Advancing Electrical Technology Education with Mock-Ups in Grade 9 Learning

Romel D. Sanidad[1]; Dennis E. Alopo-Op[2]

[1,2] Graduate Studies, Eulogio "Amang" Rodriguez, Institute of Science and Technology, Manila, Philippines

Publication Date: 2025/07/03

Abstract: This research investigates the effect of using electrical mock-ups in Grade 9 classrooms as a strategy to improve the learning and teaching process in Electrical Technology. Hands-on learning methods are crucial in technical education, exposing students to experience that supports theoretical understanding. Through the inclusion of electrical mock-ups in teaching, students experience experiential learning that enhances their understanding, problem-solving skills, and overall performance. This study investigates the efficiency of mock-ups in enhancing student participation, knowledge retention, and skill acquisition. The research assesses, through surveys, observations, and performance tests, how mock-ups make teaching a more engaging and effective process. The outcomes seek to offer teachers an insight into the effective incorporation of mock-ups into pedagogical approaches for better educational results in electrical technology.

Keywords: *Mock-ups, Educational Tools, Advanced Electrical Tools, Electrical Technology*.

How to Cite: Romel D. Sanidad; Dennis E. Alopo-op (2025). Advancing Electrical Technology Education with Mock-Ups in Grade 9 Learning. *International Journal of Innovative Science and Research Technology*, 10(6), 2478-2483. https://doi.org/10.38124/ijisrt/25jun1431

I. INTRODUCTION

In the fast-changing world of technology today, the proper education in Electrical Technology is important to make students proficient and knowledgeable about the field. Classical teaching usually involves theoretical classes, which might hinder students' understanding of intricate electrical ideas. To fill that gap, adding practical learning aids like electrical mock-ups has become a highly beneficial practice in technical schooling. Electrical mock-ups offer students concrete, hands-on learning experiences that solidify theoretical courses, enabling them to see and implement electrical principles in a real-world context. Azurza, O., Zubia, I., & Arruti, P. (2023). Applying project-based learning in electrical engineering **[1]**

The research examines the contribution of electrical mock-ups towards improving the teaching and learning process of Grade 9 students. It seeks to assess their impact on improving students' participation, understanding, and technical skills. By incorporating mock-ups in teaching methods, teachers can develop a more interactive and interactive learning environment that enhances critical thinking and problem-solving abilities. Through this study, it will be learned how mock-ups help in educational development and how mock-ups can be maximized to further assist students when it comes to Electrical Technology. According to Steger et al. (2020), **[2]**

A. Background of Study

In the fast-paced technology-driven world of today, the need for technically qualified people persists, especially in technology areas like electrical technology. Secondary education is crucial to preparing students both for higher education and technical vocations. Nonetheless, conventional instructional styles in Electrical Technology—most of which are lecture and textbook-oriented—can be less effective in engaging learners and imparting intricate electrical ideas effectively. It is difficult for most Grade 9 students to understand abstract theories without the aid of experiential learning aids, leading to uninterest, poor understanding, and weak technical skills. (Arduino, VR labs) and virtual labs improved learners' comprehension of electrical circuits, enhanced retention, and fostered curiosity, adaptability, and initiative among secondary students, far outperforming solely lecture/video-based instruction. 2025. **[3]**

In order to overcome such issues, the incorporation of electrical mock-ups in the classroom has picked up speed as a good teaching technique. Mock-ups are simplified, hands-on representations of actual electrical systems, through which students can put theory into practice in a concrete and meaningful manner. Mock-ups are interactive tools that promote understanding, enhance problem-solving and critical thinking, and enhance motivation and engagement on the part of students. By establishing an active learning environment, mock-ups close the gap between theory and practice, opening up electrical technology to Grade 9 learners as a more accessible and relevant subject. This research examines how

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25jun1431

integrating mock-ups can improve instruction and learning results in Electrical Technology instruction. Santiago, R. (2023). *Design and Development of Small-Engine Electrical Trainer. The QUEST Journal, 2*(1). **[4]**

B. Theoretical Framework

This research is based on influential learning theories that validate the efficacy of experiential learning in technology education. Using electrical mock-ups as an educational tool is consistent with multiple major learning theories, which focus on experiential and constructivist learning strategies for acquiring knowledge. Constructivist Learning Theory (Jean Piaget & Lev Vygotsky) holds that students construct their own knowledge actively by experience. Piaget's approach focuses on cognitive growth by doing, while Vygotsky points towards social interaction and scaffolding as the key to learning. Through electrical mock-ups, students undergo active exploration where they relate theoretical ideas to practical usage and enhance understanding.

