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REVIEW ON FLY OUT ACCIDENT DURING LATHE MACHINING OPERATION

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Abstract: *Fly-outs are identified as the most happening accidents in lathe machining. This study aims at determining the causal factors leading to fly-out accidents during lathe machining operations and also determine the probability of occurrence of fly-out accident. Fault tree analysis (FTA) was used to identify risk factors for any field of work. Boolean algebra equations were used to analyze the probability of fault occurrence. Monte Carlo simulation was carried out using Open FTA software and the output of 1000 iterations was compared with the output of Boolean algebra. Safety intervention alternatives were evaluated by comparative analysis of before and after implementation of safety measures.*

Key words: *fly-out, iteration, intervention, lathe, machine, FTA, Monte Carlo Simulation.*

I. INTRODUCTION

Over the last thirty years there were developments in the maintenance and servicing industries, of a distinctive approach to hazards and failures that cause loss of life and property, following 'loss prevention' approach. It involves putting much greater value on technological measures to control dangers, accidents and on trying to get things right first time. The intensely fast development of new technology has essentially changed the nature of work and has increased the difficulty of systems within many industries. Hence, the world becomes increasingly complicated. These hard systems require a combination between technical and human subsystems (Kletz, 1999).

In fact, increased technological dependence has taken to bigger fortuitously, involving more people, and greater hazard to property and the surroundings. It has become clear that such vulnerability does not originate from just human error, technological failures, or environmental factors alone. Rather, it is the fixed organizational strategy and standards which have restate been shown to predate the disaster. Therefore, safety practitioners in recent years have begun to aim on the organizational values that might improve risk and calamity management and safe performance in industries difficult conditions. Some specialists (Simon and Leik 1999) believed that culture and technology actually go on same way. Culture consists of point of views, cognizance, trust, and values, which need to be set in context. In the face of new compensates, it is believed that culture can play a important role in helping organizations respond to the many safety challenges. Most accidents in Nigerian industries are a direct result of not sticking to their foundered safety procedures, as well as missing of strong safety culture, safe working conditions, and employees' safe work point of views and actions (Oyesola and Kola, 2014).

II. MATERIALS AND METHOD

Having discussed and scrutinize series of safety reports associated to lathe operations of a case study workshop; this research seeks to consider *fly-outs* during machining operations. These fly-outs predicts the possibility of tool fly out during a machining process, work piece fly out as well as the effect of discontinuous chips removal during operations that obtained from turning, shaping etc. to reach to objectives using the tools.

III. FAULT TREE ANALYSIS

Fault tree analysis (FTA) is used to examine potential faults, its ways and causes and to measure their contribution to systems erratic in the course of product design. FTA is a technique by which conditions and factors that can contribute to a specified unwanted event are identified and organized in a logical way and represented graphically (Jane, 2012).

IV. BOOLEAN ALGEBRA EQUATIONS

With human Experts judgments, Boolean algebra equations were used to examine the probability of fault occurrence. Boolean algebra is a devise for dealing mathematically with philosophical propositions which have only two possible values of TRUE or FALSE represented by the digits “0” and “1”. It deals with the rules which govern various operations between the binary variables. “AND” operation describes events which can occur IF and only IF two (2) or more other events are TRUE. “OR” Operation describes events which can occur IF at least one (1) of the other events are TRUE (Ovidiu, 2003).

V. MONTE CARLO SIMULATION

Monte Carlo simulation of the fault tree was conducted using the commercial software called “OpenFTA”. 1000 Iterations were carried out and the output compared with the Boolean algebra equations. Monte Carlo simulation, also called probability simulation, is a technique widely used to understand the impact of risk and uncertainty in forecasting models.

VI. SAFETY INTERVENTION MEASURE

The safety intervention alternatives were evaluated by relative examination of before and after application of safety measures. Safety intervention for the respective faults was examined to evaluate how well and how much the measure can bring about a reduction in the probability of the top-event. This tailors the research into the subject matter of identifying hazard conditions, sequence of accident, qualitative and quantitative evaluation, and finally, anevaluation of the case-study’s safety intervention program to see how the intervention would reduce the probability of accident occurrence. To ascertain the effectiveness of a safety intervention program, an appraisal of the case-study safety intervention program was carried out by firstly identifying areas that require intervention and by making appropriate recommendation.

