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GUARDING OF TABLE SAWS WITH LIGHT BEAMS: THE LIGHT GUARD CONCEPT

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SUMMARY:

This paper describes a unique type of psychological safety guard for hazardous tools such as table saws, presses, and other tools with areas and components which are dangerous to human fingers, hands, and limbs. It is not a piece of hardware but rather a shaft of light which defines a danger zone around the saw blade or cutting area.

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ABSTRACT

This invention is a unique type of psychological safety guard for hazardous tools such as table saws, presses, and other tools with areas and components which are dangerous to human fingers, hands, and limbs. It is not a piece of hardware but rather a shaft of red light which defines a danger zone around the saw blade or cutting area. Figures 1 illustrates the concept. A sharply defined and highly visible zone is created by the light beam from above. This safety device does not create a physical barrier but rather a psychological one; it impresses the user of the tool by casting a red light on to anything which enters the proximity of the saw blade but without the awkwardness and visual obstruction created by a physical safety guard.

INTRODUCTION

The construction of conventional table saws allows the hand and, in particular the thumb and index finger, to easily make contact with the spinning blade (especially when the guard has been removed) even though users are cautioned to use push sticks and to follow normal safety procedures. The limits of the accident zone (the zone within which the probability of an accident is dramatically increased) are ill-defined. Quite competent table saw users can unconsciously infringe upon the accident zone, and if lucky, escape unharmed. However, in times of fatigue or boredom a slight erratic movement or perturbation will bring fingers or thumbs in contact with the blade.

Our analysis (Zahner and Cavaletto, 1983) has shown that:

1. Accidents occur even to highly trained individuals,
2. Physical saw guards are clumsy and restrict ease of use and vision,
3. Saw guards are often moved out of the way thus defeating their purpose, and
4. The basic table saw design cannot easily be changed and still maintain its functional effectiveness.

We hypothesize that each individual has a different mental image of where the accident zone begins and that these zones vary according to the expertise of the individual. Because the boundary of the danger zone is a mental image which varies from person to person and which varies from time to time for the same person, there really does not exist a clearly defined and tangible danger zone. Our LIGHT GUARD device consistently shows people exactly where the accident zone lies in such a way that the user is impressed even when fatigued or bored.

The shaft of light can be created with any suitably strong light source (incandescent, fluorescent, neon, laser, etc.) and can be of colors other than red. Different colored lights could be used to define less hazardous areas and/or different types of hazards. The size of the defined danger zone should be adjusted to the equipment user's needs. A skilled (confident) user may require a small danger zone. A danger zone that is too large and is constantly infringed upon would eventually loose its ability to warn of danger. The LIGHT GUARD concept can be used to protect any type of equipment in which a danger zone needs to be defined which cannot easily be guarded by the usual types of physical guards. Examples include table saws, radial arm saws, shapers, jointers, planers, presses, nailing machines, corn picker heads, cotton picker heads, etc.

A search for concepts similar to the LIGHT GUARD resulted in several findings. The use of light as a detector of improper entry into a danger zone is not a new concept. How this information is used distinguishes the LIGHT GUARD from other devices. Five different U.S. Patents have been issued (Patent No., Issue Date; 3,912,924, 10-14-75; 3,944,818, 3-16-76; 4,310,836, 1-12-82; 4,249,074, 2-03-81; 4,166,369, 9-04-79) using light beams as a detector.

First, these devices use beams of infrared light which pass across open areas and are not visible to the operator. Thus, the danger area is not visibly defined. Secondly, each of these devices then uses the information about improper entry to shut off the machine so as to prevent injury. The user is unaware that he has entered the danger area except to note that the equipment has stopped. The LIGHT GUARD is different in that it visibly defines the danger area. There is no need to guess about how close one can get. It does not turn off the equipment, but rather psychologically deters you from entering the danger area.

THE PSYCHOLOGY OF THE LIGHT GUARD

The main advantage of this invention over existing practice is that it is a psychological guard rather than a physical guard. It therefore does not interfere with the operation of the table saw and there is thus little inclination for removing it. When the red light shines upon the user's fingers, the similarity between its color and that of blood is not lost upon the user. The shaft of light delineates the danger zone consistently and accurately and thus eliminates guesswork on the part of the user as to how far he can insert his fingers without cutting them off.

The tendency of humans to look at areas which are brightly lit (human phototropism) has been discussed by Hopkinson and Longmore (1959). In their

paper, the importance of having specific work task areas well lit is stressed, along with special emphasis on providing extra brightness at hazardous work-points, such as the blade area of a wood planer machine. This lighting helps keep the operator's attention on the danger areas, increasing the safety of the job, as compared with the usual practice of using general lighting with a uniform level of illumination over the entire working plane.

LIGHT GUARD will also provide this benefit, but in a much more immediate and dramatic fashion. While previous researchers were concerned with general lighting of work surfaces, our system is intended to sharply delineate the dangerous area in a specific and dramatic manner, thus keeping a high awareness of the danger present in the operator's mind. With LIGHT GUARD, any object crossing the user-defined danger zone line, be it board or fingers, becomes sharply illuminated, sending a clear and immediate message to the operator. This warning continues to inform the operator of the precise location of the danger area, even when the blade itself becomes obscured during the operation. This obscuring of the blade which can occur during normal operation is a major safety hazard.

