METHOD FOR PREDICTING ALERTNESS AND BIO-COMPATIBILITY OF WORK SCHEDULE OF AN INDIVIDUAL

BACKGROUND—FIELD OF INVENTION

This invention relates to the prediction of the alertness level of an individual and the suitability of work schedules therefor, especially as related to a shift worker.

BACKGROUND—DESCRIPTION OF PRIOR ART

In the modern world, many organizations rely on around-the-clock operations. Airlines, railroads, nuclear power plants, to name just a few, are entities where safety is of great concern and where it is necessary to ensure staffing twenty-four hours a day.

With the advent of around-the-clock operations came the need for the development of shift work schedules as a way to address the requirement for staffing at all hours. It soon became apparent, however, that shift work brings with it its own set of problems. Shift workers often complain of inability to obtain adequate sleep during their off-hours, chronic sleep deprivation, reduced alertness, and even falling asleep on the job, as being realities of the around-the-clock workplace.

Besides the obvious effects on productivity caused by less than fully alert workers, there is also a grave safety concern caused by this situation. Accidents such as those which occurred at the nuclear power plants at Three Mile Island and Chernobyl, the chemical plant in Bhopal, and elsewhere have been directly linked to worker fatigue.

It is now accepted that it is critical to ensure that workers are fit for duty, especially those involved in industries where safety is a major concern.

In many cases, governments regulate the number of consecutive hours a person may work without time off as well as the minimum number of hours of rest between work shifts. These hours-of-service regulations were developed, for example, for airline pilots, truck drivers, and railroad engineers. The intent of these regulations is to ensure that workers are not excessively fatigued by their work hours and are sufficiently rested to be able to perform their work in a safe manner. The assumption is made, for example, that after 8 hours off between shifts, a truck driver is ready and fit to begin work again. Because they were developed in the early twentieth century, before any substantial scientific work on measuring circadian rhythms and alertness physiology had been undertaken, these regulations do not take into account many of the variations in alertness which are due to biological factors which are now known to have an important effect on alertness.

Various scheduling methodologies exist which take into account the availability of workers to perform a certain task at a given point in time. For example, in U.S. Pat. No. 5,111,391 to Fields et al. (1992), a system and method for making staff schedules as a function of available resources as well as employee skill level, availability, and priority is described. This system and method includes a database for storing and retrieving information characterizing various scheduling requirements. However, the incorporation of alertness factors is not included in this scheduling methodology. In fact, alertness forecast and consideration is completely absent from it.

Another system, described in U.S. Pat. No. 4,845,625 to Stannard (1989), allows the selection of airline flight groupings (bid packs) based on preferences of employees. Flights making up the bid packs, however, are not scheduled using any alertness forecasting methodology.

While sophisticated scheduling algorithms exist for devising flight bid packs which take into account optimal usage of aircraft and regulatory requirements for time off of workers, none of the existing methodologies take into account the alertness of the workers.

In recent years, the existence of an endogenous circadian pacemaker, also known as a biological clock, has been discovered to be part of every individual's brain. Through our understanding of the human biological clock, we now know that people experience predictable variations in alertness as a result of their positioning within the circadian cycle or circadian time-of-day.

In U.S. Pat. No. 5,140,562 (1992), to the present inventors, we disclose a Biological Timepiece which continuously calculates and displays the actual biological time of day of an individual based on a pre-determined rate corresponding to the rate at which time would progress in a free-running circadian clock for an individual. This rate is adjusted in real time based upon the absence or presence of clock-altering stimuli, such as bright light, so that the watch is able to continuously display the individual's accurate biological time. The watch does not predict the alertness level of an individual; it simply displays the individual's "biological" time of day.

Assessing biological time of day can also be accomplished through laboratory testing. For example, U.S. Pat. No. 5,176,133 to Czeisler et al.(1993), discloses a method of assessing the phase of the endogenous circadian pacemaker by eliminating activity-related confounding factors associated with the sleep-rest cycle in order to accurately measure core temperature variations as an indication of circadian phase. Czeisler also teaches a method of modifying the circadian pacemaker through the application of periods of bright light and/or darkness.

While knowing the initial positioning of the circadian pacemaker is necessary in order to predict alertness accurately, Czeisler does not in any way provide a method for predicting alertness. His methodology is for use in assessing and modifying the biological clock of an individual.

There exists a substantial body of information which allows for the reliable estimation of the initial circadian phase of an individual based on comparisons made to the body of normative data, or the literature in general, as stated by Czeisler. From that initial estimate, a baseline alertness curve can be made for an individual. However, the process of simulating the progress of the individual through various periods of sleep, work, and rest in order to predict alertness is not in any way addressed by Czeisler.

Making an assessment based on normative data of the alertness of an individual after several work periods is not reliable since each individual's schedule and habits are different and must be evaluated separately.

In 1977, a laboratory methodology for measuring sleep tendency was developed. This method, involving a test known as the Multiple Sleep Latency Test (MSLT), was developed by Mary Carskadon and William Dement at Stanford University. Although not