Coll. Antropol. **31** (2007) 4: 1031–1038
Original scientific paper

New Anthropometric Instruments

Darko Ujević[1], Gojko Nikolić[1], Ksenija Doležal[1] and Lajos Szirovicza[2]

[1] Faculty of Textile Technology, University of Zagreb, Zagreb, Croatia
[2] Institute for Anthropological Research, Zagreb, Croatia

ABSTRACT

Anthropometric examinations have been carried out since 1901 (USA) with the aim of developing and furthering the garment and footwear size system. The contribution to the solution of these problems was noticed in the last decades when a technical board was founded and the propositions in ISO norm series as well as in European norm (EN) series were prescribed. Two methods are employed in anthropometric measurements: the conventional one using anthropometric instruments and the one applying a 3D body scanner. The method using 3D scanning is faster and more accurate, but at the same time it is more complicated and expensive. In the framework of STIRP Croatian Anthropometric System the classical method was applied because out of the total number of examinees (0,68% of the whole population of the Republic of Croatia) 6,380 children up to the age of 5,4 were examined. That was the reason why the development of new anthropometric instruments was taken up with the aim of developing and improving the existing ones. In this paper a new anthropometer with two legs has been described: it contributes to the stability of the instrument when a larger number of examinees has to be tested. In addition to this, new goniometers for determining the shoulder-tilt have been presented and described.

***Key words**: anthropometric instruments, measurements of human body, garment and footwear standards*

Introduction

The role of the garment throughout history has not only been to protect but also to cover, uncover, to visually enlarge the body or make it look thinner or longer, to emphasize some parts of it, and to express in many ways the spirit of the time[1].

In the conditions of the manufacture of fashionable garments and footwear, the meaning of the size system is exceptionally important; that is why it is necessary, in order to satisfy the largest possible number of purchasers to develop such systems that will make possible the selection of garment and footwear sizes that would meet individual and group needs[2,3].

Anthropometrics can be defined as a science concerned with measuring people. Pheasant extended this definition by adding the word »applied« to anthropometry that would include numerical data referring to size, shape and other physical human features which can be used in the context of garment design[4].

Joint Clothing Council was the first to publish the classical terminology and the procedures of taking body measures in the garment area. Body measures were divided into four groups: the height, the length of a segment, the width and the circumference (girth) of the body. In 1996 Beazley proposed a procedure for determining a list of sizes according to ISO 8559 (E) which included a natural order in body measures covering three types of data: the horizontal, the vertical and the others[5,6].

Anthropometric Points

When determining the body measures a set of anthropometric instruments is used, a measuring tape and other instruments at hand as well as some specially designed instruments. In order to work out cuts it is necessary to study a large number of proportions and in order to do that we need to get to know the human body well i.e. the relations between the proportions of the body.

The regularity of relations between individual body measures is determined by means of proportions, and then the departure of a certain body build from the average build is established i.e. the possible existence of a deformity crucial for working out cuts.

Received for publication September 20, 2007

Before anthropometric measuring is performed, the most important thing to do is to determine the exact position of individual anthropometric points on a human body. Anthropometric points can be either fixed or virtual[8].

Fixed anthropometric points are always on the same part of the body. They are clearly discernible and their position is easily established.

Virtual anthropometric points are those the position of which changes with the position of the body. Their position sometimes directly depends on the plane the examinee is on while being measured. The determination of their position depends on the skill of the examiner in charge of measuring.

When establishing the position of anthropometric points the existence of numerous individual variations in the shape of the skeleton used for determining individual points must be taken into account. For example, if there is a pronounced curvature in the extended part of the skeleton, its position cannot be found in the same place. In such cases the approximate center of the rounded surface or edge will be considered as the position of that anthropometric point. When carrying out anthropometric measuring the spot of an anthropometric point is taken first, then it is marked with a demographic pencil or else the characteristic points are marked by a label (HAS is used). The position of all anthropometric points must be established at the so-called standard body posture, which is upright except for newborns and infants.

The position of anthropometric points is marked on the right side of the body. Only after the body has assumed its »standard posture« and the position of individual anthropometric points has been marked, the anthropometric measuring can be carried out in which all parts of measuring instruments are placed on the examinee's body i.e. on its anthropometric points.

Measuring instruments

Anthropometric measuring is carried out by means of the following instruments:

- measuring tape
- sliding caliper
- one-leg anthropometer
- two-leg anthropometer
- specially-designed goniometer and
- digital scale

Practical measurements

The international organization for the standardization (ISO) recommended in the early seventies of the last century a number of norms which mark the beginning and the basis of a unique system for designating garment and footwear sizes all over the world[9,12,13,15]. Later on the establishing of norms ISO 3635, ISO 8559 and ISO 9407, laid the foundations for the unique definitions of the human body measures for the needs of garment and footwear manufacturers; this also affected the manner the anthropometric measuring is carried out[9–16].

A comment on systems and issues concerning size determination

In 1968 in Sweden there took place the first formal approach to the International standardization organization (ISO) with the purpose of determining the clothing sizes, since it was particularly important to create an international system. The Swedish delegation proposed discussing terminology and definitions, dimensions and clearances as well as size selection.

