



Feasibility study for cutting oil delivery through a flycutter



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Introduction:

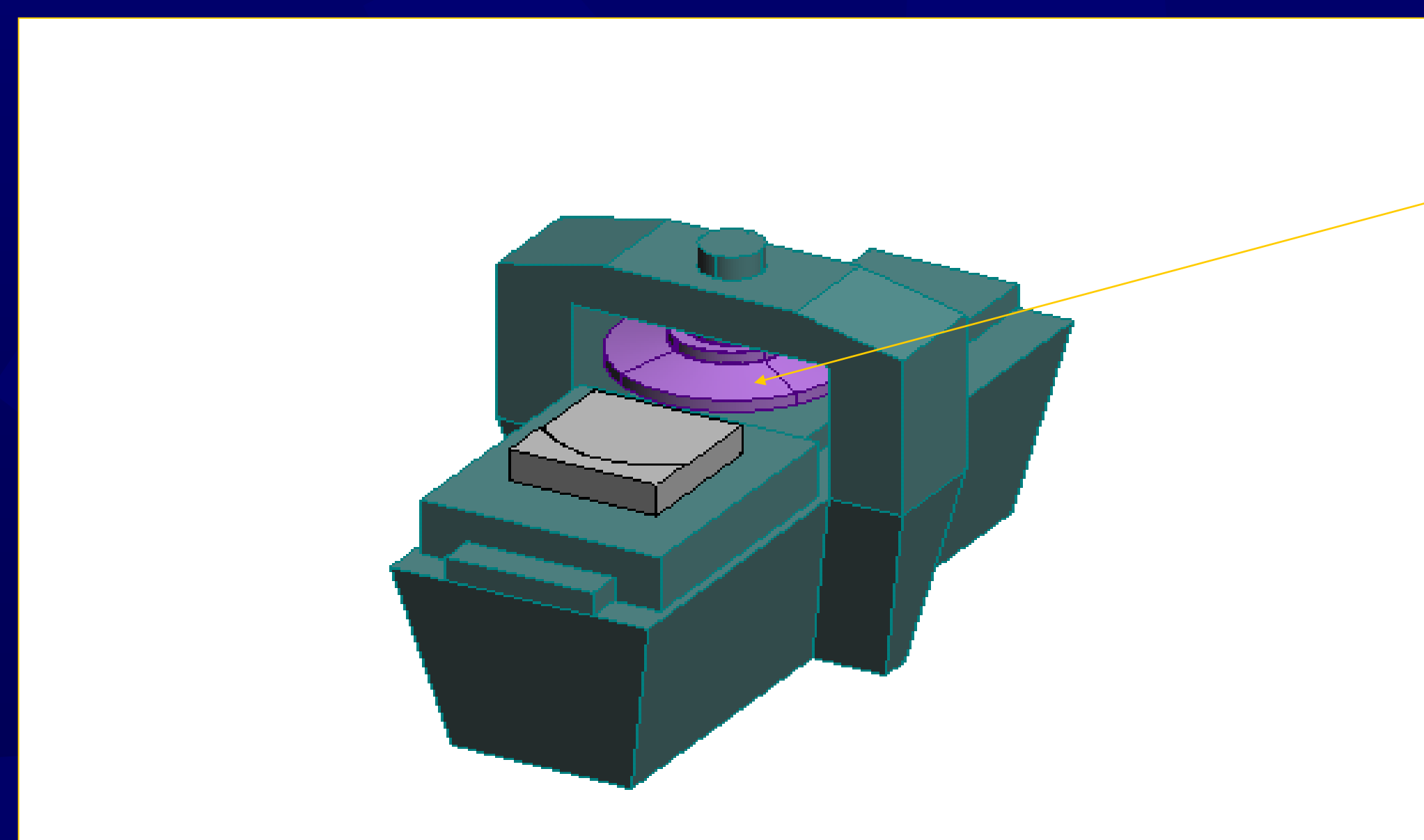
- Proper cutting oil flow is essential to produce good surface finishes on brittle materials that are single point diamond turned.
- The current method of cutting oil delivery is to spray the oil around the rotating flycutter's perimeter.
- This method produces thin and thick oil areas during the cutting process which reduces overall surface quality and can cause surface damage.
- The proposed delivery of cutting oil through the flycutter to the tool will improve the quality of surface finishes by eliminating variations in oil thickness produced by the rotating flycutter's aerodynamic effects.