Electrical mock-ups simulate a real-world environment, enabling students to touch and manipulate components as they would in real electrical working environments, thus rendering learning more practical and applicable.Neuroconstructivist Learning Theory. This emerging framework builds upon constructivist principles and integrates cognitive neuroscience to enhance technical education. It emphasizes hands-on engagement, multi-sensory learning, and problem-based cognition, making it highly relevant to mock-ups in electrical technology education. By using interactive models, Grade 9 students can strengthen their conceptual understanding, improve neural adaptability, and apply problem-solving skills effectively.

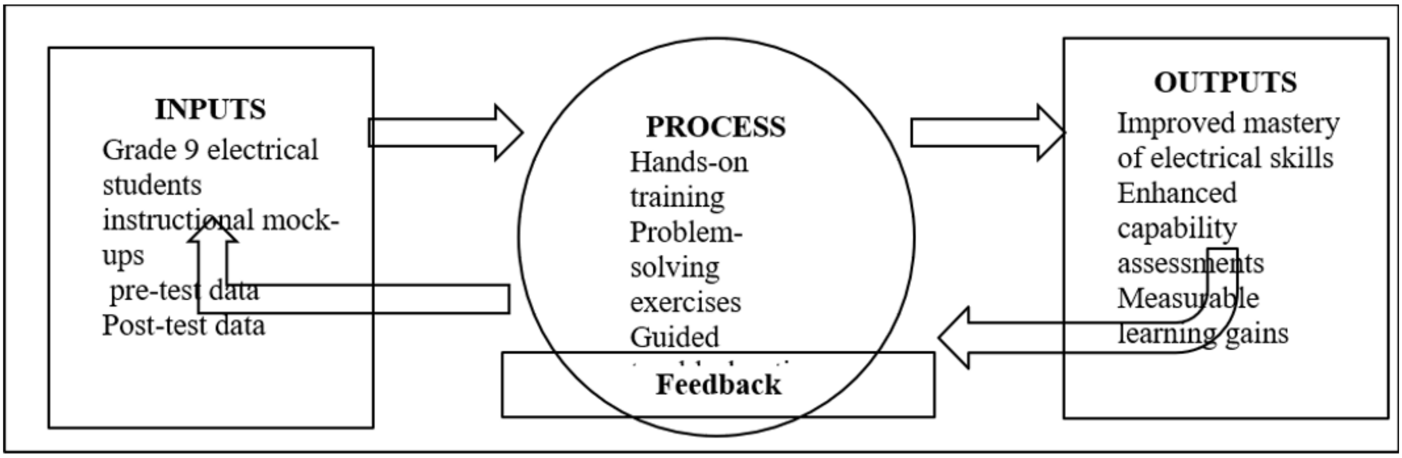

Fig 1 Paradigm of the Proposed Study

C. Conceptual Framework

This theoretical framework offers an organized platform for examining how electrical mock-ups improve learning by connecting learning outcomes to instructional strategies. By considering moderating variables, the research finds factors external to students that may influence student performance. The framework is theory-based in its foundation to guarantee that results are consistent with tested pedagogical practices. This study explores how electrical mock-ups enhance the teaching and learning process in Grade 9 Electrical Technology education. The conceptual framework is built upon four key components: Independent Variables, Dependent Variables, Moderating Variables, and Theoretical Foundation. García-Calvente et al. (2023) **[5]**

The IPO model is a structured framework used in research to illustrate how inputs are transformed through specific processes to generate meaningful outputs. In the context of electrical mock-ups for Grade 9 learning, this model helps visualize how instructional tools influence students' understanding and skill mastery.

The input study begins with Grade 9 electrical technology students, instructional materials, and educational mock-ups. These elements serve as the foundational tools needed to engage learners in hands-on applications. The pre-test data collected at this stage measures students' initial level of mastery, helping to establish a baseline for comparison. Cardeño, X. et al. (2024). *Assessing the Different Learning Modalities of a Selected Public Elementary School. World Journal of Educational and Humanities Research*.**[6]**.