In the framework of the International standardization Organization (ISO) the technical committee TC 133 was formed named Sizing Systems and Designations for Clothes. 17 countries became its members actively participating in its work, and the committee held its first formal session in 1970. Following long discussions and numerous proposals the name »Mondoform« was adopted as an appropriate term for the work on designating sizes. Mondoform implies that for the purpose of designating clothes pictographs be used with marked body measures representing the size of clothing items[2,12,16].

At the end of 5th meeting held in 1979 the members of individual countries handed in the documents containing secondary body dimensions, their definitions and measurement methods. Thus was eventually published ISO 8559 Garment Construction and Anthropometric Surveys – Body Dimension, which is used as international standard for all kinds clothing size surveys. ISO is an international association of national standardizing organizations in over 140 countries in the world. The latest version of the international garment and footwear norm is to be found in ISO/TR 10652:1991.

The ISO system suggested that garment sizes be described in a pictograph showing the illustration of the basic dimensions of the item. The system should also reduce the manufacturers' and the sellers' cost arising from the return of ordered merchandise and clothing items damaged on account of their being tried on. Up to 1994 the first attempts at working out a European standard in the framework of the technical committee TC 133 had failed. In the next attempt made in 1996 a work team made up of professionals from 12 countries was founded. They revised Mondoform so as to be able to relate the important body measures (height, waist and hips) to the size series.

Anthropometry and the Development of New Anthropometric Instruments

Anthropometry deals with procedures of accurate measuring of the human body. The procedures, the methodology and the instruments for anthropometry have been devised so as to enable valid and reliable measuring of individuals, populations of regions and countries, which is indispensable for garment construction and design. The instruments include anthropometers with one or two legs (upright instruments for measuring straight linear distances), special goniometers for determining the shoulder-tilt, sliding calipers, calibrated measuring tapes, elastic tapes, chains and digital scales. Linear heights are measured by means of anthropometers with one or two legs, whereas linear depths and widths are taken by means of a sliding caliper, a measuring tape, a chain and a goniometer. Liminal points must be carefully positioned and marked on the examinee's body so as to ensure accuracy and consistency of measuring. Working out anthropometric surveys is an extremely complex and time-consuming job, and that is why an interdisciplinary team of professionals and skilled technical staff has to participate in its organizing, execution and elaboration[2,17–22].

New anthropometer with two legs

An anthropometer is a 2 m long instrument for measuring different distances and heights on the human body with the chief purpose of establishing the body dimensions.

Various anthropometers with one or two legs used so far took a lot of the anthropometrist's time just to be folded. The tube holder was not strong enough to hold the connecting tubes firmly, which caused sliding and measuring errors that resulted in inaccurate measuring and reduced the efficiency of the measurer. The main parts of the existing anthropometers with one or two legs are built of four tubes, which means that more time is needed to fold them and the rigidity of the structure is diminished.

The new anthropometer design is free of all the shortcomings of the existing ones and, in case of a larger number of examinees, better stability of the instrument at work, simpler handling and higher accuracy of measurement are achieved. Figure 1.

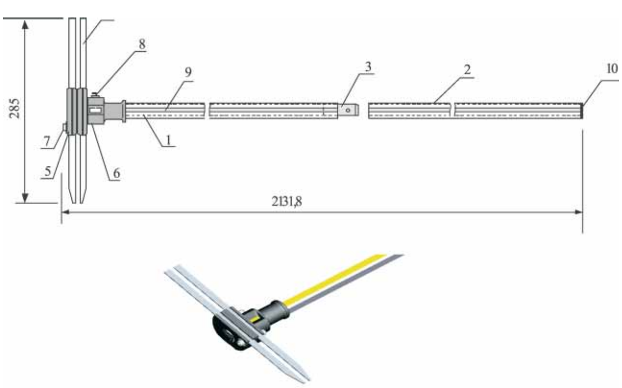

Fig. 1. New anthropometer with two legs.

The anthropometer consists of two tubes having a quadratic cross section[1,2]. They can be simply joined by means of the tube holder[3]. This holder is placed as the end of the upper tube (1) in which it is firmly joined (Figure 2). At the other end of the tube holder which is loose (outside the upper tube) a ball provided with a spring is built in which after mounting the other tube (2) falls into the provided hole and (detachably) fixes this tube. The other tube (2) is longer, and it is open at one end. From this side the holder is mounted. The lower end is closed with a rubber plug (10).

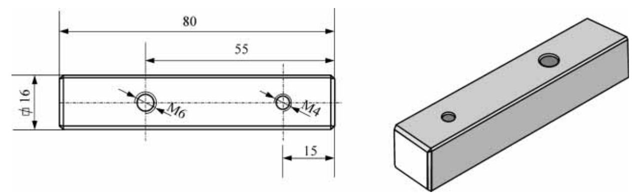

Fig. 2. Tube holder.

It has a quadratic shape so that it precisely falls into the inner tube opening. Its function is to absorb blows when the anthropometer is placed on the support in the process of taking bodily measures. On the outside of the tube a measure tape or a millimeter tape is affixed (9). By joining the shorter and longer tube over the holder the measure tapes run further on the tubes too.

The tube holder (9) is made of quadratic brass shown in the drawing, and the edges of the holder are trimmed.

