LOGGING INDUSTRY RESEARCH ASSOCIATION

CHAINSAW KICKBACK

The chainsaw has long been recognised as a potentially dangerous tool. The kickback effect is a prominent factor amongst those which contribute to chainsaw accidents. In New Zealand it causes approximately half (around 70) of the total number of chainsaw injuries each year. LIRA investigated safety as part of the project *"Chainsaws - Criteria for Selection"*, and reported briefly on kickback tests carried out on various chains. The results were inconclusive and it was difficult to obtain agreement on what causes kickback and what should be done to reduce it.

In order to increase the understanding of kickback, LIRA assisted Roger Foy, a senior student in the Department of Mechanical Engineering, University of Canterbury with his Bachelor of Engineering Project Report. His report, titled *"An Investigation of Chainsaw Kickback"*, presents a theoretical analysis of kickback and includes the design of a rig for practical analysis of the problem. The study includes a review of overseas literature on kickback but finds that to date most of the actual testing has been carried out by chain manufacturing companies who are reluctant to release all details of methods and results. The project is summarised in this report.

What is Kickback?

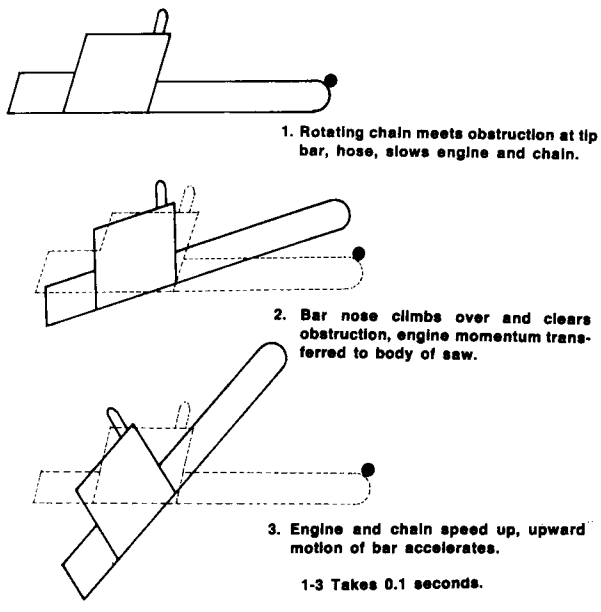

FIG.1 *The Kickback Reaction*

Kickback is the sudden, violent up and backward movement of the chainsaw guide-bar. If the chain, moving at speed, strikes the operator it can cause severe lacerations to the hand, arm, face or torso. Kickback is initiated when the moving chain meets an obstruction at the tip of the saw guide-bar and is forced to slow down. The resulting kickback pushes the bar nose away from the obstruction causing the saw to rotate about its centre of mass. This sudden movement may break the saw away from the operator's grasp at the forward hand. The saw can then continue up and back until it strikes the operator. The reaction may be initiated by an object becoming jammed in the chain, or by a cutter on the chain grabbing at an obstruction. The relative importance of these two factors is not clear.

Tests have shown that the time taken for the saw to interact with the obstruction and to rise 45° from the horizontal is about one-tenth of a second. This is too fast for the operator to react defensively.

What Causes Kickback?

There are three interacting factors.

(i) The material being cut. Small diameter flexible material causes greatest problems, thus trimming work can be the most dangerous. Kickback can also be initiated when the guide-bar tip meets an obstruction during felling or cross-cutting.

(ii) The operator. The chainsaw operator has several factors in his control. He should avoid contact between the bar nose and any stray objects, and keep a firm grip on the saw with both hands at all times. Correct chain maintenance is very important. Training and education programmes help awareness in this area.

(iii) The power unit and chain. Foy's report concentrates on analysing the power unit and chain as they can be physically controlled by design or maintenance. The results are summarised below.

THE CHAIN. *Chain characteristics are primarily responsible for initiating kickback through interaction with the material being cut.*

1. Chain Type.

There are three factors in chain design which may affect kickback. *CHAIN PITCH* determines the length of the hazard zone. *(See Fig.2)* If it could be conclusively shown that kickback is caused when obstructions enter the hazard zone, then a longer hazard zone or greater pitch would mean a higher incidence of kickback.

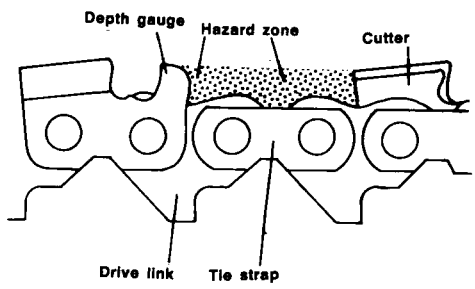

FIG.2 Section of Standard Chain

CUTTER TYPE. The shape of the cutters affect the smoothness of the cutting action. Rounded or chipper cutters may cut the wood less aggressively than the square or chisel type of cutter which may tend to grab at the wood and initiate a kickback reaction.

