Title: Criminology

Topics: Physics – measurement of quantities – length Mathematics – working with expressions, statistics – average value, ploting a graph	**Time**: 90 minutes	**Age**: 14-16

Differentiation:	**Guidelines, ICT support etc.:** ICT – Excel (GeoGebra) Software Faces

Equipment needed for this activity: Measure tape, calculator, chalk, water, paper, computer, internet, worksheets **Required knowledge:** Working with computer programs Excel, GeoGebra **Health and Safety:** Wet shoes – the ground may be slippery.	**Learning outcomes for this activity:** Work with text (text staging study of criminology and trasology) Application of basic formulas for calculating the statistical characteristics of the file Students will carry out practical measurements - work in groups. Students process their measurements, plot a graph. Students draw up and implement tasks, carry on discussions Students process results in available computer programs, search for information from the biometric laboratory and compare the measured results in the classroom with biometric statistics Students work with the PC – software Faces

Lesson description

Motivation
Criminology around us, revising the fundamental mathematical links with statistics, physical concepts trajectory, velocity, unit conversions lengths

Students read the introductory text

Main activity

Students work in groups.
Laboratory work – students perform measurements according to the prepared instructions.
Students process results of the measured values.
Groups present the results of their measurements.
Final data processing in the classroom.

Search for biometric tables on the Internet. Comparison of class student's height with printed results of statistical surveys. Discussion on gender dependence. Trasology importance in criminology.
Further study:
http://www.prisonstudies.org/sites/prisonstudies.org/files/resources/downloads/world_pre-trial_imprisonment_list_2nd_edition_1.pdf

Study text

Trasology

Trasology is a branch of forensic techniques that specializes in identifying, securing and examining of bare foot and shoeprints, vehicles and other objects of similar kind traces.

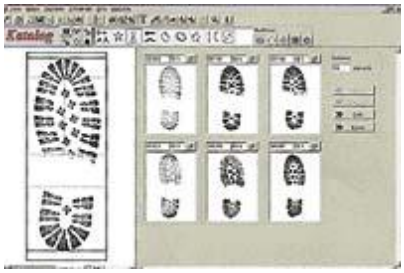
 (Taken: http://img.blesk.cz/static/old_abc/abctisk/47/3/53558.jpg)

Fig. 1 Traces

(Taken: https://www.google.cz/?gfe_rd=cr&ei=gh0AVMqDH8T4-gaSuoDQBg&gws_rd=ssl#q=trasologie&start=0) Obr. 1 Stopy

Trasology traces;
depict characters of external structure of the object that left them, often to such an extent that they can be used for individual identification or at least class identification of the object. They contain information on its properties and also on the mechanism and circumstances of the trace. Some types of trasology traces are the image of biological properties of a man. In particular, bare footprints, traces of human locomotion, ears and teeth prints. Other prints that can be find - trasology traces such as elbows, knees, lips and other parts of a body. Trasology uses and develops the knowledge of physics, geometry and morphology.

Identification of persons by bare feet traces

Bare foot print - the so-called **plantogram** - arises from foot contact with the pad under loading of the own body weight. In this case ridges are shown and so we can rank it among fingerprint traces. At the scene we can find the so-called locomotion paths. On the foot we can measure nineteen characteristics usable for identification. Among them we can rank inch angle, the angle of the foot, flatness of the foot and the so-called bumps (curvature in the line of footprints in the metatarsal area). The research results so far confirm the assumption that there are no two people with the same combination of these dimensions on one leg and in case of usage of both feet plantogram the probability of successful identification increased significantly. In addition, from individual characteristics of bare foot we can determine the body height.

To calculate the height of the body from the knowledge of bare feet characteristics (b_h) we can use the formula, which Bertillon published in 1989 (in the journal Revue Scientifique):

body height (b_h): $b_h = 6.98 \cdot L - 0.1$.