On top of the first (shorter) tube there is the holder of the upper movable finger (5) (Figure 3) fixed with a socket screw through an insert attached to the tube (Figure 4). The finger dimensions are 285 × 10 × 2 mm. In its groove on the holder it slides perpendicular to the tube direction, and it is fixed with a socket screw (7) in the selected position.

The lower movable holder (6) (Figure 5) carries the lower finger in the groove. It can also be placed in the desired position and fixed with a socket screw. The lower movable holder slides linearly along the tubes (as their

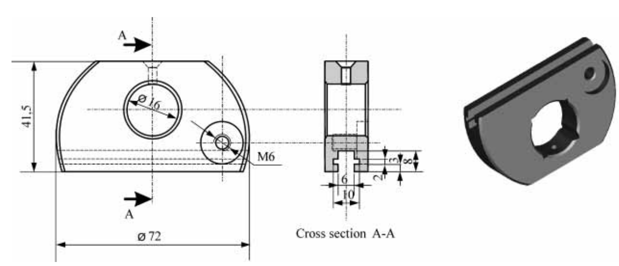

Fig. 3. Upper (fixed) holder.

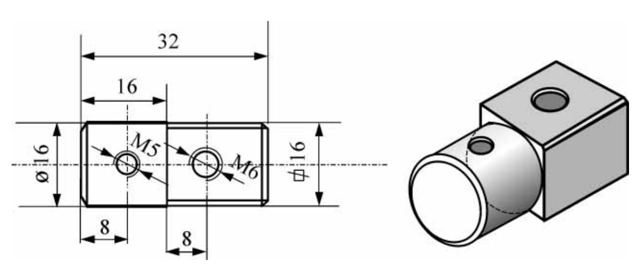

Fig. 4. Steel insert on top of the tube for joining the upper holder.

cross-section is quadratic, they cannot be rotated). Through the holes on the front and rear side with 0 mark the value measured on the measure tape can be read which is placed along the tubes. The tapes are placed on the front and rear side in such a way the one starts at 0 and rises to 200 cm, and the other starts from 200 cm and decreases to zero. Reading accuracy is 1 mm. The slider contains a brake (8) consisting of a spring plug and a screw for adjusting spring force. Its function is to control the sliding of the movable holder (Figure 6).

Measurements can be made using one arm or both arms and the shorter tube or adding the longer one, depending on measurement requirements.

The anthropometer has its specially designed protective bag made of strong fabric which makes transport damages of any part impossible. The upper and lower tube and fingers are packed separately into specially designed pockets. The bag is closed with a Velcro strap.

The holders are made of plastic material in black for contrast when reading measured values.

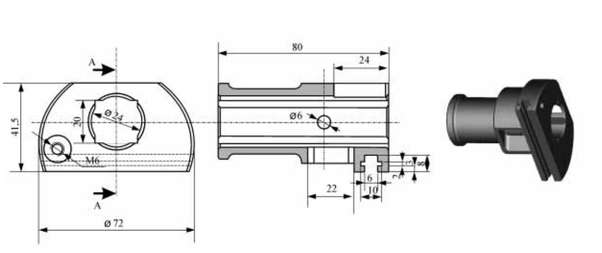

Fig. 5. Lower movable holder.

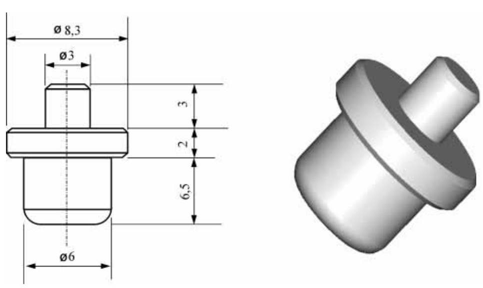

Fig. 6. Brake plug.

New goniometers for determining the shoulder tilt

For appropriate clinging of a garment to the shoulder of the user it is essential to know the exact amount of tilt. A shoulder does not have the same tilt throughout its length. The tilt of the lower part is lesser, the tilt of the higher part is bigger, as can be seen from figure 1. That is the reason why it is rather important to apply a unique way of measuring i.e. to define unique anthropometric points and lines to start the measuring of the tilt from. The seventh (cervical) vertebra has always been taken as the starting point for designing clothes, because it is the most prominent and it is easily palpated. A virtual horizontal line going along the middle of the seventh vertebra intersects with the tilt of the shoulder in a point from which the tilt is measured.

Measurements so far have relied on superficial assessment of the horizontality of the virtual line passing along the seventh vertebra and intersecting with the shoulder in a point from which the tilt is measured. The measuring of the tilt was carried out by means of a simple protractor and the angle was roughly assessed. That method was inaccurate for the following reasons:

- The assessment of horizontality of the virtual line was based on memory
- The position of the intersection of the virtual line with the shoulder tilt i.e. the starting point for taking measurements
- The method of measuring by means of a protractor based on rough assessment

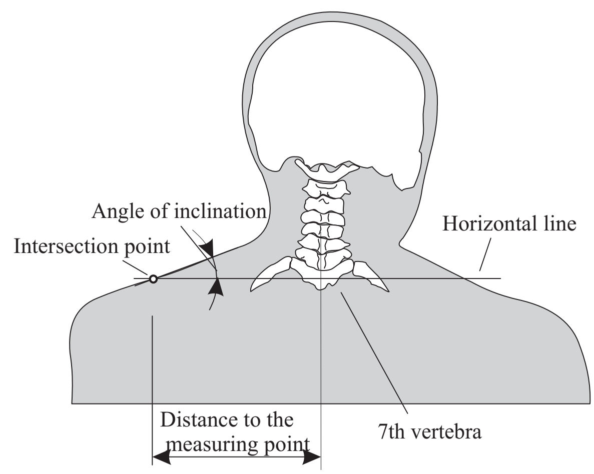

Fig. 7. Measuring point of the shoulder slope.

