

COOPER-HARPER HANDLING QUALITIES RATING SCALE

Authored by
mohammad looti

November 12, 2025

RECOMMENDED CITATION

mohammad looti (2025). *COOPER-HARPER HANDLING QUALITIES RATING SCALE*.
PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=68559>

COOPER-HARPER HANDLING QUALITIES RATING SCALE

Primary Disciplinary Field(s): Aerospace Engineering, Human Factors, Aviation Psychology

1. Core Definition

The Cooper-Harper Handling Qualities Rating Scale (CH HQR) is a highly specialized, ten-point ordinal scale utilized primarily in aerospace engineering and flight testing to quantify the subjective opinion of a test pilot regarding the handling qualities of an aircraft during specific, defined flight tasks. Unlike purely objective engineering measurements, the CH HQR provides a standardized method for translating a pilot's complex, nuanced subjective assessment of controllability, stability, and required mental workload into a quantitative value that engineers can use to refine aircraft design and flight control systems. The scale serves as a crucial bridge between the mathematical modeling of aircraft dynamics and the operational reality experienced by the human interface--the pilot--making it an indispensable tool for certifying the airworthiness and operational suitability of new aircraft designs or modifications to existing ones. This systematic approach allows for the rigorous comparison of handling characteristics across different flight regimes or design iterations, providing actionable data that directly correlates to pilot satisfaction and operational safety margins.

The core function of the scale is to assess the level of difficulty a pilot encounters when attempting to maintain a desired flight path or execute a specific maneuver, such as landing in a crosswind or performing high-G turns. A central feature of the CH HQR is its inherent structure, which incorporates a decision-tree methodology. This methodology forces the pilot to systematically answer a series of cascading questions relating to the adequacy of aircraft performance, the requirement for pilot compensation (effort), and the overall quality of control. The final assigned numerical rating is therefore not merely an arbitrary score, but the result of a structured psychological evaluation process that isolates deficiencies in the aircraft's control response or stability characteristics. Ratings range from 1 (Excellent, highly satisfactory, minimal compensation required) to 10 (Major deficiencies, uncontrollable, catastrophic).

In the context of the initial research environment, the CH HQR was postulated as a generalized measure of pilot mental load, designed specifically for use by pilots following extensive test flights focusing on maneuvering aspects. The underlying necessity for such a standardized measure arose from the recognition that highly complex and high-performance aircraft, particularly those developed during the Cold War era, placed increasingly high demands on pilot cognitive resources. A rating of 1 to 3 indicates satisfactory handling, generally deemed acceptable for operational use; 4 to 6 suggests deficiencies requiring moderate pilot compensation but still acceptable for specific mission phases; and 7 to 10 signifies handling qualities that are deficient, unacceptable, or even dangerous, necessitating redesign or major modifications before fielding the aircraft.

2. Etymology and Historical Development

The Cooper-Harper Handling Qualities Rating Scale traces its origins to the collaborative work of two distinguished American aerospace test pilots, **Robert P. Harper, Jr.**, and **George F. Cooper**. Their work, primarily conducted within the framework of the National Aeronautics and Space Administration (NASA) and its predecessor, the National Advisory Committee for Aeronautics (NACA), sought to address a critical ambiguity in the aircraft development process: the lack of a reliable, objective method for documenting and comparing qualitative pilot assessments. Prior to the establishment of the CH HQR, pilot commentary often relied on vague terminology, making it difficult for engineers to pinpoint the specific aircraft characteristics causing dissatisfaction or high workload.

George Cooper, a prominent researcher at NACA/NASA Ames Research Center, had previously been involved in developing earlier iterations of handling qualities scales, notably the 1957 Cooper Scale. However, as aircraft complexity increased--particularly with the advent of supersonic flight and complex, fly-by-wire control systems--a more robust and detailed framework was needed. Robert Harper joined Cooper in refining this concept, culminating in the seminal publication of the full, ten-point Cooper-Harper scale in 1969 (NASA Technical Note D-5153, "The Use of Pilot Rating in the Evaluation of Aircraft Handling Qualities"). This publication provided the definitive decision-tree logic and standardized descriptors that are still used internationally today, ensuring that the subjective assessment of control response is systematically linked to the objective requirements of the mission.