Nowadays the height of the body is calculated with help of the formula:

Male: b_h = 95.60 + 2.88 x length of bare foot (cm)
Female: b_h = 91.10 + 2.84 x length of bare foot (cm)

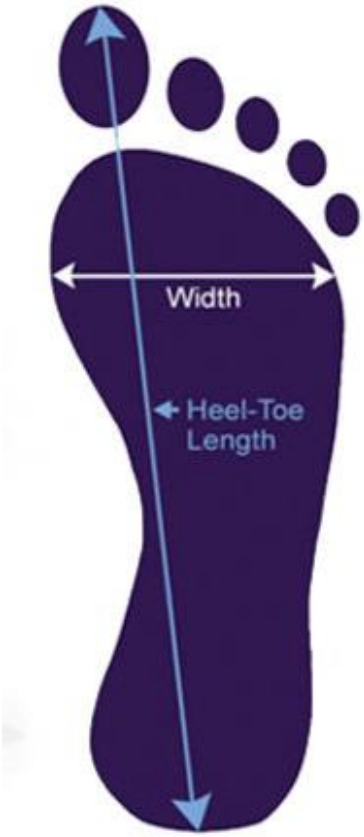


Fig. 2 Bare footprint

In practice we mostly use the formula published by Prof. Straus. Using this formula you can calculate body height by using the boot trace with a precision of 4 cm:

b_h = 2.6 x length boots + 4.3 x width boots + 55 (all in cm).

Identification of persons by human locomotion [citation 3]

The method of identification of people by their walk has been recognized since the early nineties. One of the advantages of this method is that the footage recorded using video cameras used for identification can be recorded at low resolution. It means that monitoring can be carried out from relatively large distances and the persons do not know, that they are monitored. From geometric symbols we can be read information about the musculoskeletal system of the individual, kinematic characteristics indicate the speed and dynamic characters display power and energy relationship of movement. From bipedal locomotion footprint we can also deduce locomotion habits or anomalies (lameness).
Functional and dynamic locomotion habits are fairly stereotypical, but on the other hand, are variable within certain types of relocation, such as fast or slow walking, running, etc. Human gait may change rapidly under the influence of external factors - carrying a heavy load, rough roads (steep descent or ascent) and internal causes (pain, fatigue, etc.).

The disadvantage of identification of a person by walking is, as it was mentioned above, that although each person gait is theoretically unique in ideal conditions, changing conditions may cause more deviations of one person's gait than those between two different people, in addition people can deliberately change their gait. These circumstances lead to discussions about how accurate the identification of the peson by their walk can actually be.

For our purposes we will analyze parting locomotion - measure stride length and double step length using the relations a) and b) determine the height of the person who left a footprint.

a) Determination of a body height (b_h) from stride length (s) and double step length (ds):

$$b_h = 0.153 \cdot s + 0.083 \cdot ds + 155$$

b) Findings of height (b_h) from a length (s), double step (ds), length of the shoeprint (dSO) and width of the shoeprint (sSO):

$$b_h = 0.076 \cdot s + 0.041 \cdot ds + 1.35 \cdot dSO + 2.4 \cdot sSO + 101.25$$

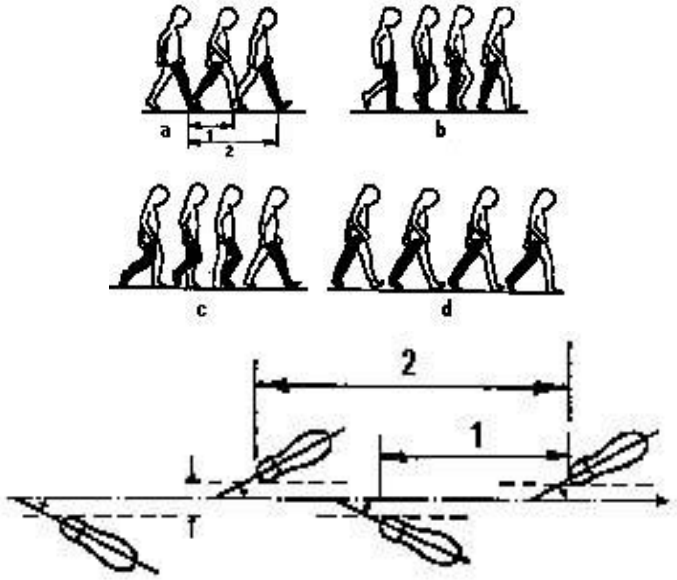


Fig. 3 Measurement of stride (1) and double step length (2)

c) walking speed

$$v = 9{,}314 \cdot s - 2.226$$

where v - locomotion speed (m / s), s - stride length (m).

Laboratory work 1

a) Measurement of bare foot length. We can use the plastic ruler with graduations in mm. The length of bare feet is measured by every student (left and right foot is measured).

Measurement is repeated three times for each foot. Then we calculate the arithmetic average of the measured values.

b) Measurement of bare foot width. The width is measured at the point of the greatest width under the big toe. Measurement is repeated 3 times for each foot.