That method of work is inaccurate and arbitrary, thus not applicable, especially not for establishing differences in the tilt of the two shoulders. Those tilts in humans are not the same. The difference may or may not be considerable.

Besides for the purpose of creating clothing items, measurements are taken for medical and anthropological purposes.

New goniometers for measuring the tilt of the shoulder have been designed for field measurements in the framework of extensive research, but also for taking measures for the benefit of ready-made clothing manufacturers and smaller firms in this line of business.

Two basic types of goniometers have been designed:

- Goniometer for measuring one shoulder
- Goniometer for simultaneous measuring of both shoulders

For each goniometer there are several technical solutions which have advantages and drawbacks. Only one solution will be presented for each type of goniometer.

New one-side goniometer for measuring the angle of the shoulder tilt

A one-sided goniometer should be able to measure the slope of the left and right shoulder. The measurement of different shoulder slopes, accurate starting point of measuring the shoulder slope and accurate reading should be enabled. The instrument should easily be handled and carried and be insensitive against manipulations.

The goniometer shown in Figure 8 makes the above-mentioned requirements possible.

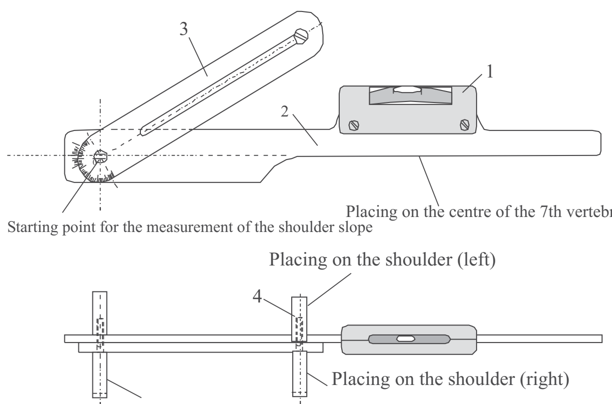

Fig. 8. Goniometers for determining the shoulder tilt.

The goniometer consists of the following parts:

- spirit level for mounting on the base holder
- base holder
- rotary (inclination) arm
- finger for placing on the shoulder (left)
- finger for determining the starting point for measuring

The base holder (2) is attenuated under the spirit level up to the bisector of the fulcrum of the rotary arm. This attenuated section and its bottom edge respectively is placed approximately in the middle of the 7th vertebra. The attenuated section is longer in order to be able to measure different shoulder widths. The holder, i.e. the whole protractor, is moved until the finger (5) rests on the shoulder. The spirit level keeps the movement horizontal. In this manner the starting point for measuring is obtained. The inclination arm (3) is rotated in such a way that the upper finger rests on the shoulder. Since the finger diameters (4 and 5) are equal, the correct inclination is obtained which is read on the marked angle scale.

To measure the other shoulder a rotary goniometer is used. This is the reason why the fingers (4 and 5) are on both sides of the goniometer.

New two-side goniometer for simultaneous determination of shoulder tilts

The two-side goniometer for simultaneous determination of the shoulder tilt must satisfy the same requirements described above in 4.2.1. (one-side goniometer). The most important thing is dealing with differences in shoulder width, which did not present any problem with one-side goniometer. The solution was found as shown in

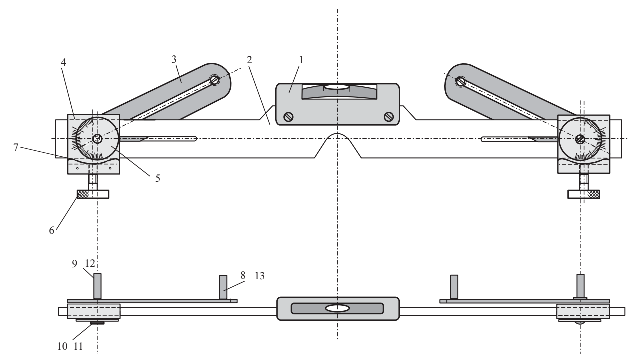

Fig. 9. Two-side goniometer for simultaneous determination of shoulder tilts.

The two-side goniometer consists of the following parts:

1. Level
2. base holder
3. rotary (inclination) arm
4. slider with 0 angle scale
5. rotary plate with angle division fixed with rotary arm
6. clamping bolt of the slider
7. compressing spring
8. finger for placing on the shoulder
9. finger with quadratic extension
10. disc
11. screw
12. bushing
13. screw

The new feature of this protractor are sliders with rotary arms fixed with a screw to the shoulder width. The manner of measuring is similar to the measurement made with the one-sided protractor. When the seventh vertebra is felt, it is placed into the hollow in the middle of the base holder (2). The sliders moved into the end position move towards the centre until the fingers (9) touch the shoulder. Their position is fixed by the screw (6). All along the spirit level should indicate the horizontal position. After fixing the rotary arms are rotated against the spirit level until the fingers (8) touch the shoulder.

