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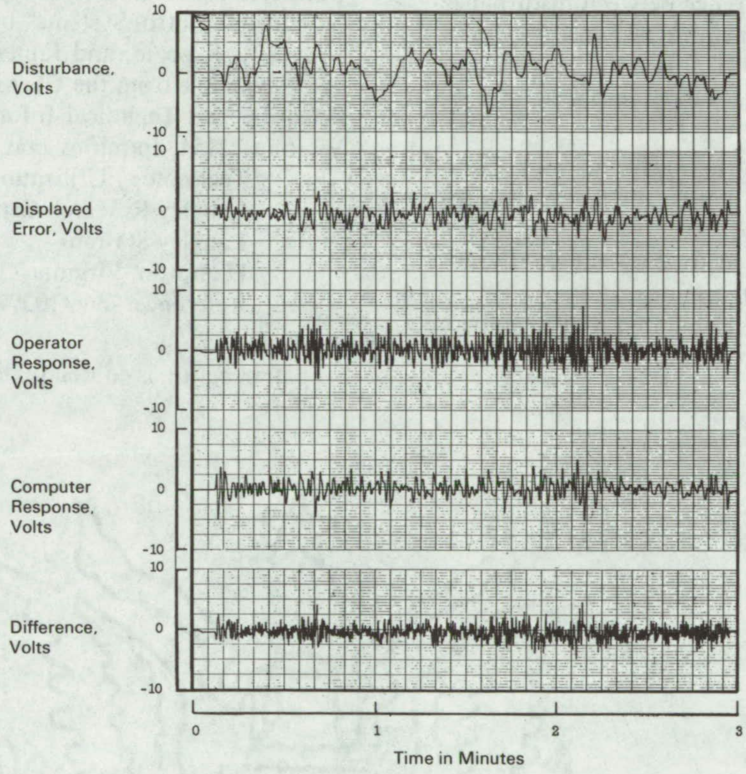
NASA TECH BRIEF

Human Transfer Functions Used to Predict System Performance Parameters



The problem:

In the design of complex and expensive mechanical or electromechanical systems, it is desirable to gain a quantitative understanding of the system prior to construction of hardware. Operator opinion, based upon trial of prototype systems, leaves much to be desired, especially in systems that will be operated by numerous personnel.

The solution:

An applications technique that employs transfer functions that represent the input–output relation for a human operator when controlling a compensatory, closed-loop system. An automatic, parameter-tracking, model-matching method compares the transfer functions of a human operator with the output of an analog computer model of the human operator that

(continued overleaf)

is fed the same inputs that the human operator reacts to.

How it's done:

In this application, the human operator and the computer are fed identical disturbance signals plus feedback related to system response. An oscilloscope display conveys the signals to the human operator by moving a display line or lines away from a reference line or lines a distance related to the amplitude of the error between disturbance and system response. The human operator reacts to keep the displayed signal aligned with a fixed reference on the display by moving a control stick similar to that used to manuever conventional aircraft. The difference between disturbance and system response may be in one or two axes and appears as linear or nonlinear variations from normal, changing with time. An oscillograph is used to plot, as functions of time, (1) the disturbance signal, (2) the displayed error (difference between disturbance and system response), (3) operator response, (4) computer model response, and (5) difference between operator response and computer model response.

Notes:

1. This technique provides the means to make analytical studies of a wide variety of manually controlled systems.
2. This system could be used to train previously unused muscles for artificial arm operation.
3. The technique could be a valuable tool in gravity control training of hemiplegics.
4. Human operators are adaptive, and the same transfer function will not apply for all mechanical systems and displays. Measurements of the variations in human transfer functions have been made and are reported in the publications listed in Note 5.
5. Further information concerning this innovation is presented in NASA TN D-1952, "Measured Variation in the Transfer Function of a Human Pilot in Single-Axis Tasks" by James J. Adams and Hugh P. Bergeron, October 1963; NASA TN D-2177, "Measured Transfer Functions of Pilots During Two-Axis Tasks with Motion" by Hugh P. Bergeron and James J. Adams, March 1964; NASA TN D-2394, "Measurements of Human Transfer Function with Various Model Forms" by James J. Adams and Hugh P. Bergeron, August 1964; and NASA TN D-2569, "Measured Human Transfer Functions in Simulated Single-Degree-of-Freedom Nonlinear Control Systems" by Hugh P. Bergeron, Joseph K. Kincaid, and James J. Adams, January 1965, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151. Inquiries may also be directed to:

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    Reference: B66-10379

Patent status:

No patent action is contemplated by NASA.

Source: Langley-203