CHAIN PROFILE. The height and shape of the depth gauge in relation to the cutter edge and the shape of the drive link are important. If the depth gauge is too low the cutter edge may grab in the wood causing a kickback reaction. Kickback may also be caused by obstructions striking the front of the depth gauge in the hazard zone.

2. Chain Speed.

A fast chain results from the engine operating at high speeds. In this state the engine can impart more kickback reaction to the moving bar and chain than at slow speeds. On the other hand, a fast chain is less likely to grab or jam as it has greater cutting power. Thus the initiation of kickback is more likely at the varied engine and chain speeds as commonly occur during the delimbing process.

3. Chain Condition.

The sharpness of the cutters and the depth gauge height and profile

must all be correctly maintained to reduce kickback severity. Correct chain tension is important as a loose chain is more prone to kickback. These factors are within the control of the operator.

THE GUIDE-BAR. *It is responsible for transferring the kickback reaction from the chain to the power unit.*

The kickback reaction is initiated at the tip or nose of the guide-bar. The radius of the nose is important. A larger radius means a greater susceptible length of chain, and as the chain is running flatter, the depth of the hazard zone is greater. Although the kickback reaction can occur when an obstruction meets any part of the nose of the guide-bar, the problem is greatest around the top half of the nose. In this position, the forces of the kickback reaction will tend to drive the saw backwards away from the operator's forward-hand grip, and the bar up where it could strike the operator.

THE POWER UNIT. *It is responsible for amplifying the kickback reaction.*

The magnitude of the kick reaction is primarily due to the momentum transferred from the rotating engine parts to the body of the saw. This occurs when the engine is slowed down momentarily because of an obstruction jamming the chain. In addition, if the saw chain clears the obstruction the engine parts and chain will accelerate, and reaction to the developed engine torque will increase the force of the up and backward movement of the saw.

Developments to Reduce Kickback Injuries

Anti-kickback devices are a big selling point on today's chainsaws. Some developments reduce the frequency of the kickback reaction while others reduce its severity.

1. SAFETY CHAIN AND GUIDE-BAR.

The profile of the chain can be changed in several ways. Low profile cutters and ramped drive links are often used on safety chain to guide any obstruction out of the hazard zone without causing a kickback reaction. *(See Fig.3)* The effectiveness of these devices is not clearly understood.

Small radius guide-bar noses are now common as this should reduce the frequency of kickback. On such bars, rollers and sprockets can be used at the nose to overcome higher wear factor associated with the small radius nose.

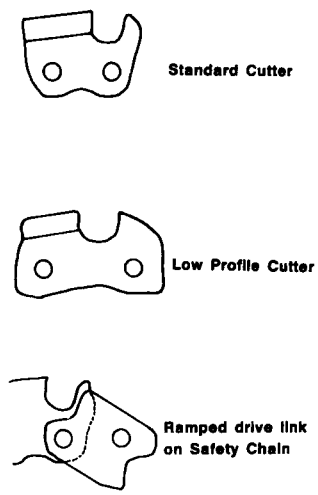

FIG.3 *Chain Safety Features.*

2. SAFETY AT THE FORWARD-HAND GRIP.

A mitt may be strapped to the forward handle to prevent the operator from losing his grip. A rigid shield may be placed in front of the handle to prevent the forward hand from contacting the moving chain. These devices do not decrease the frequency or severity of the kickback reaction but, if used correctly, decrease the incidence of injury.

3. CHAIN BRAKES.

There are several devices to stop the chain before it strikes the operator. In some, a brake is applied to the clutch drum when a lever in front of the forward handle is struck by the hand. Another type simultaneously disengages the clutch and applies a brake when a lever is struck. A more recent type operates on the differential movement of the guide-bar/power unit and the handle/fuel tank unit made possible through the use of resilient anti-vibration mounts, and will therefore work in any situation regardless of the position of the operator's forward hand.

4. THE BAR NOSE COVER.

Kickback can be eliminated by attaching a cover to the guide-bar nose. However, since the nose cannot then be used for cutting it is of limited use to professional cutters.

Conclusions

The work which is summarised in this report clearly points to three interrelated factors in the chainsaw kickback problem.

- The kickback reaction is initiated when the moving chain meets an obstruction at the tip of the guide-bar. There is uncertainty about the effectiveness of devices for reducing the incidence of the reaction.

- The power unit is responsible for amplifying the kickback reaction.

- The operator can prevent the kickback reaction by keeping the tip of the guide-bar away from potential obstructions. Correct chain maintenance will reduce the kickback problem. The operator can decrease the danger of the kickback reaction by keeping a firm grip on the saw and by using saws with chain brakes or safety features at the forward handle.

LIRA assisted this study with the objectives of examining kickback mechanisms and stimulating the building of a chain testing device. However, extensive literature research and theoretical analysis showed that the complex nature of kickback and its causes are not fully understood, and that it would thus be premature to build such a testing rig. The report however provides a basis upon which to do further work on kickback when the resources become available. In looking at the technical aspects of kickback it is important not to lose sight of the part played by the operator. Given the present understanding of kickback, the greatest gains in safety can be made through improved operator awareness and techniques brought about by training.

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