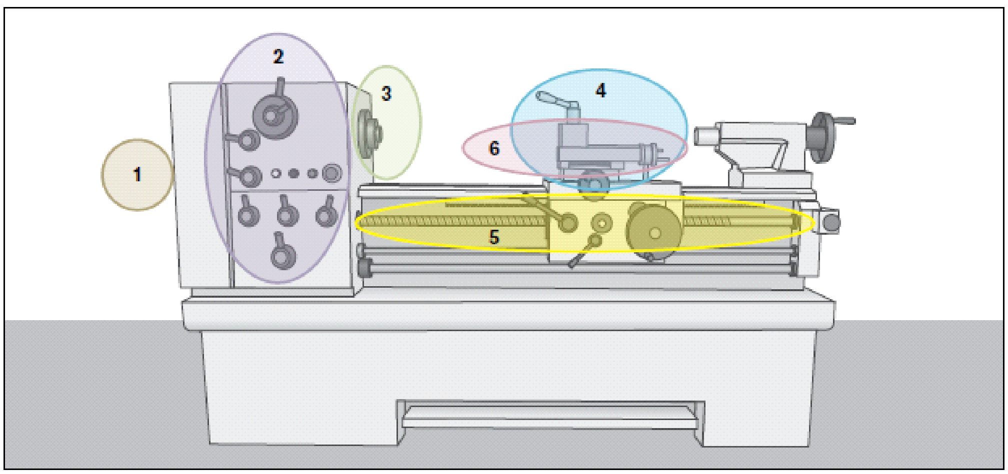

Figure1. *Dangerous SECTIONs of Metal Turning Lathe Machine*

VII. RESULTS

A. Lathe Hazard Identification and Consequences Analysis

Safety measures on lathe operations were considered under various categories of vital lathe hazards and the usual causes of death and injury from metal lathes were observed. These include:

- Entanglement of clothing in moving parts such as drive gears, chucks, lead and feed screws, and the work piece.
- Being hit by loose objects on the lathe such as chuck keys, tools or chips.
- Entanglement from inappropriate tooling and polishing techniques.
- Being struck by a work piece that has not been adequately secured in the lathe or is oversized.

Figure 1 shows the sections of metal turning lathe hazards. Six hazard sections have been identified. Each section was analyzed to include the possible situations (e.g. entanglement) of the hazard and their recommended controls.

B. Qualitative Safety Evaluation: Fault Tree Construction

The child root for a tool fly-out is as represented Figure 2. Seven causal factors capable of actuating a tool fly-out during machining operations on a lathe were observed as chuck fault, work piece holding fault, tool post fault, coolant fault, improper operating speed, safety guards fault, chips guard and chuck guard and wrong mounting. Further analysis of root/optional events into minimum cut sets i.e. basic events that could lead to the child node event; twenty four (24) basic events are recognized and showed in fault tree in Figure 3.

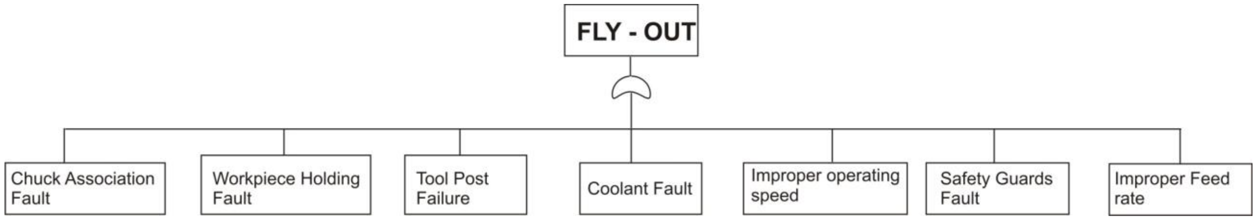

Figure 2: Hazards/causal Factors Capable of Triggering a Tool Fly-out During Machining Operations on a Lathe

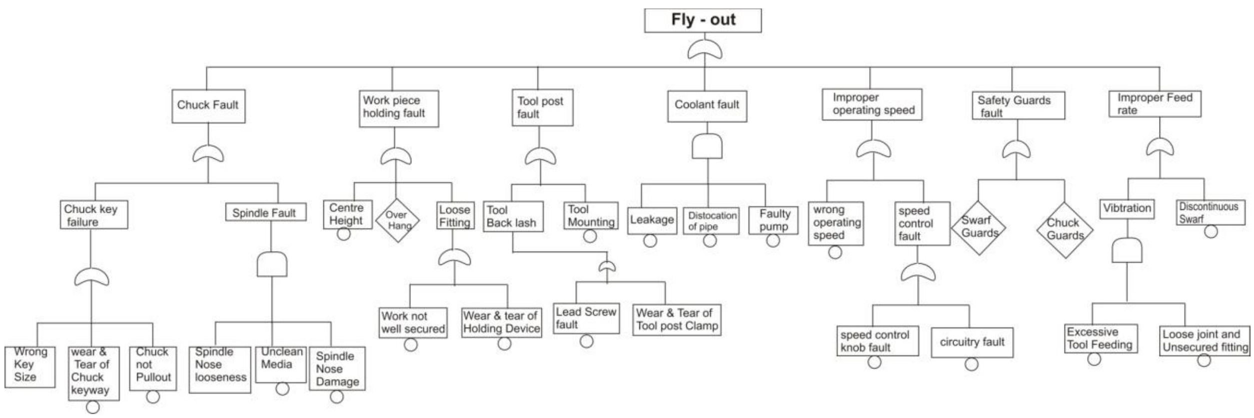

Figure 3: Fault Tree of Fly-out Accident during Metal Lathe Machining Operation

VIII. HAZARDS AND CONSEQUENCES IN LATHE MACHINE

- *Section 1:*

When our work piece beyond the headstock then such problem can occur like bar can bend and strike operators nearby, during the spindle rotation.