In both protractors the rotation of the rotary arm should have a slight resistance (self braking) so that because of its weight the arm would not only move. The joint between the rotary arm (3) and the rotary plate transferring the rotation is obtained by the quadratic extension at the bottom end of the finger (9). A bushing (12) is mounted around it which makes the rotation in the slider possible (4). By tightening the screw (11) it is possible to obtain the self braking of the arm movement.

The measuring procedure is shown in figure 10. The one-side goniometer is more appropriate for extensive and mass application in field testing because of both-side measuring of the tilt angle while keeping the horizontal position. However, when it is necessary to obtain or to immediately compare the exact amount of tilt of both shoulders, the two-side goniometer is more adequate.

Its advantage is the simultaneous determination of anthropometric points for the left and the right shoulder. That grants the accuracy of the starting point for measurements[16,23].

All parts of the goniometer are made of translucent plastic and standard levels are available at low price.

The practical and simple handling of the work this new goniometer makes possible was confirmed in field measurements for the needs of the complex technological research-developmental project (STIRP) »Croatian Anthropometric System (HAS) code TP-02/117-02. It was supported my the Ministry of science, education and sport of the Republic of Croatia and was carried out on 30,866 examinees during an uninterrupted 17-month period and included 109 field measurements that took place following two exhaustive practical seminars. That was definitely the best possible confirmation of the efficiency and simplicity of the solutions we have presented.

The development of new solutions for anthropometric instruments is continued and will be presented in one of the afore-mentioned papers; we can only promise that they will contribute to the improved measurements of various deformities in the human body through the application of sensorial and computing support.

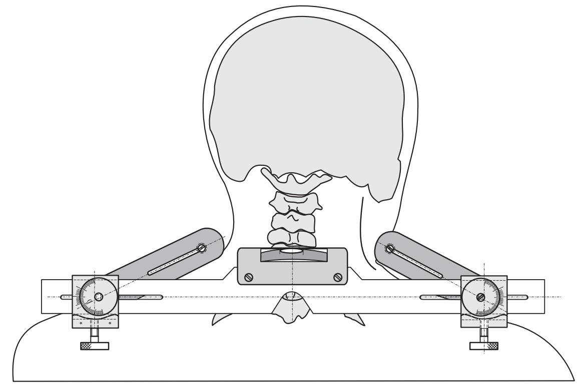

Fig. 10. Measurement with the two-sided goniometer.

The Results of Investigation in the Framework of Complex Technological Developmental-Research Project (STIRP) Croatian Anthropometric System

The complex technological research-developmental project STIRP *Croatian Anthropometric System*, included an interdisciplinary team of experts consisting of 25 university professors, collaborators and consultants from corporate work as well as technical staff. Field measurements in all the counties and in the city of Zagreb were carried on by 109 anthropometrists starting from the beginning of June 2004 through the end of December 2005, a total of 17 months of continuous work. All field measurers had attended two educational seminars with practical training.

The entry of the data was carried out by 15 younger persons and another dozen was in charge of sorting out the documentation. After the completion of all activities and after all the data have been recorded the statistical processing in now under way. The statistical methods were defined by the project task, and the final results of the investigation have been presented in 7 professional books as follows [3–30]:

- Croatian Anthropometric System – Results of Anthropometric Measurements of Children at the Age of 5.4 years
- Croatian Anthropometric System – Results of Anthropometric Measurements of Boys between 5.5 and 12.4 Years of Age
- Croatian Anthropometric System – Results of Anthropometric Measurements of Girls between 5.5 and 12.4 Years of Age
- Croatian Anthropometric System – Results of Anthropometric Measurements of Boys between 12.4 and 20.4 Years of Age
- Croatian Anthropometric System – Results of Anthropometric Measurements of Girls between 12.5 and 20.4 Years of Age
- Croatian Anthropometric System – Results of Anthropometric Measurements of the Male Population between 18.5 and 82.0 Years of Age
- Croatian Anthropometric System – Results of Anthropometric Measurements of the Femal Population between 18.5 and 82.0 Years of Age

Conclusion

The development of new anthropometric instruments was inevitable, then it became a challenge and eventually it resulted in two entries for patents. In addition to that the new two-leg anthropometer, the one-side and two-sides goniometer for accurate determination of shoulder-tilt proved to be an outstanding scientific contribution to anthropometric measuring when there is a large number of examinees to deal with.

New sciences have always been treated as heresies. The complex technological research- developmental project *The Croatian Anthropometric System*, which has for the first time discovered and scientifically and professionally presented the national predispositions of the population of the Republic of Croatia, is definitely a scientific advance.

STIRP HAS will change the archaic system forever, and the inhabitants of Croatia, men, women and children, will possess their standard in keeping with their proportions and predispositions.

HAS was the beginning, it was a complicated and challenging task, the first step towards genuine science: anthropometric studies and national surveys have a great value due to an increasingly fast rate of change in body measures.

