the sensory and health-related conditions that exist within PLEs. Of these conditions, the ones that have been studied most extensively relate to air quality, thermal factors, lighting, and noise level. Each has been found to affect the quality of teaching and learning. When the General Accounting Office (1996, pp. 39-42) surveyed the states regarding school conditions, it found that substantial percentages of schools in most states were reported to have inadequate HVAC systems and lighting. Perhaps no area of environmental quality has received greater attention recently than the quality of the air that students breathe in school. The problems range from respiratory infections and allergies to drowsiness and shorter attention spans (Ornstein, 1994, pp. 121-122). The causes include energy conservation efforts that result in tightly-sealed buildings, use of allergy-promoting floor coverings, and toxic emissions from cleaning fluids, paint, and other frequently used substances. If students do not

The study hall located in the junior accommodation building is a modern, well equipped area. Computers are available in this area, with internet access.

Discipline issues related to study hall will be handled by the ACE program.

Local Schools

Aranda Primary School (years 3 to 6)

Aranda Primary School is located close to the AIS in a suburb whose streets are all named after Australian Aboriginal language groups.

The school's motto is the Aboriginal phrase Marima Ergurirai which means grasp the things that are good.Aranda Primary was established in 1965 and has a reputation for providing a rich and innovative curriculum. Athletes wear the school colour code and must purchase their own uniforms. A clothing pool is available at the school. The ACE advisers liaise regularly with the teachers at the school. Athletes must attend school every day, and are only exempted from participating in sporting and physical activity lessons. There is a separate AIS multi-age class.

Parents of non-residential athletes are responsible for liaison with the school on the educational progress of their child, and also for advising the school of all absences that are not related to sporting commitments.

For residential athletes ACE advisers, in conjunction with the house parents, advise the school of all absences. Educational progress is monitored by the ACE advisers.

All levies and financial contributions required are paid by the AIS up to the stated education allowance.

Canberra High School (years 7 to 10)

In 1998 Canberra High School celebrated its 60th anniversary. The present school building was opened in 1969. Canberra High School has a fine academic, cultural and sporting reputation.

The school aims to provide a curriculum which draws upon traditional academic knowledge but also takes account of advancing technology, and seeks to provide subjects which are relevant.

The school has a rich curriculum. It recognises the diversity of abilities, aptitudes and interests, and seeks to provide an environment that encourages the full development of individual abilities.

ACE advisers maintain regular contact with the school and any problems which arise will be discussed with the house parents, coaches and the athlete's parents.
The wearing of a Canberra High School uniform (colour code) is strongly encouraged. It is the athlete's responsibility to provide his/her uniform. A clothing pool is available at the school.
All levies and financial contributions required are paid by the AIS up to the stated education allowance.

Some general points about Canberra High School:

- athletes must attend school every day.
- AIS athletes in programs other than gymnastics attend mainstream classes, with a modified workload.
- a written report on each athlete's work will be issued at the end of each semester and sent directly to parents. Further information can be obtained from the Canberra High School Handbook or from the Education Adviser.
- a five day static timetable has been introduced to suit the gymnastic training schedule. Athletes will follow a designated program of a minimum of four subjects: English, Mathematics, Science and Social Science. All students will take a Wednesday activity each term from one of the areas of technology, arts and language.
- for residential athletes, absences are notified to the school by an ACE adviser or from the house parent. Academic progress is monitored by the ACE advisers who attend parent-teacher interviews and who liaise regularly with the teachers at the school.
- parents of non-residential athletes are responsible for liaison with the school on the educational progress of their child, and also for advising the school of all absences that are not related to sporting commitments.

Athlete Career Education (ACE) Program

The ACE program provides the athlete with access to a wide range of services which assist them in preparing for 'Life after sport' while they are still competing.

The services available include:

- career and education assessments
- career planning
- educational guidance
- training workshops to promote skill development in public speaking and media presentation, job search techniques, time management, financial planning and interpersonal development.
- employment and career referrals through the Australian Sports Commission and the Olympic Job Opportunities Program for eligible athletes.
- post sporting support
- debriefing and transition phase support from AIS into new program.

ACE personnel assist in planning your time at the AIS in relation to your career and education needs to fully maximise your sporting potential and the opportunities that exist for an athlete while at the AIS.

Many of the athletes who enter the AIS are students at primary, secondary or tertiary level. Those transferring from interstate may face upheavals in their education and AIS staff make a significant effort to help them adjust. School-age athletes are enrolled in local schools where AIS and school staff monitor and report on their academic progress. Because training and competition travel can disrupt school work, the Institute arranges tutoring to help athletes with their studies.

Young athletes live in AIS residences or rented accommodation under the care of house parents and athlete supervisors. Help is available on day-to-day problems, personal development issues and decisions about education and employment.

Older student athletes are given advice and assistance with enrolment in courses at universities and TAFE colleges. Course loads are negotiated to fit in with training and competition commitments.

For those athletes who are not students, the AIS provides a number of in-house traineeships, or ACE advisers can help with finding employment.