The development was largely driven by the demands of complex military and experimental programs which required precise feedback on dynamic stability and control effectiveness. The scale gained rapid acceptance because it formalized the link between the subjective experience of pilot compensation--the degree to which the pilot must exert mental and physical effort to achieve the desired flight path--and measurable engineering criteria. The CH HQR successfully institutionalized the feedback loop between the test pilot (the primary sensor) and the design engineer, establishing a common language for discussing critical aspects of aircraft performance that fall under the umbrella of handling qualities. The resulting standardization proved invaluable, moving handling quality evaluation from an anecdotal exercise to a rigorous scientific discipline supported by documented methodology.

3. Key Concepts and Components

The CH HQR is fundamentally built upon three interlocking concepts: the definition of the **Task**, the assessment of **Compensation Required**, and the determination of **Adequacy of Performance**. The effectiveness of the rating is highly contingent upon the precise definition of the flight task being evaluated, often referred to as the Mission Task Element (MTE). The MTE defines the

specific maneuver, the flight environment (e.g., turbulence, visibility), and the performance standards required (e.g., maintaining altitude within plus or minus 50 feet). Without a clearly defined MTE, the resulting CH HQR score loses its context and engineering utility.

The scale operates through a structured decision tree that leads the pilot through a series of yes/no questions:

Initial Assessment of Performance Adequacy: The pilot first asks if the aircraft performance is adequate for the specified MTE, resulting in a binary split between satisfactory and unsatisfactory conditions.

Pilot Compensation Required: If the performance is deemed adequate, the pilot then evaluates the amount of compensation (effort, attention, physical input) necessary to achieve the desired performance goals. Minimal compensation leads to ratings 1-3 (Satisfactory), while significant compensation may push the rating toward 4-6 (Deficiencies).

Controllability and Tolerability: If performance is deemed inadequate, the pilot must assess whether the deficiencies are controllable and whether the required compensation is excessive. Ratings 7-10 are assigned when control is difficult, highly erratic, or impossible, often related to instability or severe control system flaws.

Each numerical rating (1 through 10) is linked to a specific descriptor, ensuring consistency across different pilots and testing programs. For example, a rating of 3 is described as, "Good, pleasant to fly; pilot compensation is not a factor for desired performance," while a rating of 8 is described as, "Major deficiencies; adequate performance not attainable; maximum pilot compensation required." The hierarchical structure of the scale, moving from performance satisfaction to compensation effort to tolerance of deficiencies, ensures that the final score systematically reflects the operational impact of any handling deficiency identified during the flight.

4. Application and Methodology

The application of the Cooper-Harper Handling Qualities Rating Scale is central to modern flight vehicle design and verification processes. It is systematically integrated into structured test programs to evaluate a wide range of characteristics, including static and dynamic stability, control harmony, response latency in fly-by-wire systems, and the integration of automated functions. The methodology requires meticulous planning; test cards specify not only the MTE but also the precise environmental conditions, the specific configuration of the aircraft (e.g., fuel load, stores configuration), and the critical evaluation parameters. This rigorous documentation ensures that ratings are repeatable and contextually relevant for engineering analysis.

During a test flight, the pilot typically executes the defined MTE multiple times, focusing solely on the specified task while actively monitoring the aircraft's response characteristics and the level of effort required to achieve the performance goals. Immediately following the completion of the task,

the pilot reviews the decision tree of the CH HQR and assigns a numerical rating. This rating is then supported by detailed subjective comments, which provide the qualitative data necessary to interpret the score. For example, a rating of 5 ("Moderately objectionable deficiencies; acceptable for the mission phase but required considerable pilot compensation") must be accompanied by comments explaining what specific control characteristic--such as excessive adverse yaw or sluggish pitch response--necessitated the high compensation.

The scale is not limited to assessing fixed-wing aircraft; it is extensively used for rotary-wing aircraft (helicopters), spacecraft, and remotely piloted vehicles (RPVs) or drones, where the operational demands and stability concerns are often vastly different from those of conventional aircraft. Furthermore, the scale has been adapted for use in sophisticated flight simulators to validate proposed control laws or to assess pilot training effectiveness before committing to expensive and risky flight testing. The consistency of the scale allows aerospace regulatory bodies and militaries globally, including NATO and the U.S. Department of Defense, to mandate its use in design standards, ensuring that all newly developed aerospace vehicles meet minimum operational handling quality standards specified by criteria such as MIL-STD-1797.