Creation of a new standard in garment sizes is historic for the Republic of Croatia. Anthropometric measurements and determination of body measures and of a system of designation of garment sizes in accordance with the recommendations of ISO norms is indispensable for the Republic of Croatia. Through STIRP HAS the quality of the export offer of fashionable clothes and footwear as a significant parameter for the possibility of placement on the foreign market will be increased.

And finally a very relevant piece of information is that the results of the research carried out for the project *Croatian Anthropometric System* were accepted on February 6th 2007 by the Technical Board (TO – 38) of the Croatian institute for norms and forwarded to enter further procedure of acceptance as a new Croatian norm for garment and footwear sizes.

The presented results derive from the complicated technological research-developmental project »*The Croatian Anthropometric System*« and from the scientific project »Anthropometric Measurements and Adaptations to the Garment Size System« (code 117-1171879-1887) executed with the support of the Ministry for science, education and sport.

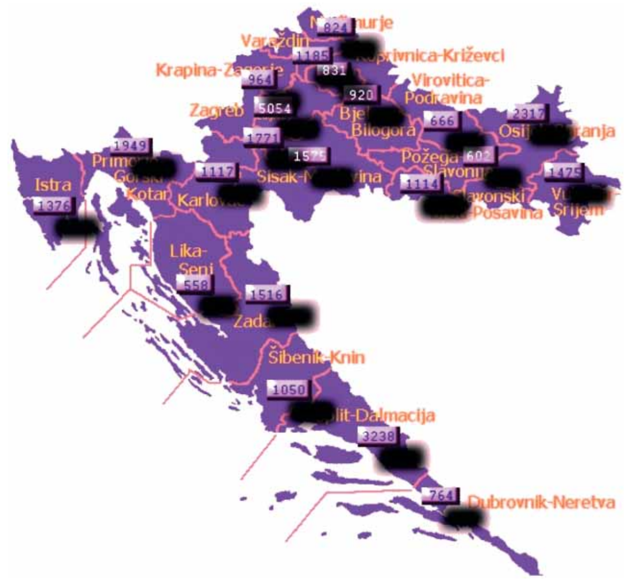

Fig. 11. Map of the Republic of Croatia showing the total number of subjects measured in 20 counties and the city of Zagreb proportional to the number of the inhabitants (a total of 30,866).

