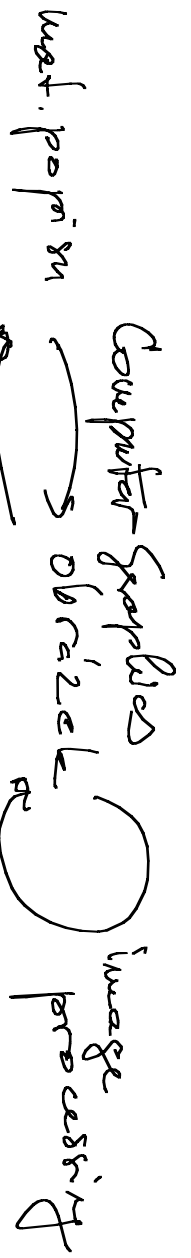


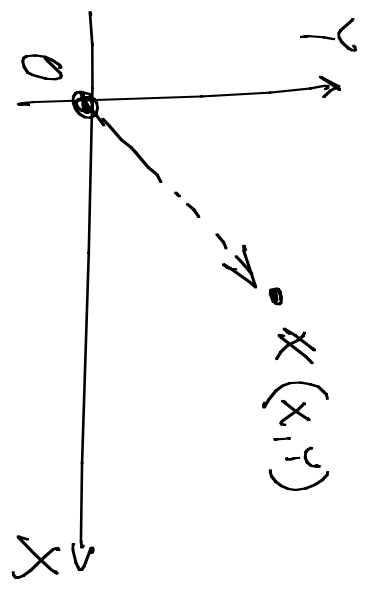
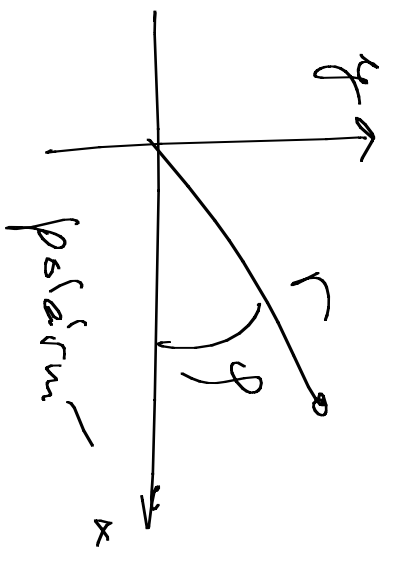
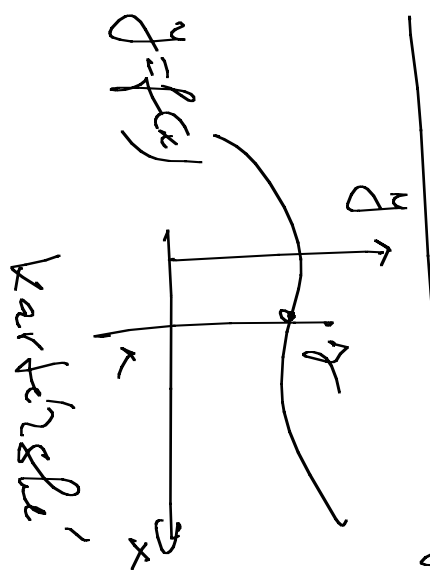