An additional feature of LIGHT GUARD is its use of the warning color, red. This color is commonly used as a sign of danger in our society, as in traffic signs and hazardous material labels. Studies in the literature have shown that people tend to associate red with excitement, power, defiance, protection, and defense (Wexner, 1954). While the influence of color on people's moods is not totally agreed upon (Bennett, 1977), the "exciting" aspects of red combined with its ubiquitous use as a color of warning in our society makes it an ideal color for use in LIGHT GUARD. In addition, Reynolds et al. (1972) found red to be the color which best stands out against a bright white

background. He further found that the response time to a red signal is faster than the response times to green, yellow, and white signals with the mean response time for red in one experiment being 0.222 seconds faster than for the next fastest color, green. Such response times to stimulus colors, he argues, are a measure of their attention-getting power and therefore red attracts the greatest amount of attention.

EVALUATION OF THE LIGHT GUARD

The LIGHT GUARD concept was first evaluated on June 3, 1983, using two slide projectors mounted above a table saw in the agricultural engineering woodshop. Light was projected through red filters mounted in plastic slide mounts. The resulting beam of red light was focused upon the danger zone of the table saw directly below the projectors.

Two slide projectors were used in order to provide a large enough illuminated area. Their beams overlapped in the center of the projected area. Each projector was a standard Kodak projector with a 400 Watt bulb and a 3" (7.62 cm), f3.5 lens. The projectors were mounted 24" (70 cm) above the saw table. The size of the projected light on the table was 17.75" (43.68 cm) by 2.375" (8.57 cm). The average room illumination was 745 lux. The illumination on the table saw was 565 lux. This lower reading was due to the shadow cast by the projectors. With the projectors turned on, the light intensity on the saw table was 2,550 lux at the front and rear of the projected area and 4,100 lux in the center (over lapped area).

RESULTS AND COMMENTS FROM THE EVALUATION

Several of our University faculty and staff tested the LIGHT GUARD in actual operation. Both slide photographs and videotapes were made of the tests.

The individuals that tested the LIGHT GUARD found it an asset to the table saw operation. The lack of physical interference was immediately appreciated. Almost subconsciously as their fingers came near and entered the danger zone they were pulled back into the safe zone. It was felt that the defined area might prevent one from reaching quickly into the danger area to correct a problem without "thinking" about the consequences. The color red was felt to be appropriate in that it signaled a warning to the participants. The ability to adjust the size of the danger zone to the needs of the individual was thought to be important.

CONCLUSIONS

The LIGHT GUARD concept effectively uses an intense red beam of light to define a danger zone. This danger zone is sharply defined and illuminates a hazard that may not be perceived by the user. The LIGHT GUARD may be used with conventional physical guards thus providing added protection. Because most physical guards are removed or placed out of the work area, the LIGHT GUARD would still be there to give some protection. There is very little motivation to remove this guard so that it does not interfere with the operation of the table saw. The color red is used because in our culture we are brought up to view this color as a warning or as a danger and its similarity to the red color of our blood helps reinforce that there is a definite danger in this defined zone to the user.

SUGGESTIONS FOR FURTHER RESEARCH AND EVALUATION

1. Effectiveness of the LIGHT GUARD.
2. Testing of concept in an industrial setting.
3. Development of an inexpensive method to generate the light beam.

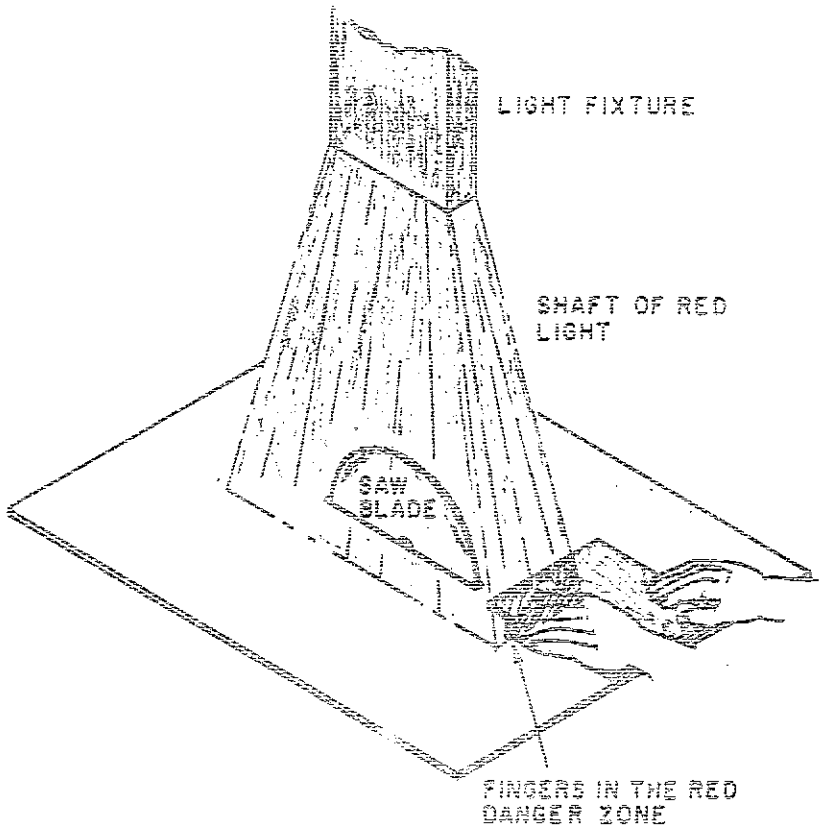

Figure 1. Using the Light Guard concept on a table saw.

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