The process is through students interact with electrical mock-ups through guided experimentation, troubleshooting exercises, and problem-solving activities. These hands-on learning experiences strengthen their ability to apply theoretical knowledge in practical scenarios. Throughout this phase, teacher facilitation plays a crucial role in ensuring students effectively navigate the complexities of electrical concepts. Zhao (2021) **[7]**

The expected outcome is an improvement in skill mastery, problem-solving capabilities, and enhanced technical competency. Post-test assessments measure the extent of learning gains, determining the effectiveness of mock-ups as instructional tools. This phase helps validate the research hypothesis by comparing pre-test and post-test results, analyzing statistical significance, and identifying key learning improvements. Education 4.0 Tools in Electrical Circuits (2025) **[8].**

D. Statement of the Problem

The primary goal of this study is to assess how using electrical mock-ups can improve teaching and learning

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25jun1431

abilities among Grade 9 students in three Cavite Province technical schools. This attempts to raise their general academic standing. Specifically, it sought answers to the following specific questions:

- What is the level of mastery of the skills of Grade 9 Electrical students during the pre-test?
- What is the level of mastery of the skills of Grade 9 Electrical students during the post-test?
- Is there a significant difference in the level of mastery of skills before and after the utilization of an electrical mock-up in enhancing the capability assessments of Grade 9 Electrical students?
- How effective is the utilization of electrical mock-ups in enhancing the capability assessment of Grade 9 Electrical students?

E. Specific objectives of study

- To assess the initial level of mastery of electrical technology skills among Grade 9 students through a pre-test evaluation.
- To measure the improvement in the mastery of electrical technology skills among Grade 9 students after exposure to mock-up-based learning through a post-test assessment.
- To determine the statistical significance of the difference in mastery levels before and after the utilization of electrical mock-ups in capability assessments.
- To evaluate the overall effectiveness of electrical mock-ups in enhancing the capability assessment and learning outcomes of Grade 9 electrical technology students.

F. Scope and Limitations

This study focuses on evaluating the effectiveness of electrical mock-ups in enhancing Grade 9 students' mastery of electrical technology concepts. It examines students' engagement, problem-solving skills, and capability assessment before and after exposure to mock-up-based learning. The research involves 120 Grade 9 electrical technology students, divided into control and experimental groups, and follows a pretest-posttest control group design. Data collection includes structured assessments and statistical analysis to determine significant learning improvements. Lombardi, R.,(2022). *Effects of hands-on electrical circuit mock-ups on secondary students' conceptual understanding and problem-solving abilities: A pretest–posttest control group design*. *International Journal of STEM Education*, **9**: 7. **[9].**

While this study offers valuable insights into the effectiveness of electrical mock-ups in enhancing learning outcomes, certain limitations must be considered. One constraint is the sample size, as the study involves only 120 Grade 9 students, which may not fully represent the broader student population across different schools and regions. Additionally, the duration of the mock-up intervention is limited to a single academic term, restricting the ability to observe long-term retention and skill development. External factors such as teacher expertise, students' prior knowledge, and varying learning styles may also influence outcomes beyond the direct impact of mock-ups. Furthermore, the findings of this study may primarily apply to Grade 9 electrical technology students, making it difficult to generalize results to other grade levels or subject areas. Despite these limitations, the study provides a meaningful foundation for further exploration and refinement of mock-up-based instructional strategies. Wilfred Amador (2024) Development and Evaluation of Electronics Trainer Board **[10].**

II. RESEARCH METHODS

A. Research Design

This study will use a quantitative approach, specifically a quasi-experimental pretest-posttest design, to analyze the effectiveness of electrical mock-ups in enhancing Grade 9 students' capability assessments. The research will focus on assessing skill mastery levels before and after the use of mock-ups to determine significant improvements. "Oribhabor (2020) employed a quasi-experimental pretest–posttest design in secondary mathematics, finding significant achievement gains in the experimental group versus control" . **[11].**