5. Significance and Impact

The enduring significance of the Cooper-Harper Handling Qualities Rating Scale lies in its successful role as a universal metric for evaluating the critical human-machine interface in aviation. Its introduction marked a pivotal shift in aerospace design methodology, forcing engineers to incorporate subjective pilot factors--often previously relegated to anecdotal observation--into the core requirements matrix. The scale effectively standardized the "feel" of an aircraft, transitioning the evaluation of handling qualities from an art into a robust, repeatable science. The quote from the source content confirms this impact, noting that the CH HQR results displayed "marked improvements in pilot satisfaction with the aircrafts," directly validating the scale's ability to guide successful design modifications.

In modern aerospace engineering, the CH HQR is the benchmark against which flight control systems, including the complex algorithms defining fly-by-wire performance, are judged. When a major defense contractor develops a new fighter jet, or when NASA designs a new atmospheric entry vehicle, specific handling quality requirements are established, often dictating that the aircraft must achieve a rating of 3 or better for critical mission elements. If the initial flight tests yield a rating of 7, for instance, this numerical score mandates a systematic redesign of the flight control laws, stability augmentation systems, or control surface sizing, until the required operational handling rating is achieved.

Beyond technical design, the scale has had a lasting impact on aviation safety and training. By quantifying the mental workload associated with various flight tasks, the CH HQR assists

regulators in defining acceptable operational envelopes. If a specific flight mode consistently yields a high CH HQR score, it signals a high risk of pilot error and potential accident, prompting restrictions on that mode or mandatory modifications. The scale's influence has extended into related fields, with variations of the Cooper-Harper methodology being adapted to evaluate the human-machine interaction in complex ground vehicles, maritime vessels, and even virtual reality systems where control interface and workload are paramount concerns.

6. Debates and Criticisms

Despite its near-universal acceptance, the Cooper-Harper Handling Qualities Rating Scale is subject to ongoing academic scrutiny and professional debate, primarily centered on the inherent subjectivity of the pilot rating process and the potential for context contamination. One persistent criticism is the potential for rating compression or pilot bias. A highly experienced test pilot, accustomed to flying difficult, experimental aircraft, might unconsciously assign a lower (better) rating to a challenging aircraft than a pilot with less experience, even when executing the same MTE. Furthermore, a pilot's overall experience during a flight--for example, a successful landing sequence following a difficult approach--can influence the rating assigned to the approach maneuver itself, leading to potential contamination of the data.

Another key area of debate revolves around the challenge of defining the precise boundaries between the numerical ratings, particularly in the middle range (ratings 3 through 6). While the decision tree aims for clarity, the distinction between "negligible" and "minimal" compensation, or between "moderate" and "considerable" deficiencies, remains dependent on the individual pilot's cognitive interpretation of their own mental workload. Researchers continually work to correlate CH HQR scores with objective physiological measures, such as heart rate variability or eye tracking, in an effort to provide objective validation for the subjective score, but a perfect correlation remains elusive due to the complexity of pilot compensation mechanisms.

Finally, critics note that the CH HQR, being rooted in the evaluation of manned aircraft, may not fully capture the critical nuances of controlling highly automated systems or remotely piloted vehicles. In these systems, the human role shifts from direct control to monitoring and intervention, introducing different types of cognitive workload (monitoring fatigue, rapid task switching) that the original scale was not designed to capture. As aerospace technology continues to evolve toward higher levels of autonomy, the applicability and potential modifications of the Cooper-Harper methodology for evaluating human trust, automation reliability, and supervisory control effectiveness remain areas of active research and discussion within the human factors community.

7. Further Reading

[The Cooper-Harper Rating Scale \(Wikipedia\)](#)

NASA Technical Note D-5153: The Use of Pilot Rating in the Evaluation of Aircraft Handling Qualities (Cooper & Harper, 1969)

Handling Qualities of Aircraft (Review of Historical Context and Application)

ARABPSYCHOLOGY.COM