Oil spray tubes

Flycutter

Existing flycutter and oil system



Flycutter

Conceptual diamond turning machine



Diamond turned precision optic

Methods:

Given:

$$\text{Pressure Equation: } p(r, \omega) = 0.5 \rho \omega^2 [r^2 - r_f^2]$$

$$\text{Continuity Equation: } v_1 d_1^2 = v_2 d_2^2$$

$$\text{Bernoulli Equation: } \frac{p_1}{\gamma} + \frac{v_1^2}{2g} - h_L = \frac{v_2^2}{2g}$$

and requirements:

$$\text{Exit velocity: } v_2 = \omega r_t$$

$$\text{Flow Rate: } Q$$

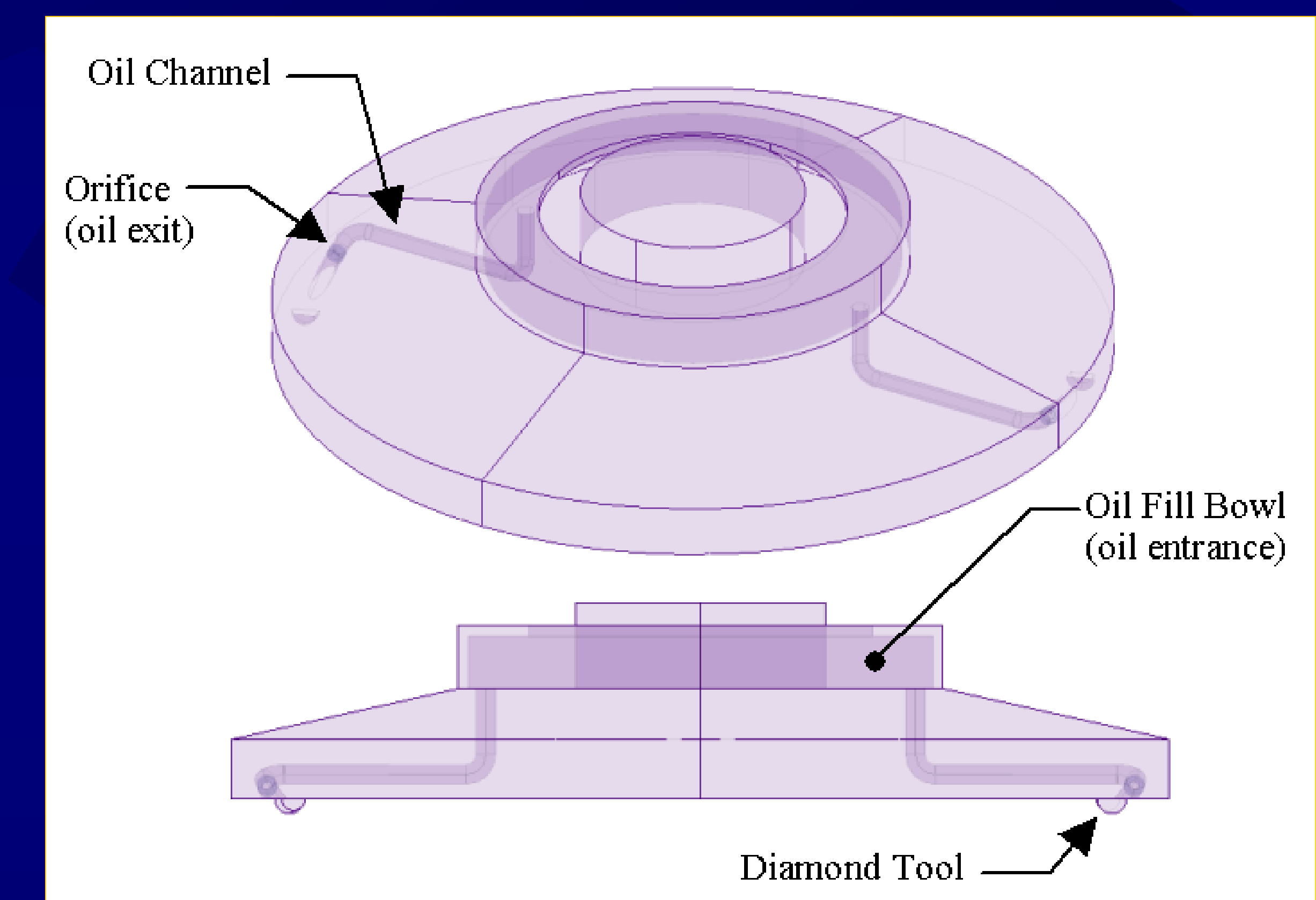
the channel diameter, d_1 , and the orifice diameter, d_2 , can be found

$$d_1 = \frac{\sqrt{\omega r_t d_2^2}}{\left[2g \left(\frac{(\omega r_t)^2}{2g} - \frac{\rho \omega^2 [r_t^2 - r_f^2]}{2\gamma} + h_L \right) \right]^{1/4}}$$

$$d_2 = \sqrt{\frac{4Q}{\pi \omega r_t}}$$

Results:

- It is feasible to deliver oil through the body of a flycutter.
- Direct, controlled oil placement in front of the tool reduces the aerodynamic effects during the cutting process.
- The flycutter's operational parameters determine oil channel and orifice size.
- The desired exit velocity and flow rate can be achieved once the oil channel and orifice are properly sized.



Conceptual flycutter

Discussion:

- The desired oil exit velocity will be equal, but opposite in direction to the cutting tool velocity.
- Placement of the cutting oil directly in front of the tool will eliminate any unnecessary oil flow.
- The dependence of the oil channel and orifice size on the flycutter's operational parameters seems to indicate that the proposed delivery system will only work for a certain set of operational parameters.
- Experiments must be conducted to determine if a flycutter's oil delivery system will function if the flycutter's operational parameters change.