Technische Zeichnung

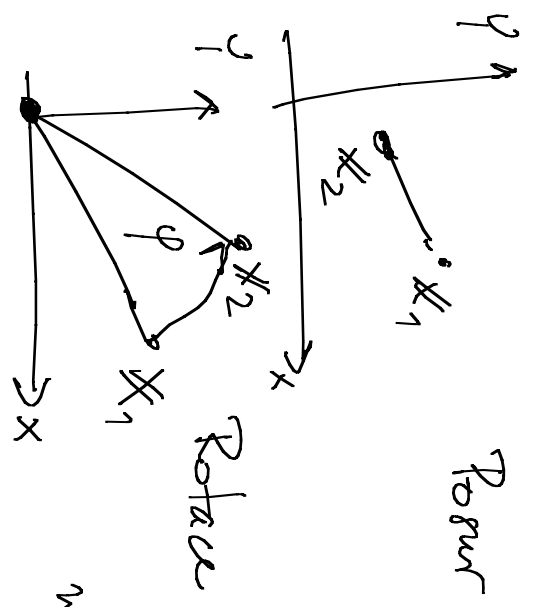


Pos. graf. ; Visualisierung dat & informations

Schnittstelle systeme & vektoren



r



Rotate

$$x_2 = x_1 + \Delta x$$

$$y_2 = y_1 + \Delta y$$

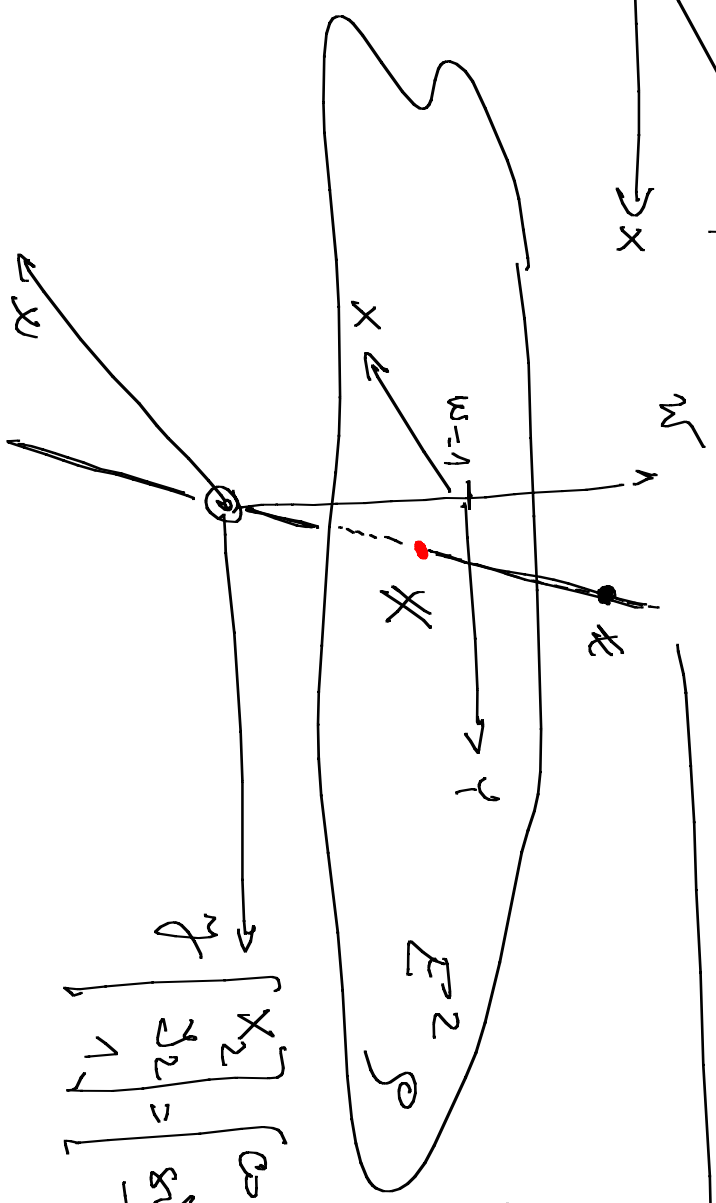
$$\underline{x} = [1, 1]^T$$

$$\underline{\tilde{x}} = [2, 2]^T$$

$$x_2 = x_1 \cos \phi - y_1 \sin \phi$$

$$y_2 = x_1 \sin \phi + y_1 \cos \phi$$

$$\underline{x} = \frac{x}{w} \quad y = \frac{y}{w} \quad w \neq 0$$

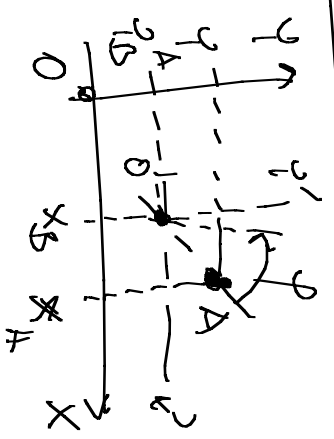


$$T: \begin{vmatrix} x_2 \\ y_2 \\ 1 \end{vmatrix} = \begin{bmatrix} 1 & 0 & \Delta x \\ 0 & 1 & \Delta y \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x_2 \\ y_2 \\ 1 \end{bmatrix} = \begin{bmatrix} \cos \phi & -\sin \phi & 0 \\ \sin \phi & \cos \phi & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix}$$