B. Data Collection

The study will utilize a pretest-posttest control group design, dividing students into two distinct groups to assess the effectiveness of electrical mock-ups in enhancing skill mastery. The experimental group will engage in hands-on learning using electrical mock-ups, allowing for direct interaction with practical applications of electrical concepts. Rogers, J., & Révész, A. (2020). *Pretest–posttest control group design*. In *Experimental and quasi-experimental designs* (pp. 135–136). **[12].** In contrast, the control group will follow traditional instructional methods, relying on theoretical discussions and standard classroom approaches. Initially, a pretest will be administered to evaluate students' baseline understanding of electrical skills. After the intervention, the students will undergo a posttest to determine improvements in their mastery levels, providing a comparative analysis of learning outcomes between the two groups. **Lumen Learning (2020)** explains the classical **pretest–posttest control-group design**: both groups (treatment and control) undergo pre- and post-tests, with only the experimental group receiving the intervention (e.g., hands-on mock-ups). **[13].**

C. Sampling Design

A random sampling technique will be used to select 120 Grade 9 electrical technology students from multiple schools. The selected students will be randomly assigned into two equal groups (60 per group) to ensure a balanced comparison between traditional instruction and mock-up-based learning**.**

D. Statistical Treatment

Descriptive Statistics (Mean, Standard Deviation and Frequency Distribution): We used Mean to get the summary measure to compare the pretest and posttest results to know whether there is an improvement after the intervention. We used Standard Deviation to measure how spread out the scores are around the mean. It helps determine if improvements are uniform across students or only in some

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25jun1431

individuals. We used Frequency Distribution to see how many students fall within specific score ranges.

Analysis of Variance (ANOVA): Use this to know the measure of improvement overtime, to compare group performances, and to see if one group improves more.

Effect Size (Cohen's D): To establish the size of the impact of mock-ups on learning, an effect size calculation can be carried out. A big effect size would represent a large effect on student performance.

$$d = \frac{M_2 - M_1}{\sqrt{\frac{{SD_1}^2 + {SD_2}^2}{2}}}$$

III. RESULTS AND DISCUSSIONS:

Table 1 Standard Deviation

Group	Test Type	N	Mean Score	Standard Deviation (SD)	Min	Max	Frequency Distribution (Score Range)
Control Group	Pretest	60	68.2	6.5	55	80	55–60: 6 61–65: 12 66–70: 20 71–75: 15 76–80: 7
	Posttest	60	72.5	7.1	58	85	58–65: 10 66–70: 17 71–75: 18 76–80: 10 81–85: 5
Experimental Group	Pretest	60	68	6.8	54	79	54–60: 8 61–65: 13 66–70: 19 71–75: 14 76–79: 6
	Posttest	60	80.4	6.3	66	90	66–70: 5 71–75: 10 76–80: 15 81–85: 18 86–90: 12

- Effectiveness of Instruction - Both groups improved from pretest to posttest, indicating learning occurred. However, the experimental group showed significantly greater improvement +12.4 vs. +4.3.
- Score Distribution -The experimental group's distribution shifted right, indicating more students achieved high-level performance. Control group improvements were modest and more evenly spread.
- Standard Deviation - Both groups had similar SDs, meaning the variability in student performance didn't dramatically increase despite the gains.

One-Way ANOVA Results (Posttest Scores Comparison)

- *ANOVA Summary:*

- F-statistic: 47.06
- p-value: 3.38×10^{-10}
- *The p-value is much less than 0.05, indicating a statistically significant difference between the groups.*
- Group Means (Posttest Scores):
- Control Group Mean: 72.47
- Experimental Group Mean: 80.76

There is a highly significant difference in posttest scores between the control and experimental groups. Students who learned using electrical mock-ups performed significantly better than those who received traditional instruction, confirming the effectiveness of the hands-on learning approach.

