

Division III – Mechanical and Electrical Engineering

IPEK – Institute of Product Engineering

PTP – Power Tool Test Lab

Fully Automatic Testing of Power Tools for Product Development

Technical systems can only be validated in interaction with their surrounding systems. Surrounding systems that interact with power tools are the user and the environment. IPEK – Institute of Product Engineering of Karlsruhe Institute of Technology (KIT) has developed the Power Tool Test Lab for scientific studies of interactions between the power tool and the user. The Test Lab allows fully automatic and reproducible simulation of these partial systems and their interactions in the product development stage. The Power Tool Test Lab comprises three test rigs.

Automatic Power Tool Test Rig for Active and Passive User Influences

The **automatic power tool test rig** consists of an industrial robot to which a hand-arm model is attached. Via the robot, active user forces, e.g. feed force, determined in prior manual tests are applied to the power tool. In future, the automatic power tool test rig is planned to be complemented by a control for dynamic variation of these active forces, which still is under development. Passive dynamic properties, such as mechanical vibrations in the human arm during interaction with power tools, have been reproduced by a commercial hand-arm model so far. Research, however, is aimed at developing new highly valid handarm models for the automatic power tool test rig. They will enable parallel integration of passive user properties and active user behavior when testing power tools.

Development of Highly Valid Hand-arm Models

The **user interaction test rig** measures passive dynamic properties of the user. Vibration excitation by an electromechanical shaker system allows dynamic characterization of human hand-arm systems. The excitation is either translational, rotational or superimposed in a maximum of two degrees of freedom. Frequencies of up to 1000 Hz can be generated. For transfer to the power tool, vibration responses of the user are measured directly at the hand using a specially developed measurement handle. The suspension of the shaker system allows free positioning of the measurement handle in vertical direction. In addition, the shaker system can be tilted for investigating different body postures. This is the only test facility of its kind worldwide. With the data collected, mechanical hand-arm models can be further developed and produced in the future.



IPEK Power Tool Test Lab: Research project to understand, simulate, and model user influence on power tools

The hand-arm models are validated directly at the shaker system. Their use in the automatic power tool test rig will then allow reproducible power tool tests under close-to-application conditions.

Reproducible Testing on the Surface

Combination of the automatic power tool test rig with the power tool interaction test rig, a widely usable surface positioning system, allows reproducible and automatic testing of power tools taking into account passive and active user influences on various surfaces. Orientation of the surfaces can be varied for modeling different application scenarios. A temperature control unit enables simulation of various climatic conditions in order to push the power tools to their performance limits. Dust extraction and noise protection devices are integrated for tests of power tools in permanent operation under compliance with all legal requirements.



Person operating the user interaction test rig for measuring dynamic properties of the hand-arm system when working overhead

Automatic power tool test rig

Setup

- APP Automatic power tool test rig. Industrial robot with attached hand-arm model.
- PIP Power tool interaction test rig.
 Flexible surface positioning system to simulate various applications.
- AIP User interaction test rig.
 - Shaker system to determine passive dynamic hand-arm properties in the translatory and rotatory modes.

Goals

- Reproducible simulation of the relevant impact of the user on power tools.
- Development of highly valid hand-arm models.
- Development of a robot control to simulate active user behavior.

Technical Data

Robot KR 500MT	
Nominal lifting capacity	500 kg
Maximum acceleration	2 m/s ²
Repetition accuracy	± 0.08 mm
Surface Positioning System	
Materials	Concrete, steel, wood
Max. material dimensions	2.4 m x 1.6 m x 0.2 m
Rotation range	-90 to +90°
Travel adjustment	0.5 to 3.5 m
Shaker System	
Axial acceleration	About 1000 m/s ²
Angular acceleration	About 1000 m/s ²
Excitation frequencies	0 to 1000 Hz
Force measurement	In the handle, at the hand

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