2

# Rotations-Transformation



$$\begin{aligned}
 x' &= T x \\
 x'' &= R x' \\
 x''' &= T^{-1} x''
 \end{aligned}$$

- 1) Posuv  $(-x_B, -y_B) \rightarrow x'$
- 2) Rotace  $PR \rightarrow x''$
- 3) Posuv  $(x_B, y_B) \rightarrow x'''$

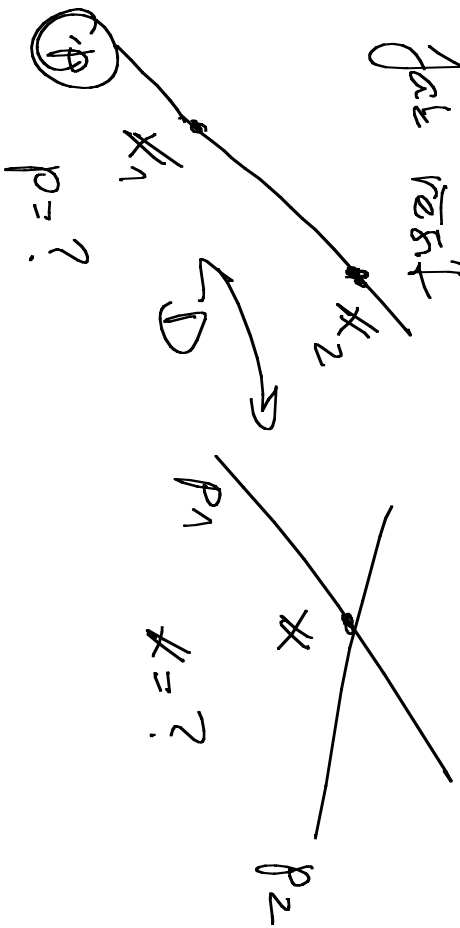
$$T R T^{-1}$$

$$x''' = T^{-1} R T x = Q \cdot x$$

$$\begin{aligned}
 & \boxed{3 \times 3} \cdot \boxed{3 \times 3} \cdot \boxed{3 \times 3} = \boxed{3 \times 3} \\
 & \boxed{3 \times 3} \cdot \boxed{3 \times 3} = \boxed{3 \times 3}
 \end{aligned}$$

$$R^{-1}(p) = R(-p) = R^T(p) \quad \text{Zkouška, Zpracování}$$

fast result



$$ax + b_1y + c = 0 \quad / \cdot \xi \neq 0$$

$$ax_1 + b_1y_1 + c = 0$$

$$ax_2 + b_1y_2 + c = 0$$

param.  $x(t) = x_A + (x_B - x_A)t$

implicit.  $ax + b_1y + c = 0$

exp.  $y = kx + q$

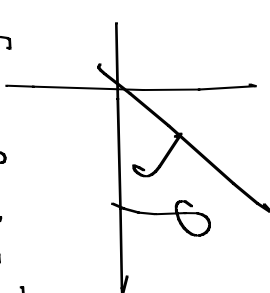
$$a_1x + b_1y + c_1 = 0 \quad p_1$$

$$a_2x + b_2y + c_2 = 0 \quad p_2$$

$$x = \frac{D_x}{D} \quad y = \frac{D_y}{D}$$

$$p_1 = [a_1, b_1, c_1]^T$$

$$p_2 = [a_2, b_2, c_2]^T$$



Prinzip  $\begin{matrix} \text{Quality} \\ \text{Quantity} \end{matrix} \quad p \in \mathbb{R}^2 \quad D$

