„CUSTOM MADE“ LOAD LIMITS SHAPED BY AGE, GENDER AND STATURE DISTRIBUTIONS – A NEW ISO-APPROACH

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A new load evaluation procedure is proposed featuring adjustments of load limits to any optional target population. These populations are characterized by age, gender and stature. The procedure is going to be integrated into ISO 11228/2 providing adjustable limits for pushing, pulling and holding operations. An example is given to demonstrate variabilities of resulting limits.

„CUSTOM MADE" LOAD LIMITS

Generally human physical strength is varying widely with differing populations. In an attempt to limit loads at manual work ISO is going to meet those worldwide variations by drawing up flexible standards. Such standards should provide „custom made" load limits – limits following variations of the envisaged user or working population.

ISO 11228/2

In particular ISO 11228/2 provides load limits when pushing pulling or holding. Generally these limits depend on demographic and anthropometric characteristics. Major factors are distributions of age, gender and stature. A new procedure was designed to realize these factors in ISO 11228/2.

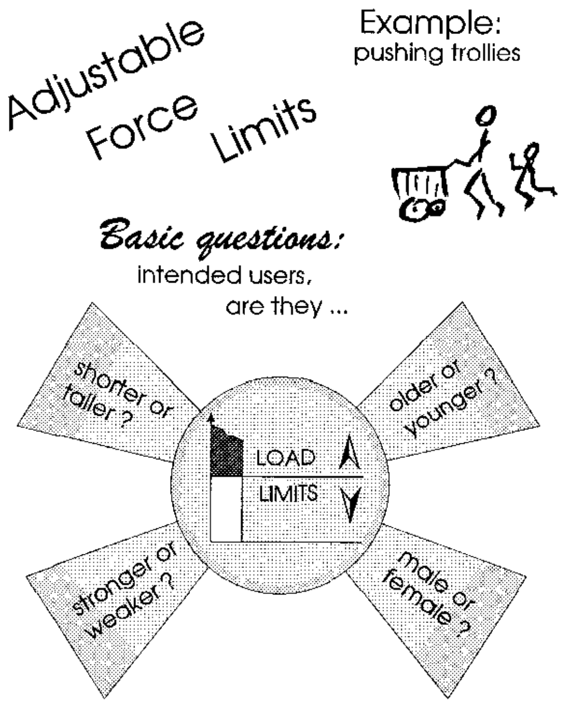

Fig. 1: Major user characteristics determining load limits

OBJECTIVES

Traditional load ratings are quite blind when looking at „their" populations they are going to protect. In an attempt to support current ISO work, a new load rating procedure was designed. That kind of rating is supposed to yield „custom made" load limits. In particular this approach is focussing

- ✧ on varying target populations
- ✧ when pushing, pulling or holding
- ✧ at selcted absolute working heights.

INGREDIENTS

„Custom made" load limits demand two kinds of input data:

Demographic profiles

Adjusting limits to age and gender requires demographic profiles of the envisaged target populations. So we introduced 3 age groups of males and females accordingly: ① age < 20; ② 20 ≤ age ≤ 50 and ③ age > 50 years.

Strength distributions

Distribution parameters (average and standard deviation) are describing physical strength at selected relative working heights. These parameters are derived from a very particular reference group: young females between 20 and 30 years.

PERCENTILE APPROACH

Limits in ISO 11228/2 are based on percentiles. Such an approach ensures that a wide and defined majority (e. g.: 85 %) will be reasonably well protected from muskuloscelettal disorders in a transparent and reproduceable way.

On the other hand percentile approaches require detailed distribution functions. When pushing or pulling these distributions are varying with age, gender and stature. To meet those variations ISO 11228/2 introduces two kinds of fitting procedures. These are in particular

- ✧ demographic fitting and
- ✧ stature fitting.

DEMOGRAPHIC FITTING

Demographic fitting (Schaefer, 1997) was first introduced into CEN by prEN 1005/3 (1999). This standard synthesizes strength distributions of any optional target population on the base of particular reference groups.

STATURE FITTING

When pushing or pulling at constant absolute heights, human strength additionally depends on given body statures. In our approach stature effects are realized by the following procedure:

- ✧ start with a set of strength distributions as recorded experimentally at different relative working heights;
- ✧ adjust these reference distributions to given target populations (demographic fitting);
- ✧ predict statures required to work at selected relative heights at the very same absolute working level;
- ✧ determine frequencies of these predicted statures within a given target population;
- ✧ apply above frequencies as weighting factors and reduce distributions accordingly at all selected relative heights;
- ✧ sum up these weighted distributions to find combined strength distribution functions reflecting given statures of optional target populations.