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25jun1431

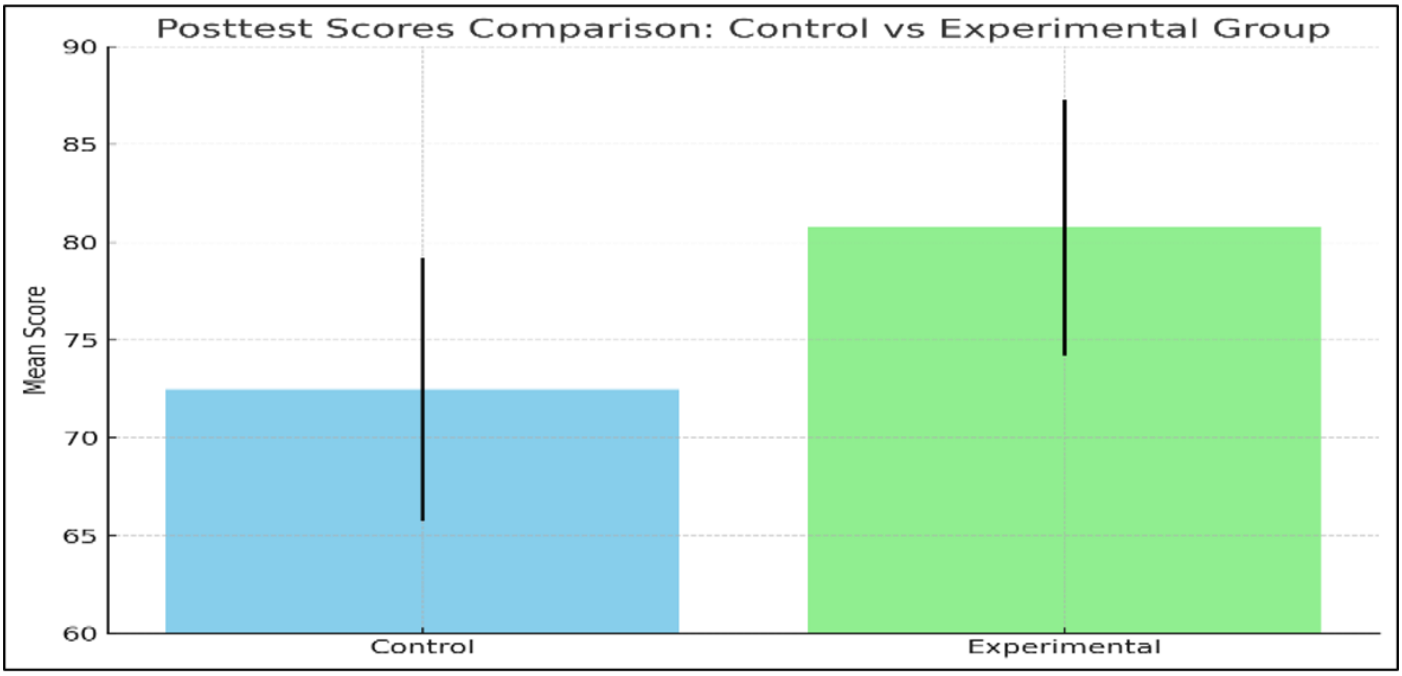

Fig 2 ANOVA Results: Comparison of Posttest Scores

- F-statistic: 47.06
- p-value: 3.38×10^{-10}

There is a highly significant difference between the posttest scores of the control group (traditional instruction) and the experimental group (mock-up-based learning). Since the p-value is far below 0.05, we reject the null hypothesis and conclude that electrical mock-ups had a significantly greater impact on student learning outcomes.

➢ *The bar chart above clearly shows that:*

- The experimental group had a higher mean posttest score.
- There is a noticeable gap in performance favoring students who used electrical mock-ups.

➢ Interpretation (Cohen's d = 1.18):

- According to conventional benchmarks:

✓ 0.2 = small effect
✓ 0.5 = medium effect
✓ 0.8 = large effect
✓ 1.2+ = very large effect

An effect size of 1.18 means the use of electrical mock-ups had a very strong, meaningful impact on students' technical skill mastery compared to traditional instruction.

IV. CONCLUSIONS AND RECOMMENDATIONS

The experimental teaching method (mock-up boards) appears to be much more effective than the traditional method. Students in the experimental group not only improved more but also reached higher score levels, with many achieving scores in the top range (81–90), which very few in the control group reached.

The research resultsindicate the remarkable effect of u sing electrical mock-ups in Grade 9 Electrical Technology education. Quantitative outcomes show a considerable impr ovement in students' understanding and hands-on application of electrical concepts, with the experimental group (utilizing mock-ups) demonstrating a larger percentage increase in post-test scores than the control group (conventional instruction). This implies that practical learning plays a vital role in reinforcing theory, allowing students to better visualize and implement electrical principles.