REFERENCES

1. KUNICK P, Modern Sizing and Patern Making for Women's and Children's Garments: A Scientific Study in Pattern Construction and a Standard Textbook for the Clothing Industry (Philip Kunick Publications, London, 1984) — 2. UJEVIĆ D, ROGALE D, HRASTINSKI M, DRENOVAC M, SZIROVICZA L, LAZIBAT T, BAČIĆ J,. PREBEG Ž, MENCL-BAJS Z, MUJKIĆ A, ŠUTINA M, KLANAC I, BRLOBAŠIĆ ŠAJATOVIĆ B, DOLEŽAL K, HRŽENJAK R, Tekstil, 55 (2006) 11, 516 — 3. PHEASANT S, Bodyspace, Anthropometry Ergonomics and Design (Taylor & Francis, London, 1984). — 4. KEMSLEY R, Women's Measurements and Size – A Study Sponsored by the Joint Clothing Council Limited (HMSO, London, 1957). — 5. LOHMAN TG, ROCHE AF, MARTORELL R, Anthropometric Standardization Reference Manual (Human Kinetics Books, Illinois, 1998). — 6. BEAZLEY A, J Fashion Marketing and Management, 2 (1997) 55. — 7. UJEVIĆ D. Croatian Anthropometric System – situation, demands and perspective (Inovacijsko žarište, Bilten MZOŠ, 2004). — 8. BUZINA R, GRGIĆ Z, KOVAČEVIĆ M, MAVER H, MOMIROVIĆ K, RUDAN P, SCHMUTZER LJ, ŠTAMPAR-PLASAJ B, Morphologic and Functional Anthropometry (Praktikum biološke antropometrije, Zagreb, 1984). — 9. UJEVIĆ D, ROGALE D, HRASTINSKI M, DRAGČEVIĆ Z, LAZIBAT T, BRLOBAŠIĆ ŠAJATOVIĆ B, HRŽENJAK R, DOLEŽAL K, DRENOVAC M, KARABEGOVIĆ I, MIMICA Ž, SMOLEJ NARANČIĆ N, SZIROVICZA L, Croatian Anthropometric System – Path to Europe (2004). — 10. UJEVIĆ D, SZIROVICZA L, DIMEC M, Presentation of Investigation and Comparison of Garment Size Systems, Tekstil 52 (2003) 711. — 11. SMOLEJ NARANČIĆ N, SZIROVICZA L, Ergonomic Measurements. Investigation of the Anthropometric Status of Conscripts of the Croatian Army (Centre of Strategic Investigations of the Ministry of Defense of the Republic of Croatia, Zagreb, 1995). — 12. ISO 3635 – Size designation of clothes – Definitions and body measuremant procedure — 13. EN 13402 – Size designation of clothes – Terms, definitions and body measurement procedure — 14. KNEZ B, MILIČIĆ J, RUDAN P, SZIROVICZA L, TABORŠAK D, TUCAKOVIĆ-MUJAGIĆ LJ, Applied Anthropometry for Antropology, Biomedicine, Ergonomics and Standardization, Handbook for Fieldwork, (Republic of Croatia, Ministry of Defense, Zagreb, 1995). — 15. UJEVIĆ D, ROGALE D, DRENOVAC M, PEZELJ D, HRASTINSKI M, SMOLEJ-NARANČIĆ N, MIMICA Ž, HRŽENJAK R, Croatian Anthropometric System Meeting the European Union, Tekstil 54 (2005) 206. — 16. UJEVIĆ D, ROGALE D, HRASTINSKI M, SZIROVICZA L, MENCL–BAJS Z, BAČIĆ J, PREBEG Ž, MUJKIĆ A, VINKOVIĆ M, SMOLEJ-NARANČIĆ N, HRŽENJAK R, DOLEŽAL K, BRLOBAŠIĆ ŠAJATOVIĆ B, DRENOVAC M, PEZELJ D, LAZIBAT T, DRAGČEVIĆ Z, MIMICA Ž, NIKOLIĆ G, RUDAN P, KARABEGOVIĆ I, AKALOVIĆ J, FIRŠT–ROGALE S, PEZELJ E, PETRUNIĆ I, KLANAC I, LEŠINA I, ŠUTINA M, ŠABARIĆ I. Hrvatski antropometrijski sustav – Podloga za nove hrvatske norme za veličinu odjeće i obuće (Faculty of Textile Technology, University of Zagreb, Zagreb, 2006). — 17. MAIER A, Knitting Technology 22 (2000) 1, 32–36 — 18. UJEVIĆ D, Hrvatski antropometrijski sustav – stanje, potrebe i perspektiva, Inovacijsko žarište, [In Croatian] (Bilten MZOŠ, 2004). — 19. UJEVIĆ D, HRŽENJAK R Hrvatski antropometrijski sustav, [In Croatian] In: Proceedings (Prvi kongres znanstvenika iz domovine i inozemstva, Zagreb – Vukovar, 2004). — 20. UJEVIĆ D, ROGALE D, HRASTINSKI M: Tehnike konstruiranja i modeliranja odjeće, [In Croatian] (Faculty of Textile Technology, University of Zagreb, Zagreb, 2004). — 21. UJEVIĆ D, ROGALE D, HRASTINSKI M, DRAGČEVIĆ Z, LAZIBAT T, BRLOBAŠIĆ ŠAJATOVIĆ B, HRŽENJAK R, DOLEŽAL K, DRENOVAC M, KARABEGOVIĆ I, MIMICA Ž, SMOLEJ NARANČIĆ N, SZIROVICZA L, Hrvatski antropometrijski sustav – Priručnik za obrazovanje mjeritelja HAS-a, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2004). — 22. HRASTINSKI M, UJEVIĆ D: ISO 3635 i ISO 8559 – Temeljnica Hrvatskog antropometrijskog sustava, zbornik izlaganja na stručnom skupu, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2004). — 23. UJEVIĆ D, ROGALE D, HRASTINSKI M, SZIROVICZA L, BAČIĆ J, MENCL–BAJS Z, RUDAN P, DRENOVAC M, MUJKIĆ A, DRAGČEVIĆ Z, HRŽENJAK R, DOLEŽAL K, BRLOBAŠIĆ ŠAJATOVIĆ B, KARABEGOVIĆ I, SMOLEJ NARANČIĆ N, PREBEG Ž,