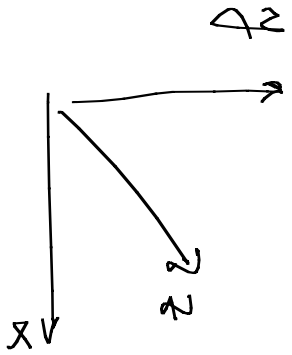
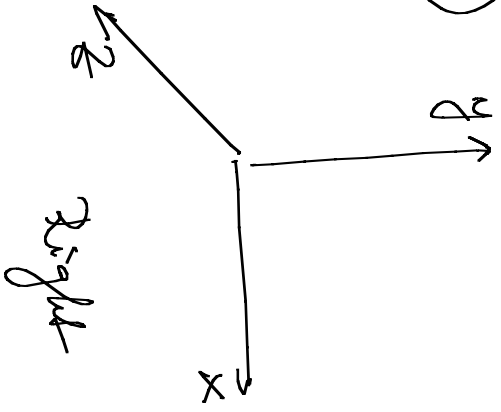
$$\begin{array}{c|c} p_1 & p_2 \\ \hline x_1 & x_2 \\ \hline y_1 & y_2 \end{array}$$

bod  $\Leftrightarrow p_1^T w_k$   $x = [x, y, w]^T$

$$p = x_1 \times x_2$$

$$= p_1 \times p_2$$

Ex 3



Prestriziva + rotacija

1055 B. Aere

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = Q \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

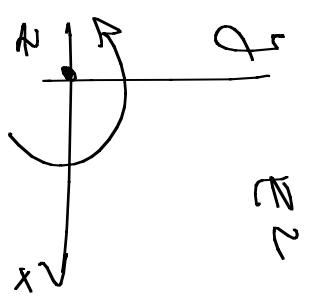
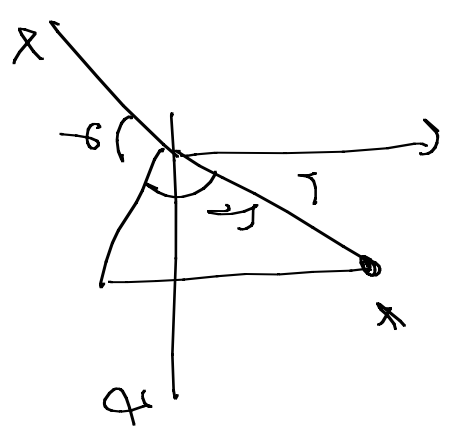
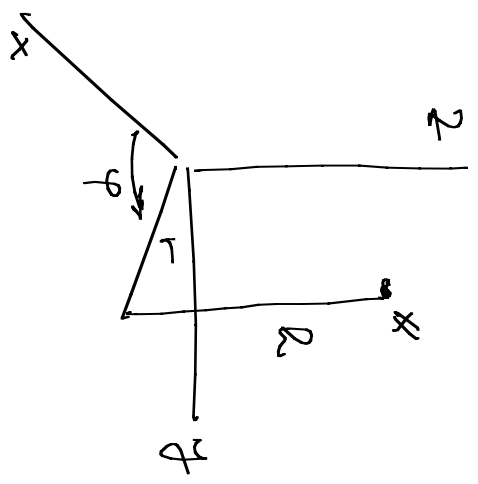
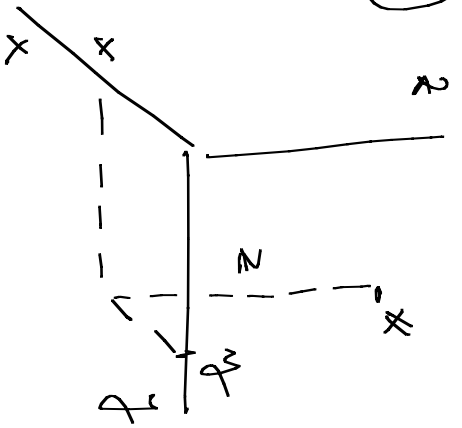
$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} \phantom{x} \\ \phantom{x} \\ \phantom{x} \end{bmatrix} Q^T$$

$$x^T = Q^T x$$

$$x = x^T Q$$

Q

E3



Posuv

$$\begin{vmatrix} x & y & z \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{vmatrix} = \begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{vmatrix} \begin{vmatrix} x & y & z \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