EXAMPLE: PUSHING

Working scenario:

- ➢ activity: pushing
- ➢ population: American & Japanese
- ➢ absolute working height: 1,5 m

Assumptions:

- ➢ rel. working heights: 30, 50, 70, 80, 90, 110 u. 130 %
- ➢ load limit: 15 th %-tile
- ➢ strength: equal strength in both nationalities

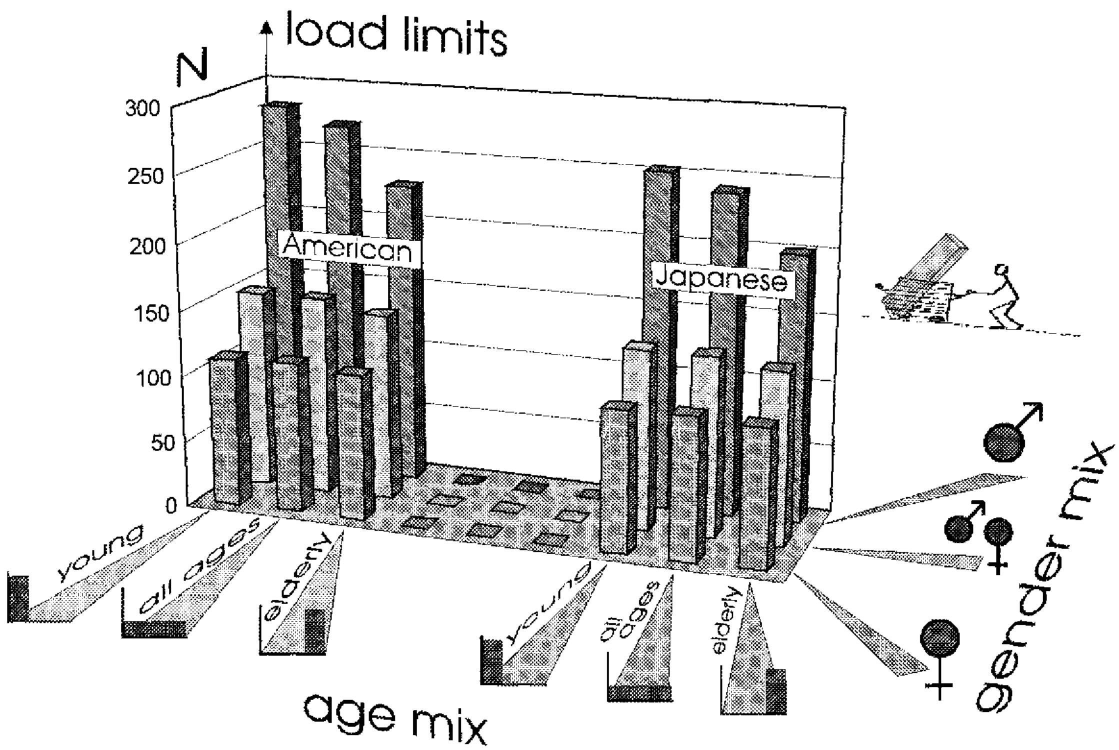

Fig. 2: „Custom made" load limits varying within and between two different target populations assuming identical strength distributions.

RESULTS

Above procedure yields strength distributions

- ✧ for any given target population
- ✧ at any given absolute working level.

These distributions provide percentile limits reflecting variations of age, gender and stature. An example of those variations within American vs. Japanese populations is given in Fig. 2. For the sake of transparency basic strength distributions are assumed to be identical in both nations. So in Fig. 2 differences of load limits between both populations are immediately reflecting effects of diverging stature distributions.

QUALIFICATION

In Fig 2 „custom made" load limits verify some well known experiences:

- ✧ limits increase with increasing male representation,
- ✧ limits decrease with increasing age and
- ✧ working near ground level is easier for short people.

So far our procedure is complying with real life.
On the other hand we managed to integrate those real life effects quantitativly into a new class of load rating procedures. That kind of precedures follow experimental evidence in a transparent and reproduceable way. Especially in the end we get „hard" load limts regardless of the „soft" input-distributions we are feeding into the procedure.

PERSPECTIVES

This approach verifies some first steps trying to realize some new kind of target group ergonomics.
Usually traditional ergonomics is drawing up regulations for a limited selection of predefined addressees – e. g. jouveniles or adults, males or females, etc. But in true life such rough patterns seem to miss reality and real user distributions frequently may be found somewhere in between.
So this approach generally may help to increase ergonomic flexibility and precision when facing optional target populations in many kinds of ergonomic application.

REFERENCES

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