- Employment Opportunities through ACE
- General Study Regulations
- Study in the Residence
- Local Schools
- Tertiary Study
- Term and Semester Dates for 2001
- Education Expenses
- ACE advisers and Tertiary admissions Centres

ACE personnel will arrange to meet with you when you arrive at the AIS to discuss your career and education status. They will assist you in planning your year ahead in relation to your career and education needs in order to fully maximise your sporting potential and the opportunities that exist for you whilst at the AIS.

Employment Opportunities through ACE

Athlete employment within the ASC

Being located on the same site as the Australian Sports Commission provides AIS athletes with unique employment and career opportunities.

Athlete Trainee Scheme

The Athlete Trainee Scheme provides opportunities for athletes to develop vocational skills with terms and conditions of employment which are flexible enough for athletes to manage their sporting commitments. Athlete trainee positions are available in a number of divisions throughout the ASC and are in high demand. Athletes must apply for these positions through the ACE program. A current resume must accompany all applications and athletes are required to attend a selection interview. These part-time positions (normally 15 hours/week) are for a 12 month period.

Casual Positions

Casual positions within the ASC may also be available for athletes. The conditions of employment vary with each of these positions as does the term. Some may only be for a few hours at a particular time, others may extend over a period of weeks and months. Working hours are usually negotiable with the supervisor and, as with the

You must not absent yourself from school without going through this procedure.

All other reasons for missing school must be discussed with an ACE adviser prior to the absence. When sporting commitments necessitate absence from school, the ACE adviser will inform school administration formally. Each athlete must also personally contact each of his/her teachers to explain any absence and to obtain details of work to be completed.

Each school provides reports on athletes' progress to the ACE advisers. These reports are sent to the supervisors, the coaches, and the athletes' parents. Unsatisfactory reports will be discussed with the above-mentioned people and appropriate action will be taken.

Academic Performance

Athletes are expected to complete all their educational commitments to the highest standard possible.

Special consideration is always given to athletes who miss classes due to sporting commitments. However, this can never be used as an excuse for failing to complete assignments. The teachers at all places of study are aware of the challenges athletes face and will provide athletes with appropriate work to be done whilst absent from school.

Plan today and achieve tomorrow.

Tertiary and TAFE students

Attendance is compulsory and all course requirements must be met. If students find it difficult to attend or meet course requirements they should see an ACE adviser immediately to discuss their problem and also contact the lecturer concerned.

Your ACE adviser must also be notified of any change in the number of units taken.

Failure to meet the required academic standard in each unit of study will jeopardise an athlete's continuation in a course and the payment of the education allowance on behalf of the athlete.

ACE advisers and Tertiary admissions Centres

Canberra ACE Advisers can be contacted on (02) 6214 1393 or (02) 6214 1038. AIS regional ACE Advisers are contacted through the AIS

sport administration offices above. Scholarship applicants seeking admission to a university in the state where their AIS sport is located must apply through that state's Tertiary Admissions Centre. The closing date for applications for 2001 is as shown below, however applicants are advised to check with the relevant tertiary admissions centre. **Strict closing dates for applications usually apply.** Admissions centres may accept a late application on payment of a late fee. You should check late application cut-off dates with the relevant admissions centre or an ACE Adviser.

NSW & ACT	Universities Admissions Centre	(02) 9330 7200	26 September 2002
Queensland	Queensland Tertiary Admission Centre	(07) 3368 1166	26 September 2002
Victoria	Victorian Tertiary Admissions Centre	1300 364 133	26 September 2002
SA	Sth Australian Tertiary Admissions Centre	(08) 8223 5233	26 September 2002
WA	Tertiary Institutions Service Centre	(08) 9347 8000	26 September 2002
TAS	University of Tasmania	(03) 6226 2514	29 September 2002
NT	Northern Territory University	1800 061 963	27 February 2003

Scholarship applicants considering external or cross-institutional tertiary study, or enrolment in a TAFE diploma or certificate course should contact the relevant ACE Adviser as early as possible.

Study in the Residences

Study Hall - Rationale

Study Hall has been arranged to assist all school aged athletes to achieve their academic potential, despite a busy sporting schedule. In line with this aim, our objectives are to:

- Provide a quiet, comfortable working environment.
- Provide the most capable supervisory service available.
- Provide the most appropriate materials and equipment that are possible with the resources available.
- Ensure that athletes attend Study Hall for the maximum time that is consistent with their academic performance.

Arrangements

All students up to and including Year 12 will be allocated to a study hall group. Participation is compulsory and valuable. ACE Advisers and the Athlete Supervisors will oversee the study programs and general academic progress of the athletes.

Each weeknight Monday to Thursday, athlete supervisors will supervise and discuss work plans and general progress with athletes.

Details of nightly study will be recorded on tutorial rolls. It is the responsibility of each athlete to be available for individual discussion with athlete supervisors during evening tutorial times and to keep supervisors informed of work requirements and results of assessment.

Athlete supervisors are willing to help at most other times throughout the week at their convenience. If you require assistance other than at evening study hall times see a supervisor and/or ACE adviser as early as possible to organise an appointment.

The main study hall is warm, comfortable and is equipped with suitable furniture. The building consists of a larger main hall and three smaller rooms and one equipped with carrels. One room has been made into a resource centre with a small library of books and other reference materials.

