```
> restart:with(linalg):
```

```
Warning, the protected names norm and trace have been redefined and
unprotected
```

```
> a:=<1,0,0>;b:=<0,1,0>;c:=<sqrt(1/2),-sqrt(1/6),-sqrt(1/3)>;d:=<0,sqrt
> (2/3),-sqrt(1/3)>;
```

$$a := \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

$$b := \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$$

$$c := \begin{bmatrix} \frac{1}{2}\sqrt{2} \\ -\frac{1}{6}\sqrt{6} \\ -\frac{1}{3}\sqrt{3} \end{bmatrix}$$

$$d := \begin{bmatrix} 0 \\ \frac{1}{3}\sqrt{6} \\ -\frac{1}{3}\sqrt{3} \end{bmatrix}$$

A Cartesian frame has its origin on O(0,0,0). Via a rotation of phi about an axis on O, and with direction numbers computed as the elements of vector x, an image in the original frame is transformed to an isometric projection in the original frame such that the unit vector b, extending from O to B along the y-axis, and its displaced image d, extending from O to D, remain aligned along the y-axis, as shown in Fig. (MECH289)ISOP73k.dw2.

```
> x:=simplify(6*<crossprod((d-b),(c-a))>);
```

$$x := \begin{bmatrix} -3\sqrt{2}+2\sqrt{3} & -\sqrt{3}\,(\sqrt{2}-2) & -(\sqrt{2}\sqrt{3}-3)\,(\sqrt{2}-2) \end{bmatrix}$$

```
> m:=simplify((1/2)*(d+b));
```

$$m := \begin{bmatrix} 0 \\ \frac{1}{6}\sqrt{6}+\frac{1}{2} \\ -\frac{1}{6}\sqrt{3} \end{bmatrix}$$

m is the position vector of the midpoint of the segment BD

```
> f:=t*x;
```

$$f := t\begin{bmatrix} -3\sqrt{2}+2\sqrt{3} & -\sqrt{3}\,(\sqrt{2}-2) & -(\sqrt{2}\sqrt{3}-3)\,(\sqrt{2}-2) \end{bmatrix}$$

```
> fd:=evalm(d-transpose(f)):
> t:=solve(multiply(f,fd)[1,1]/t);
```

$$t := \frac{1}{18}\,\frac{-2\sqrt{3}\sqrt{6}-6\sqrt{3}-6+\sqrt{3}\sqrt{2}\sqrt{6}+3\sqrt{2}\sqrt{3}+6\sqrt{2}}{-23+8\sqrt{2}\sqrt{3}+12\sqrt{2}-8\sqrt{3}}$$

```
> fdt:=evalm(d-transpose(f)):
```

f is the position vector of point F on the rotation axis x on O such that segment FD, i.e., d-f, is normal to x.

```
> fm:=evalm(m-transpose(f)):
> mfbt:=simplify(sqrt(fdt[1,1]^2+fdt[2,1]^2+fdt[3,1]^2)):
> mfm:=simplify(sqrt(fm[1,1]^2+fm[2,1]^2+fm[3,1]^2)):
> cosha:=simplify(mfm/mfbt);
```

$$cosha := \frac{1}{6}\,\frac{\sqrt{351 - 180\sqrt{2} + 144\sqrt{3} - 141\sqrt{2}\sqrt{3}}}{\sqrt{638 - 260\sqrt{2}\sqrt{3} + 348\sqrt{3} - 427\sqrt{2}}}$$

The cosine of the half-angle of rotation is the magnitude ratio —m-f—/—d-f—.

```
> phi:=evalf(2*180*arccos(cosha)/Pi);
```