PEZELJ D, LAZIBAT T, AKALOVIĆ J, VINKOVIĆ M, PETRUNIĆ I, MIMICA Ž, KLANAC I, LEŠINA I, ŠUTINA M: Hrvatski antropometrijski sustav – Rezultati antropometrijskih mjerenja djece dobi do 5,4 godine starosti, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2006). — 24. UJEVIĆ D, ROGALE D, HRASTINSKI M, SZIROVICZA L, BAČIĆ J, MENCL–BAJS Z, RUDAN P, DRENOVAC M, MUJKIĆ A, DRAGČEVIĆ Z, HRŽENJAK R, DOLEŽAL K, BRLOBAŠIĆ ŠAJATOVIĆ B, KARABEGOVIĆ I, SMOLEJ NARANČIĆ N, PREBEG Ž, PEZELJ D, LAZIBAT T, AKALOVIĆ J, VINKOVIĆ M, PETRUNIĆ I, MIMICA Ž, KLANAC I, LEŠINA I, ŠUTINA M, Hrvatski antropometrijski sustav – Rezultati antropometrijskih mjerenja dječaka dobi od 5,5 do 12,4 godine starosti, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2006). — 25. UJEVIĆ D, ROGALE D, HRASTINSKI M, SZIROVICZA L, BAČIĆ J, MENCL–BAJS Z, RUDAN P, DRENOVAC M, MUJKIĆ A, DRAGČEVIĆ Z, HRŽENJAK R, DOLEŽAL K, BRLOBAŠIĆ ŠAJATOVIĆ B, KARABEGOVIĆ I, SMOLEJ NARANČIĆ N, PREBEG Ž, PEZELJ D, LAZIBAT T, AKALOVIĆ J, VINKOVIĆ M, PETRUNIĆ I, MIMICA Ž, KLANAC I, LEŠINA I, ŠUTINA M, Hrvatski antropometrijski sustav – Rezultati antropometrijskih mjerenja djevojčica dobi od 5,5 do 12,4 godine starosti, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2006). — 26. UJEVIĆ D, ROGALE D, HRASTINSKI M, SZIROVICZA L, BAČIĆ J, MENCL–BAJS Z, RUDAN P, DRENOVAC M, MUJKIĆ A, DRAGČEVIĆ Z, HRŽENJAK R, DOLEŽAL K, BRLOBAŠIĆ ŠAJATOVIĆ B, KARABEGOVIĆ I, SMOLEJ NARANČIĆ N, PREBEG Ž, PEZELJ D, LAZIBAT T, AKALOVIĆ J, VINKOVIĆ M, PETRUNIĆ I, MIMICA Ž, KLANAC I, LEŠINA I, ŠUTINA M, Hrvatski antropometrijski sustav – Rezultati antropometrijskih mjerenja mladića dobi od 12,5 do 20,4 godine starosti, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2006). — 27. UJEVIĆ D, ROGALE D, HRASTINSKI M, SZIROVICZA L, BAČIĆ J, MENCL–BAJS Z, RUDAN P, DRENOVAC M, MUJKIĆ A, DRAGČEVIĆ Z, HRŽENJAK R, DOLEŽAL K, BRLOBAŠIĆ ŠAJATOVIĆ B, KARABEGOVIĆ I, SMOLEJ NARANČIĆ N, PREBEG Ž, PEZELJ D, LAZIBAT T, AKALOVIĆ J, VINKOVIĆ M, PETRUNIĆ I., MIMICA Ž, KLANAC I, LEŠINA I, ŠUTINA M: Hrvatski antropometrijski sustav – Rezultati antropometrijskih mjerenja djevojaka dobi od 12,5 do 20,4 godine starosti, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2006). — 28. UJEVIĆ D, ROGALE D, HRASTINSKI M, SZIROVICZA L, BAČIĆ J, MENCL–BAJS Z, RUDAN P, DRENOVAC M, MUJKIĆ A, DRAGČEVIĆ Z, HRŽENJAK R, DOLEŽAL K, BRLOBAŠIĆ ŠAJATOVIĆ B, KARABEGOVIĆ I, SMOLEJ NARANČIĆ N, PREBEG Ž, PEZELJ D, LAZIBAT T, AKALOVIĆ J, VINKOVIĆ M, PETRUNIĆ I, MIMICA Ž, KLANAC I, LEŠINA I, ŠUTINA M, Hrvatski antropometrijski sustav – Rezultati antropometrijskih mjerenja muške populacije dobi od 18,5 do 82,0 godine starosti, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2006). — 29. UJEVIĆ D, ROGALE D, HRASTINSKI M, SZIROVICZA L, BAČIĆ J, MENCL–BAJS Z, RUDAN P, DRENOVAC M, MUJKIĆ A, DRAGČEVIĆ Z, HRŽENJAK R, DOLEŽAL K, BRLOBAŠIĆ ŠAJATOVIĆ B, KARABEGOVIĆ I, SMOLEJ NARANČIĆ N, PREBEG Ž, PEZELJ D., LAZIBAT T, AKALOVIĆ J, VINKOVIĆ M, PETRUNIĆ I, MIMICA Ž, KLANAC I, LEŠINA I, ŠUTINA M: Hrvatski antropometrijski sustav – Rezultati antropometrijskih mjerenja ženske populacije dobi od 18,5 do 82,0 godine starosti, [In Croatian] (Faculty of Textile Technology, University of Zagreb, 2006).

NOVI ANTROPOMETRIJSKI INSTRUMENTI

S A Ž E T A K

Antropometrijski pregledi provode se od 1901. god. (USA), s ciljem razvoja i daljnjeg unaprjeđenja sustava veličina za odjeću i obuću. Značajan doprinos ovoj problematici uočava se zadnjih desetljeća, kada je osnovan tehnički odbor i kada su propozicije propisane u ISO normnom nizu i u Seriji Europskih normi (EN). Pri antropometrijskom mjerenju koriste se dvije metode i to: konvencionalna s uporabom antropometrijskih instrumenata i primjenom 3D body skenera. Metoda 3D skeniranja je puno brža, preciznija i jednostavnija, ali istovremeno kompleksnija, skuplja i selektivnija. U okviru STIRP-a *Hrvatski antropometrijski sustav* primjenjena je klasična metoda posebno iz razloga što je od ukupnog uzorka od 30.866 ispitanika (0.68% ukupne populacije u RH), trebalo biti i izmjereno je 6.380 djece u dobi do 5.4 godine. Iz tog razloga prišlo se i razvoju novih antropometrijskih instrumenata s ciljem daljnjeg razvoja i unaprijeđenja postojećih. U skladu s tim u ovom radu je vrlo precizno opisan novi antropometar s dva kraka koji uz preciznost mjerenja doprinosi stabilnosti instrumenata pri mjerenju većeg broja ispitanika, a priložena su i vrlo precizna tehnička rješenja novog antropometra. Predstavljeni su i opisani novi kutomjeri za određivanje kosine ramena. Nadalje, opisane su prednosti novih rješenja kutomjera za mjerenje jednog ramena te za mjerenje oba ramena istodobno. Za nove antropometrijske instrumente podnesene su dvije patentne prijave.