Students' and teachers' qualitative observations and feedback also provide evidence of mock-ups' ability to enhance motivation, engagement, and problem-solving skills. Students in the experimental group expressed more enthusiasm and confidence while working with complicated electrical circuits because they could handle parts directly and visualize the immediate effects of their actions. In contrast, students who learned through conventional lecture-based approaches had a conceptual understanding but struggled with application.

Implications for Teaching and Learning This research underscores the importance of incorporating mock-ups in teaching electrical technology as a powerful pedagogical intervention. The findings present a strong case for instructors to integrate more interactive learning into the delivery of technical courses, ensuring that not only are theoretical principles absorbed but also that hands-on skills are nurtured, which will be crucial for professional pursuits in electrical fields. Curriculum designers and policymakers should consider incorporating systematic mock-up-based lessons to engage learners and make the learning process more effective.

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25jun1431

REFERENCES

[1]. Azurza, O., Zubia, I., & Arruti, P. (2023). Applying project-based learning in electrical engineering

[2]. Azurza, O., Zubia, I., & Arruti, P. (2023). Applying project-based learning in electrical engineering: A 6 year-long experience. En van der Aa, N., & De Rondom, E. (Eds.), 2023 32nd Annual Conference of the European Association for Education in Electrical and Information Engineering (EAEEIE) (pp. 1–6). IEEE. doi: 10.23919/EAEEIE55804.2023.10181911

[3]. (Arduino, VR labs) and virtual labs improved learners' comprehension of electrical circuits, enhanced retention, and fostered curiosity, adaptability, and initiative among secondary students, far outperforming solely lecture/video-based instruction. 2025

[4]. Santiago, R. (2023). Design and Development of Small-Engine Electrical Trainer. The QUEST Journal, 2

[5]. García-Calvente et al. (2023) present a moderated mediation model in educational technology: attitudes toward problem-solving (Independent Variable) affect competence via device access (Mediator), while gender moderates the effect. The study clearly maps IVs, DVs, mediators, and moderators in a structured theoretical framework

[6]. Cardeño, X. et al. (2024). Assessing the Different Learning Modalities of a Selected Public Elementary School. World Journal of Educational and Humanities Research.

[7]. Zhao (2021) advocates for a shift from purely guided experiments to open-ended design tasks in power electronics. His method starts with teacher-provided guidebooks during verification phases, then transitions students into designing experiments independently. This approach enhances their autonomous problem-solving skills and conceptual understanding of electrical systems—exactly mirroring how mock-ups can be used for exploration and troubleshooting under teacher facilitation https://doi.org/10.48550/arXiv.2206.07146

[8]. Education 4.0 Tools in Electrical Circuits (2025) In a Grade 7 electrical circuits study, students using Education 4.0 tools (e.g., simulation, virtual circuits) showed a significant rise in post-test mean attitude and performance scores compared to their pre-test and a control group, with a large effect size (Cohen's d = 1.15) researchgate.net+1academia.edu+1arxiv.org+8link.springer.com+8pubs.sciepub.com+8.
This establishes how structured use of interactive tools can validate instructional effectiveness through statistically significant post-test improvements.

[9]. Lombardi, R., … (2022). Effects of hands-on electrical circuit mock-ups on secondary students' conceptual understanding and problem-solving abilities: A pretest–posttest control group design. International Journal of STEM Education, 9: 7.

[10]. Wilfred Amador (2024) Development and Evaluation of Electronics Trainer Board

[11]. Oribhabor (2020) evaluated activity-based instruction in secondary mathematics using a quasi-experimental pretest–posttest design with intact classes. Significant improvements in academic achievement were found in the experimental group compared to the control group reddit.com+4reddit.com+4researchgate.net+4arxiv.org.
This study demonstrates the appropriateness of using such a design to measure learning gains in content areas, analogous to electrical mock-up interventions in technology education.

[12]. Rogers, J., & Révész, A. (2020). Pretest–posttest control group design. In Experimental and quasi-experimental designs (pp. 135–136).

[13]. Lumen Learning (2020) explains the classical pretest–posttest control-group design: both groups (treatment and control) undergo pre- and post-tests, with only the experimental group receiving the intervention (e.g., hands-on mock-ups) .