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# Measurement set-up design for archaeological experiments

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## Résumé

The measurement of physical quantities in science is an important tool to gain insight into the system of interest. The quantification of physical variables is free of subjective bias and therefore allows understanding and validation of the relationship between those variables and the underlying processes. In archaeology we are interested in the relationship between object modifications or traces and the task that leads to such modifications. Experimental studies, which use sensors to monitor the task execution show that it is helpful to isolate the relevant quantities from the complex process of human manipulation. The relevant quantities often comprise kinetic trajectories of the experimental tool used including position, velocity, force, and the musculoskeletal variables of the subject, e.g. body kinematics, and muscle activity. Traditionally, the focus is on tasks like stone knapping, scraping, or spear handling. In this contribution we want to give a short overview of how such a set-up should be designed in order to obtain the measurements desired to answer the scientific questioning. Important considerations are based on the characteristics of the task studied, like the speed and range of the motion, and expected peak values. Related questions are: Which sensor type can be used for a certain physical quantity. What specification should the sensor meet. What are the requirements for the measurement chain connected to it. How should the sensor be integrated in the tool? What is the expected cost of a good set up? What are suitable tools for data processing? We will present three examples of measurement set-ups, which we were using recently for

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the study of scraping, spear thrusting and spear throwing. On the basis of these examples we evaluate different solutions, and point out pitfalls that should be avoided. Special emphasis is set on a robotic position measurement system based on camera and accelerometer measurements together with state estimation. This solution is rather cheap compared to commercial motion tracking systems, but requires more effort in installation and coordination of the sensors as well as appropriate processing software. The results of our measurement-based studies on tool-use show that precise measuring and monitoring of physical variables provide valuable insights to the principle processes of trace development.

**Mots-Clés:** measurements, setup, sensor, experiments, archaeology, tool, usewear