

## SAFETY TRAINING THROUGH GYMNASTICS AND SPORTS METHODS

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Accidents are assuming an ever-growing importance as technical means of production keep increasing. Their prevention is a real problem in all economically and industrially developed countries.

This problem is not a new one: numerous laws bearing on work accidents were passed at the turn of the last century, in the midst of the first industrial revolution.

The *International Labour Office* has been concerned with work safety ever since its creation.

In 1961, the *World Health Organization* dedicated it a World Day.

The *European Coal and Steel Community* has organized and financed a vast two-year programme of research, in which all its member countries participate.

The *Council of Europe* has placed this problem under survey in the framework of the activities of its *Committee on Extra-School Education*.

In *Belgium*, as far back as 1958, the *National Institute of Physical Education and Sports* organized in *Brussels* an *International Colloquium on Sports-Work Relationships* where professional safety problems have retained the attention of the participants.

The *International Council for Physical and Sports Education* has created a *Work-Sports Commission* which, under the drive of its dynamic President, has done excellent work. Numerous international meetings have been organized on the various topics of interest to the said Commission.

### Importance of safety training during apprenticeship

Accident prevention assumes extremely varied forms: regulation, standardization, inspection, technical research, medical re-

search, psychological research, education, training, propaganda.

A part of these preventive measures tends to the material improvement of safety conditions. The others involve human factors.

The latter are becoming more and more important in safety matters. Numerous authors estimate that 80 to 90 % of accidents are due to human factors. These human factors will be improved, first by education and training, selection and propaganda not being involved until later. Education and training depend on the apprenticeship period.

If one consults the accidents statistics drawn up in regard to age, one can have an idea of the importance of the apprenticeship period and, as young workers are, by far, those most threatened (graph extracted from: «*The Prevention of Accidents*», I.L.O., Geneva, 1961); it is they who must be preserved in the first place.

### Role of physical and psychomotor factors in safety

Statistics and research work are plentiful permitting to show the relationship between physical education and the circumstances involving an accident. I shall show you a single one, based on the accident classification recommended by the I.L.O.

The scheme established, based on American statistics drawn from three states («*Accidents Facts*»-Chicago-1959, pg. 31), shows that:

Only 40,9 % of the accidents occur during work involving machinery;

nearly 60 % cannot be blamed on the use of it;

8.5 % are due to falls from a height;

9.5 % are due to falls;

24.4 % are due to faulty manipulation;

(<sup>2</sup>) *International Colloquium on the Gymnastic Activities of Workers*. Oporto 1966. PORTUGAL.

10.1 % are due to knocks from moving objects;

6.6 % during changes in position and owing to bangs against obstacles.

Falls, injuries caused by objects, postures, displacements involving motricity, ability, dexterity, suppleness, balance, quick reaction following an unexpected occurrence. Physical strength and resistance against fatigue also play a role, as their absence might be at the source of accidents.

Consequently, the contribution of a well guided physical education would not appear to be negligible «a priori».

Starting from this working hypothesis and using previous works undertaken in *Switzerland, England, Germany, the U.S.A. and France* above all; using besides all the gymnastic and sports techniques liable to make a contribution, the Research Service of the *Institute of Physical Education of Liège* has searched for a programme of safety physical education and has submitted it to systematic testing.

To try to emphasise the role of safety physical education, let us cast a glance at Heinrich's Sequence-Accident.

According to Heinrich, for an accident to take place, a series of conditions must occur simultaneously; favourable heredity and milieu; one or several individual inaptitudes; a dangerous action where material danger exists; then come the accident and the injury, that is the final link in the chain and furnishes one of the major terms in the juridical definition of a work accident.

Heinrich represents these terms in the sequence as a series of dominoes placed side by side. When the first domino is pushed, it brings down together with it all the others. If one of the dominoes in the series is removed (for instance the material risk or the dangerous action), the sequence is broken and the accident does not occur.

To safety specialists, such an arrangement will appear rather obsolete or even somewhat simple. I have retained it just because of its simplicity and because it affords an easily accessible arrangement.

Above the Accident-Sequence I have placed the majority of the preventive measures. You will see that these concentrate their action on the middle term: the material risk and the dangerous action.

Some of the classic preventive measures try to intervene at a previous stage: medical research and psychological research, education and training strive either to make personal inaptitudes disappear or to detect them in order to select the more apt ones to do away with the others.

Other preventive measures intervene at a later stage. Work medicine, particularly, intervenes at this last term, either through the quick action of first-aid services, or suitable treatment, or even through rehabilitation services.

#### Safety physical education programme guide lines

In drawing up our safety physical education programme, we have tried to direct our action on the greatest possible number of terms of the sequence:

- The development of the individual qualities that play a role in safety (ability, dexterity, endurance to effort, strength, quickness of reaction, aptitude for team work, etc.) and permit the improvement of individual potential;
- the learning of sure techniques in manipulation and in displacement, permits the lessening of the risks of faulty actions, of falls, of injuries, etc.
- the learning of first-aid techniques permits the introduction of an obstacle between the 3rd and 4th terms and of braking the accident mechanism; it is a question of highly precise techniques allowing the obstacle to be avoided, of catching oneself up in the event of a fall in a series of circumstances.
- finally, by teaching each young worker the techniques of first-aid and of reanimation, we turn every man into a life-saver; everyone knows that quick-

ness of judicious intervention frequently permits avoiding the more serious consequences of accidents, notably in the cases of asphyxia, gas intoxication, electrocution, fainting, etc.