Measured directly on the leg or bear it on the foot pad and measure the bare foot. (We can moisturize the foot or use sand (soil) to get a trace)

c) Measurement of the length of the shoe. Using a plastic ruler measure the length of the shoe. The measurement is repeated 3 times for each leg. Calculate the arithmetic mean of the measured values.

d) Measurement of the width of the shoe. Using a plastic ruler measure the width of the shoe. The measurement is repeated 3 times for each leg. Calculate the arithmetic average of the measured values.

Students process their measurement in the group; each group presents its results. All measurements are summarized and a graph is drawn. Students will find the average value.

How to organize your data can be found on http://www.ehow.com/how_4487738_make-pictograph.

Additional task: When calculating the average values of foot length distinguish girls from boys in the group.

On completion of the work in groups prepare a summary table and calculate the arithmetic average, variance and standard deviation for each item. Use the results obtained to calculate the height of the person's body. Use the formula given in the introduction.
The results are compared with the biometric table (body height for the given child's age).
http://ciselnik.artega.cz/prumerna_vyska_a_vaha_ditete_dle_veku.php

Age (years)	Height boys (cm)	Height girls (cm)
10	141	141
11	147	148
12	153	154
13	160	160
14	168	164
15	174	165
16	177	166

Laboratory work 2 "parting locomotion"

Objective: By measuring a stride length and double step length determine the body height.

Students work in pairs. Use colored chalk to "dirty" shoe sole (or draw it) and on a suitable base (paper cloth) make a few shoeprints when walking. Use a tape to measure a step and double step length for the motion. Using relations (b) and (c) calculate the body height and the velocity of the motion.

Note: For processing the results of the measurement we can use the computer program Excel as well (tables, graphs, calculation of the arithmetic average), respectively GeoGebra.

Conclusion and discussion

Shoe prints are very important. Most suspects wear shoes and footprints are always left. Walking pattern is highly individualistic. It may therefore be of great value to study an individual. Class Characteristics can be used to eliminate a suspected shoe or suggest a shoe could have made the impression. Practical application of forensic biomechanics in criminalistic are according to prof. Straus in following directions – fall biomechanics (43%), judgement of extreme dynamic loading the organism (24%), biomechanical analysis of fall from stand on ground or fall from stairs (15%), biomechanical analysis of walk (4%) and analysis of conflict (4%). The information gathered during examination of footprints and also on closed circuit television (CCTV) may be of value for forensic application.

Further reading

In the year 2013 there were 325.366 crimes recorded in the Czech Republic. This is the fourth lowest number of crimes recorded since the year 1993, i.e. for the last 21 years.

Solved crime cases have been for a long time over 40 %. Last year it amounted up to 43.7 %. “In absolute terms we have solved 129 182 crimes and additionally 13 025 offences, so a total number is 142 207 deeds, i.e. about 8 834 more than in the year 2012. (39.70%, +0, 24%).

More information about criminology at www.prisonstudies.org

For the record: World top 10

Countries with highest reported crime rates:
(According to Total persons brought into formal contact with the police and/or criminal justice system, all crimes)

RANK	COUNTRY	Count: (2011)
1	United States of America	12,408,899
2	Germany	2,112,843
3	France	1,172,547
4	Russian Federation	1,041,340
5	Italy	900,870
6	Canada	628,920
7	Chile	611,322
8	Poland	521,942
9	Spain	377,965
10	Netherlands	372,305

http://www.mapsofworld.com/world-top-ten/countries-with-highest-reported-crime-rates.html