Where necessary, tutorial groups are allocated to other sites for study hall.

TABLE 3.3 WORK CLASSIFICATION BY ENERGY COST

Work grade	Energy expenditure (kcal/min)	O_2 consumption (liters/min)
Severe	12.5 <	2.5 <
Very heavy	10.0–12.5	2–2.5
Heavy	7.5–10.0	1.5–2
Moderate	5.0–7.5	1.0–1.5
Light	2.5–5.0	0.5–1.0

Source: Ref. [21].

0.83 liters/min, respectively. Data are also available with respect to categorization of work based on energy requirements [21]. Table 3.3 gives one such data set. More conservative (about 10% less) estimates also exist [22].

3.2.4 Fatigue

A natural result of work that is physically and mentally demanding is fatigue. Feelings of fatigue occur during or after work. Such feelings manifest themselves in forms ranging from slight tiredness to complete exhaustion. Fatigue due to mentally demanding tasks is discussed in Chapter 4. In this section we focus on fatigue due to physical stress. Many scientists have attempted to form a relationship between subjective feelings of fatigue and objective measures such as accumulation of lactate in the blood. Although such relationships have been well established for strenuous muscular effort such as athletic events, they are not clearly present in prolonged light or moderate work.

Volle et al. [23] examined the fatigue effects of a compressed workweek (40 hours in 4 days) compared with the usual schedule of 40 hours in 5 days. Two groups of subjects in industry participated in the study, working at two different plants engaged in making similar products: one group following the 40-hour 4-day schedule, and the other 40-hour 5-day schedule. Certain physiological data (heart rate, blood pressure, body temperature, oxygen consumption, CO_2 output, etc.) collected before and after the workweek did not reveal significant differences between the two groups. However, the critical flicker fusion frequency and right-hand strength showed significant deterioration in the 4-day group. Although this was the case, the extent of the higher level of fatigue indicated by these parameters can be questioned.

Astrand [24] observed a rise in heart rate in subjects who worked at loads corresponding to about 50% of the individual's maximum oxygen uptake during a period of about 8 hours. However, since the research was carried out throughout a workday, the elevation in heart rate may have been due to factors not controlled, such as the circadian rhythms and others.

Recent research with strenuous lifting tasks indicate that lactate production may be a good predictor of fatigue and exhaustion. Yates et al. [25] had three male subjects perform six progressive lifting tasks to exhaustion. Three tasks used a constant weight, increasing frequency format. The other three tasks used a constant frequency, increasing weight format. Blood lactate and heart rate were monitored throughout the experiment. Heart rate

increased monotonically with increase in work load. Lactate production was similar to that seen in treadmill or cycle ergometer tests. The results also indicated that the constant-weight, increasing-frequency format produced more consistent blood lactate than did the constant-frequency, increasing-weight format. Although Edwards [26] and Karlsson et al. [27] showed that fatigue is not due simply to depletion of energy store and accumulation of lactate, there is evidence that they collectively influence it to a great extent [28].

3.2.5 Work–Rest Cycles

Human beings cannot maintain an activity level that is physically demanding for long periods. They need rest periodically to recover from the effects of the task. Rest allowances due to physical activity may be evaluated through extensive time studies or physiological methods. Work measurement through time study leads to approximate results. An example is 15% allowance applied to the normal time in order to calculate the standard time on a stock-handling task. On the other hand, physiological methods aim at determining rest allowances based on changes in bioresponses due to work. These methods may be *strain based* or *metabolic energy expenditure based*. Rohmert [29,30] used the working heart rate (heart rate above the resting level) in order to propose rest allowances for static and dynamic muscular work.

An accepted norm in work-rest cycles due to physical activity, using the metabolic energy expenditure method, is that no work-related rest allowance is necessary for jobs that demand energy expenditure of less than the standard (4 or 5 kcal/min). However, it is a common practice to allow for rest when energy demands exceed accepted standards. Throughout the years, various researchers offered suggestions as to allowable rest periods [31,32]. Table 3.4 gives a composite suggestion. Here R_T is the allowed rest time (min), K the energy cost of work (kcal/min), S the accepted standard (4 kcal/min for females, 5 kcal/min for males), T the total expected duration of task (min), and BM is basal metabolism (kcal/min).

An example would be a shoveling task that requires 7.8 kcal/min performed over 100 minutes. Assume that a male of 40 years of age is performing the task. From line 2 in Table 3.4, R_T can be calculated as 51 minutes with $S = 5$ and $BM = 1.7$. This means that 51 minutes of rest must be allowed for each 100 minutes of work time. However, we are not

TABLE 3.4 REST-TIME REQUIREMENTS

1	$R_T = 0$	for $K < S$
2	$R_T = \dfrac{\left(\dfrac{K}{S} - 1\right) \times 100 + \dfrac{T(K - S)}{K - BM}}{2}$	for $S \leq K < 2S$
3	$R_T = \dfrac{T(K - S)}{K - BM} \times 1.11$	for $K \geq 2S$
	$BM_F = 1.4$	$BM_M = 1.7$

Source: Adapted from Refs. [31] and [32].