- Section 2:

a) When drive mechanism open this condition is also hazardous then such possible consequences occurred, operators can become complicated in pulleys, belts or gears when lathe is in operation.
b) Whenever unsecured tools and objects stored or placed on the headstock then stored objects can fall onto the spinning chuck and be propelled at the operator or nearby operators.
c) When lack of function markings on controls then operators can activate incorrect controls resulting in an unplanned function.
d) Lathe controls can only be reached by passing hand through working section then operators can become complicated in unguarded drive mechanisms, chuck, chuck assembly or work piece when the lathe is in operation.

- Section 3:

a) When our chuck is exposed this condition is dangerous then such possible situations occurred, operators can become complicated on uneven surface of chuck or work piece when in rotation.
b) When our chuck key is left in a chuck and suppose operators near lathe can be struck by key when projected from the lathe.
c) When Jaws of chuck unable to clamp work piece securely then operators can be struck by work piece not securely held in the chuck.

d) When chuck has not been adequately secured to the spindle then operators can be struck by chuck not securely held in the spindle.
e) When mounting and removing heavy chucks and face plates that time operators can sustain musculoskeletal or crushing injuries when changing heavy chucks and faceplates.
f) Use of a chuck that is not made for specified lathe and/or task specifications then use of wrong chucks can result in the chuck or work piece becoming loose and striking operators.
g) Whenever chucks and face plates used on the lathe are damaged or have catch points then operators can become caught on chucks and faceplates that are poorly maintained or have bumps.
h) When oversized work piece in self-centering chuck (three-jaw chuck) then chuck jaws in full extension to allow for oversized work pieces can be moved from the lathe when operated.

➢ Section 4:

a) When objects (e.g. cutting tools) unsecured on carriage (including tool post) or chips then unsecured objects can become projectiles when the lathe is started, possibly striking operators.
b) When worn or damaged tools being used on the lathe then use of worn or damaged tools can result in tool failure and can become projectiles or create irregular or long cuttings that can lead to lacerations.

➢ Section 5:

When exposed lead and feed screws (assessment of risk will need to include the speed at which the lead and feed screws travel) then operators can become complicated in exposed lead and feed screws when the lathe is in operation, particularly if the lathe is being used by a number of users with various levels of experience.

➢ Section 6:

a) Unsupported work pieces can become loose, striking operators.
b) When machining process produces continuous or unraveled cuttings then operators can become complicated in turning cuttings.
c) Removing metal shavings, cuttings and chips from machining area with hands unprotected handling of shavings, cutting and chips can result in slashing.
d) Incorrect methods used for polishing work pieces with emery cloth then operator can become complicated in the lathe.
e) Coupling and clamps used on the lathe are damaged or have catch points. Operators can become caught on coupling and clamps that are poorly maintained or have protrusions

➢ Others:

a) Lack of or poorly placed emergency stop button/pedal that results in immediate standstill of lathe operation. Operator is unable to stop the lathe in case of an emergency.
b) Loose clothing, cuffed or rolled back sleeves, neckties, jewelry (including watches) and long hair loose clothing, accessories and hair can become complicated in moving parts of the lathe, chuck assembly or work piece.

➢ Environment:

a) Wrong type and position of lighting. The flashing effect of fluorescent light can make a spinning lathe appear to have stopped. This can lead to operator's entanglement.
b) Lighting placed over the lathe can be struck by projectiles from the machining process. Operators nearby can be injured by the light shattering.
c) Untidy and unorganized working Environment. Operators can slip or trip on cutting oils, chips or cuttings that are not cleaned from the floor. Operators can also trip over lathe parts or work pieces that are not returned to storage areas.

IX. CONCLUSION

The study conducted a Fault Tree Analysis in metal lathe machining operation. Twenty four basic events leading to the occurrence of fly-out accident were identified. This includes Circuitry fault, Chuck Guard fault Centre-Height fault, Chuck not pulled out, Dislocation of pipe, Discontinuous chips, Faulty pump, Spindle nose looseness, Leakage, Lead screw fault, Loose joints and unsecured fittings, Overhang, Speed control knob fault, Spindle nose damage, chips guard, Excessive tool feeding, Tool mounting, Unclean media, Wrong key size, Work not well secured, Wrong operating speed, Wear and Tear of Chuck keyway, Wear and Tear of Holding device, Wear and Tear of tool post clamps. The result of FTA revealed that fly-outs are the most widely occurring accidents during metal lathe machine operations with a probability of 0.748. Monte Carlo analysis of the FTA shows the probability of fly-outs having lower and upper bounds of 0.725 and 0.773, respectively.

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