$$\phi := 56.60163659$$

(MECH289)ISOP73k.mws, 07-03-11

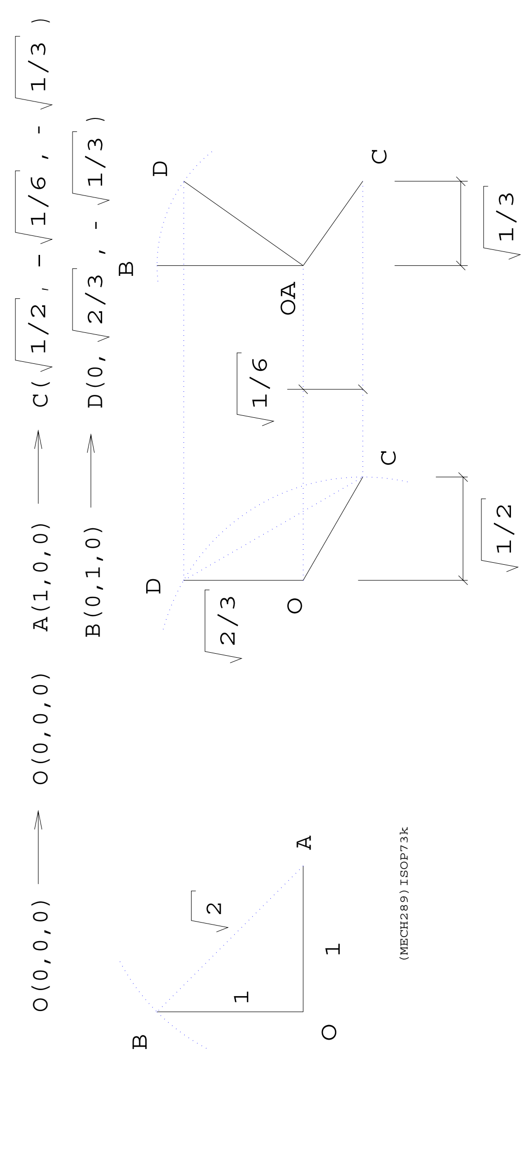

Figure 1: GCA 2 Two Chords, AC and BD

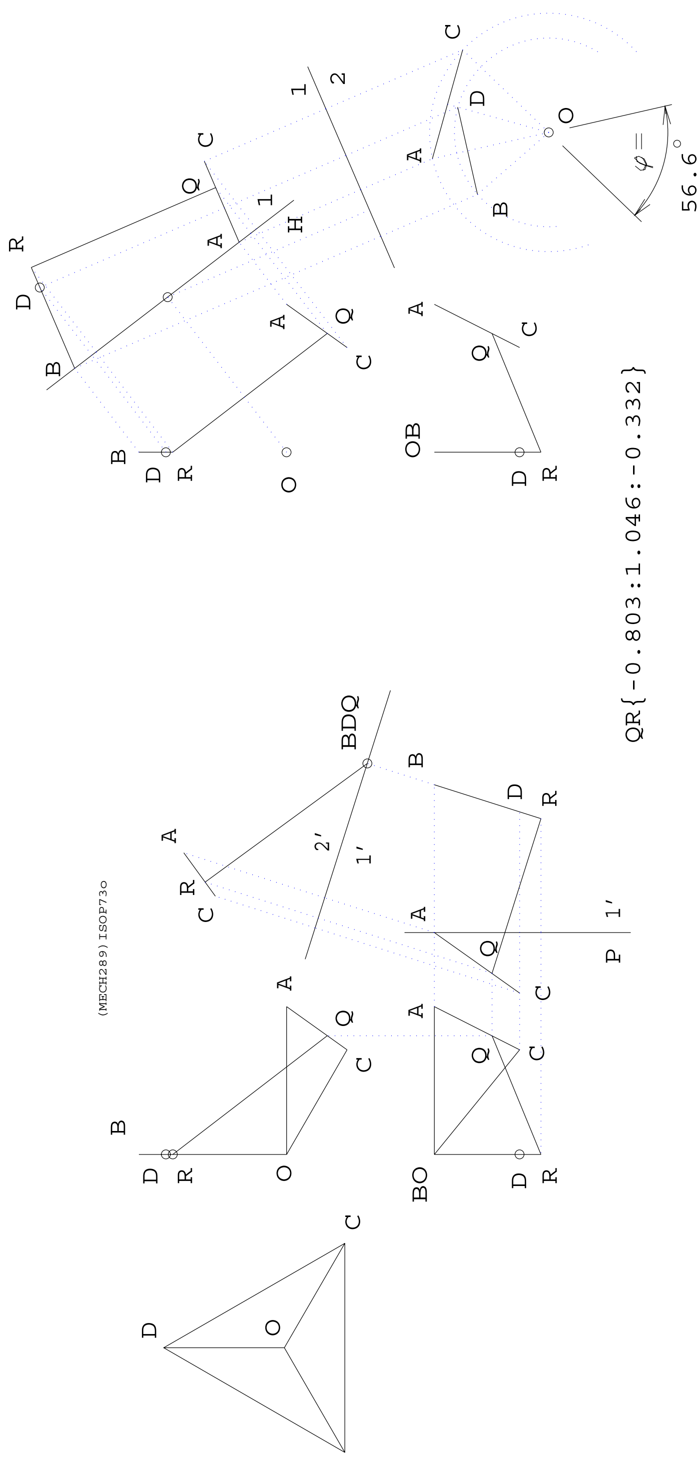

Figure 2: GCA 2 Axis Direction PQ and Angle ϕ