#### Experimental groups

After having set up this programme, in collaboration with physical education teachers in the provincial technical teaching, we submitted it to the test. We wished to know in what measure this safety physical education would have effects distinct from physical education with general aims, which is generally ministered in the technical teaching establishments in the *Province of Liège*.

The test group comprised 58 youths, the control group 60 youths, all between 15-17 years of age. The programme of the tests was applied before the training period and following it. Training for each group covered about 80 sessions of 50 minutes each.

#### Set of tests used

The series of tests given below has served to estimate the effects of specific training on certain individual qualities playing a role in safety.

1. The Boigey test permits measuring kinesthetic sensitivity at the level of the shoulder joint. Here, the measurement was taken on each arm, by movements of abduction and flexion, according to 3 different angles. By means of radii at 5° distance, the executant's error can be appreciated to about one degree of an arc.

2. To judge manual ability and, at the same time, the aptitude to control both hands, two original experiments have been studied.

In the pentagraph test, the left hand has to avoid the obstacle in the shape of a Y-shaped copper wire, while carrying out a symmetrical outline traced by the right hand.

Contacts of the left hand against the obstacle are recorded in number and dura-

tion by an error-counter. The time of the execution of the drawing is measured by a chronometer.

The work of the right hand consists in following with the greatest possible precision a standard tracing. The accuracy of the drawing obtained by tracing permits appreciating the ability of the right hand.

3. In the sinusoid test, a cart equipped with two sets of movable wheels is guided along a long copper wire. Contacts with the wire must be avoided.

These contacts, as in the previous test, are recorded, in number and in duration. The time of the test permits the estimation of the work rate.

In the two tests of manual ability, the subjects are asked to «act fast and well».

Contrary to the case in the pentagraph test, the sinusoid test calls for a great independence of both hands.

Besides, shiftings of the whole body are required, including displacements on a vertical plane.

Eye movements are indispensable to control the two sets of wheels, as the visual angle largely exceeds that of muscular vision.

The two manual control tests applied to accident-prone subjects have revealed in the latter two types of dangerous conduct: in ones, the error is accompanied by an inhibition that extends the time of error; in the others, it lets loose an aggressive reaction that multiplies the errors.

4. Fatigue increases the frequency of work accidents.

Organic resistance to fatigue, on the other hand, constitutes a safety factor of the first order.

Safety physical training should not overlook this aspect.

That is why the test subjects and those in the control group were submitted to an ergometric test.

During 5 minutes rest on a bicycle, their breathing and oxygen consumption were measured.

Cardiac frequency was recorded with skin electrodes, with the help of an ink-marking electrocardiograph.

A 10-minute work, proportional the subjects' weights, was required and, during that time, a continuous record of the breathing and oxygen consumption was made.

The work called for a consumption of O<sub>2</sub> equivalent to 8 to 12 times that at rest.

Cardiac frequency was recorded every half-minute.

Finally, during a 10 minute recuperation period, during which the subject rested on the bicycle, the blood pressure and the evolution of the pulsation wave were recorded, while the measurements of the breathing, oxygen consumption and cardiac frequency were continued.

5. For the safety test-course, the subjects studied 10 successive tasks with the instruction:

«Act fast but take no risks».

The test was valued by the measurement of time of execution, by discounting the errors made against safety (a table of all possible errors having been drawn up during sampling) and by an estimated conduct pattern set up according to three tables, each one showing safe conduct, worth 5 points, and beside this ideal conduct, other less safe ones, graded from 1 to 4 points. Thus it is that, we find on the one hand reckless conduct, and on the other timid conduct.

«Relaxed» conduct is opposed by inhibited and rash conducts, whereas the man careful of performing well is flanked by the thoughtless and the over-scrupulous.

The quickness of reaction when a sudden occurrence takes place is similarly a major safety factor.

6. The classic measurement of reaction time by means of an audible visual stimulus presents a certain interest.

In order to approach working conditions as closely as possible, we have utilized a

measurement of reaction time during a grading task (separating copper screws from steel screws) needing, at the audible signal, the displacement of the entire body and hand to shut off a light beam exciting a photo-electric cell.

Exploring kinesthetic sensitivity, studying hand-control aptitudes, research in individual resistance against fatigue, test-courses, reaction-times: these are the major tests that have allowed us to estimate the effects of safety physical education.

### Conclusions

1. Apprentices and young workers are those most exposed to accidents. Consequently, safety training efforts should be increased.

2. Among the circumstances involving accidents, a large number may be imputable to physical or psycho-motor failures. Gymnastics and sports permitted improving significantly certain qualities that play a role in safety.

3. This method presents two advantages:

- 1 It is an *active* pedagogical method that puts safety into practice;
- 2 This method attaches large importance to the development of the psychological factors indispensable in safety: watchfulness, the estimation of risks, team-work, respect for regulations, a liking for order, lack of aggressivity, recklessness of or fear, self-confidence in regard to risk.

This educational method should be included in a complete training system including two other important aspects: theoretical training and workshop training.

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