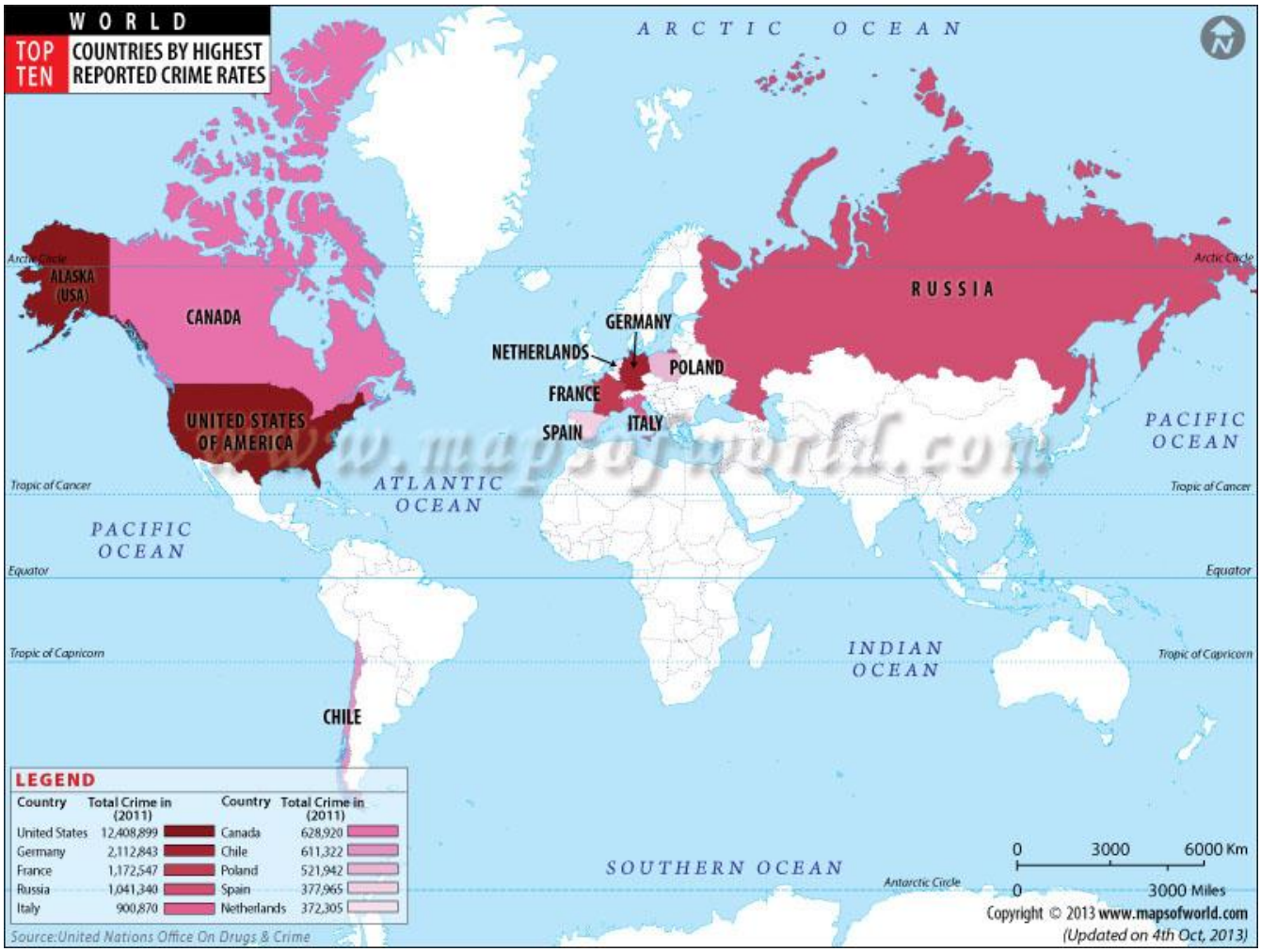
Additional activity

Compile a portrait of the crime! Use the software Faces.

Available at http://www.mat2smc-project.eu/index.asp?lang=en

References:

1. Straus, J. *Aplikace forenzní biomechaniky.* Praha: Police History, 2001
2. http://digilib.k.utb.cz/bitstream/handle/10563/16078/hajda_2011_bp.pdf?sequence=1
3. Straus, J; Porada, V. *Kriminalistická trasologie*. Praha : Kriminalistický ústav Praha Policie ČR, 2004. 287 s. ISBN 80-7251-160-2.


WORLD
TOP TEN
COUNTRIES BY HIGHEST REPORTED CRIME RATES
ARCTIC OCEAN
Arctic Circle
ALASKA (USA)
CANADA
UNITED STATES OF AMERICA
RUSSIA
GERMANY
NETHERLANDS
POLAND
FRANCE
SPAIN
ITALY
PACIFIC OCEAN
ATLANTIC OCEAN
Tropic of Cancer
Equator
Tropic of Capricorn
INDIAN OCEAN
CHILE
SOUTHERN OCEAN
Antarctic Circle
LEGEND
Country | Total Crime in (2011) | Country | Total Crime in (2011)
United States 12,408,899 | Canada 628,920
Germany 2,112,843 | Chile 611,322
France 1,172,547 | Poland 521,942
Russia 1,041,340 | Spain 377,965
Italy 900,870 | Netherlands 372,305
Source:United Nations Office On Drugs & Crime
0 3000 6000 Km
0 3000 Miles
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