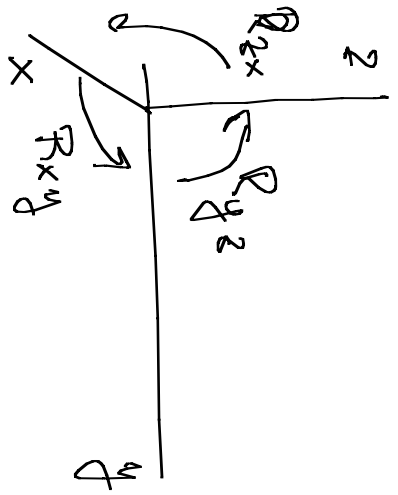
Rotace

$$R_{xy}$$

$$R_z$$

Graphic

VR  
Virtual Reality  
(Augmented  
Haptics --)



$$R_{xy} = \begin{bmatrix} \cos \varphi & -\sin \varphi & 0 & 0 \\ \sin \varphi & \cos \varphi & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_{yz} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos \varphi & -\sin \varphi & 0 \\ 0 & \sin \varphi & \cos \varphi & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_{zx} = \begin{bmatrix} \cos \varphi & 0 & \sin \varphi & 0 \\ 0 & 1 & 0 & 0 \\ -\sin \varphi & 0 & \cos \varphi & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x' = T_1 x \quad x'' = T_2 x' \quad \dots \quad x^{(n-1)} = T_{n-1} x^{(n-2)} \quad \leftarrow$$

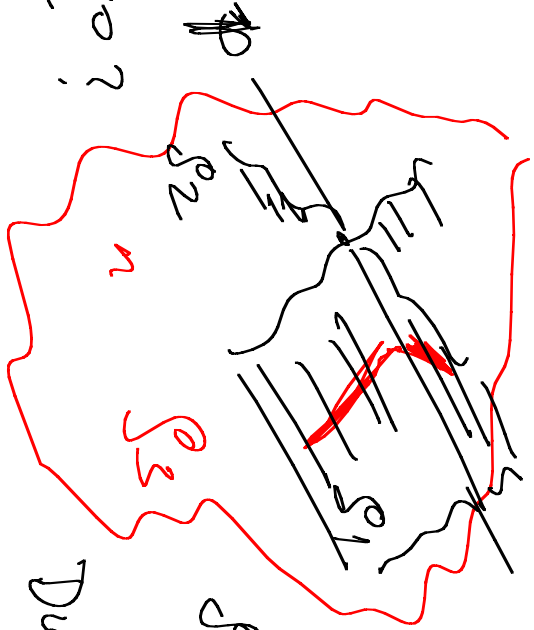


(E3)



$$\{ Ax + By + Cz + D = 0 \}$$

$A, B, C, D$



$$p_3 = [a, b, c, d]^T$$

$$p = x_1 \times x_2 \times x_3 =$$

$$\begin{vmatrix} i & j & k \\ x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \end{vmatrix}$$

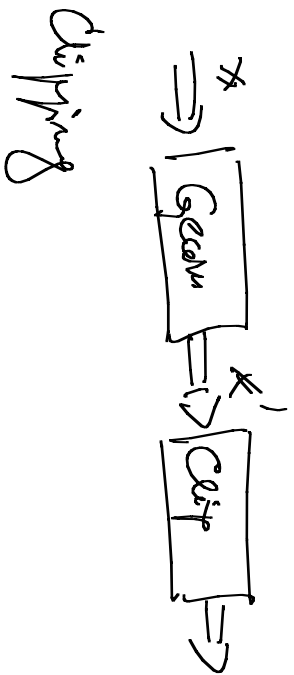
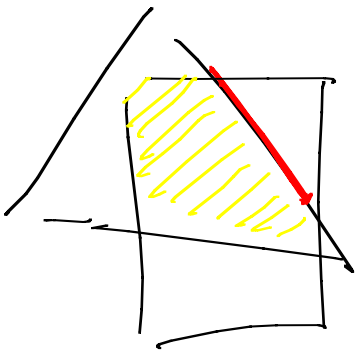
Duvalitz  $E^3$

bad  $\Leftrightarrow$  covering

$$x = p_1 \times p_2 \times p_3$$

$$E^2 \times E^3 \quad [x, y, z]^T$$

$$[x_1, y_1, z_1]^T$$



Distanz:

Criteria: begin -> End

