

DiLa

Digitalisierung in der Labordidaktik

Design and Implement E-learning in mechanical engineering laboratory courses using extended reality environments

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Institute for Automotive System Engineering



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Innovation in der
Hochschullehre

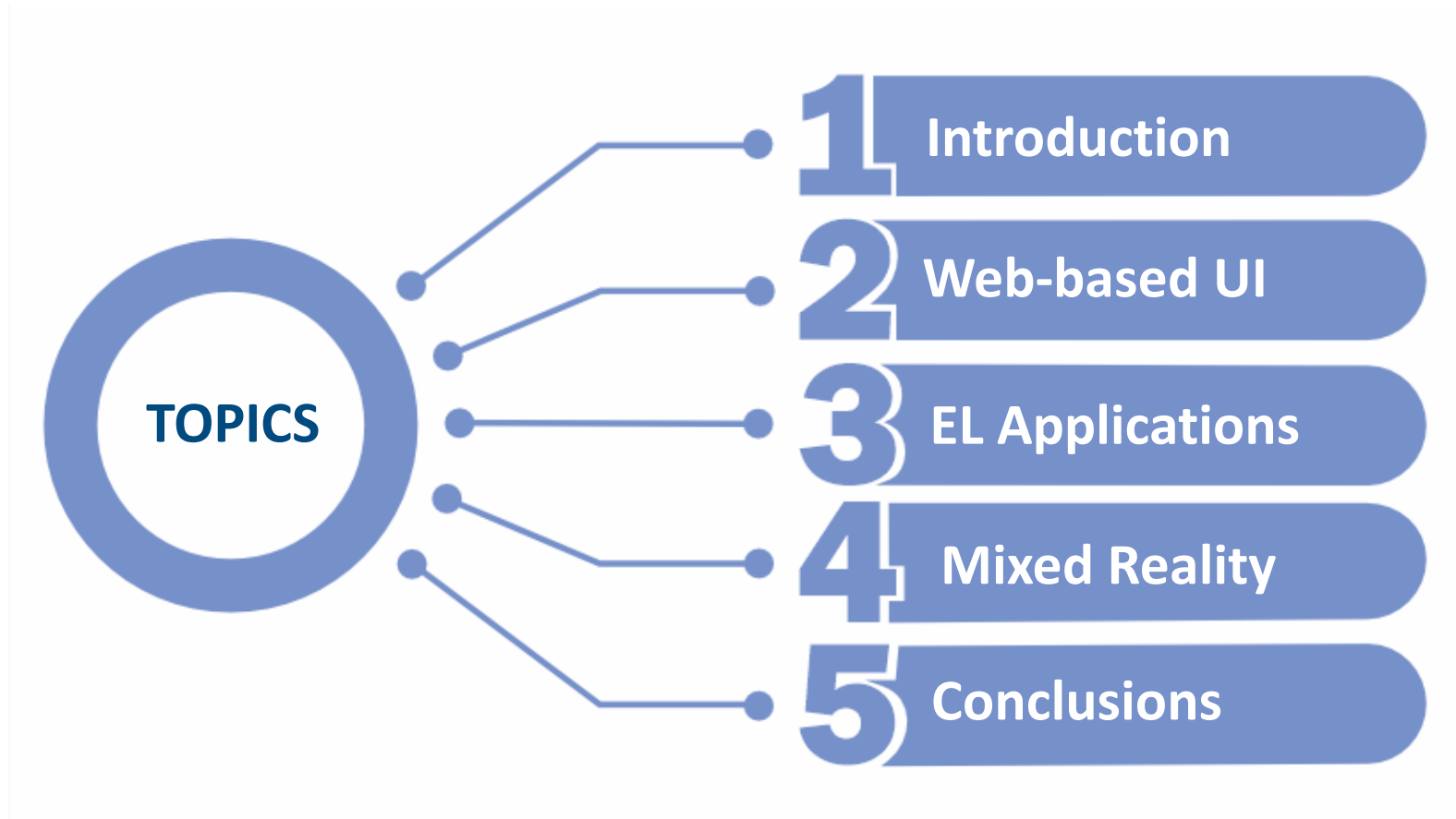


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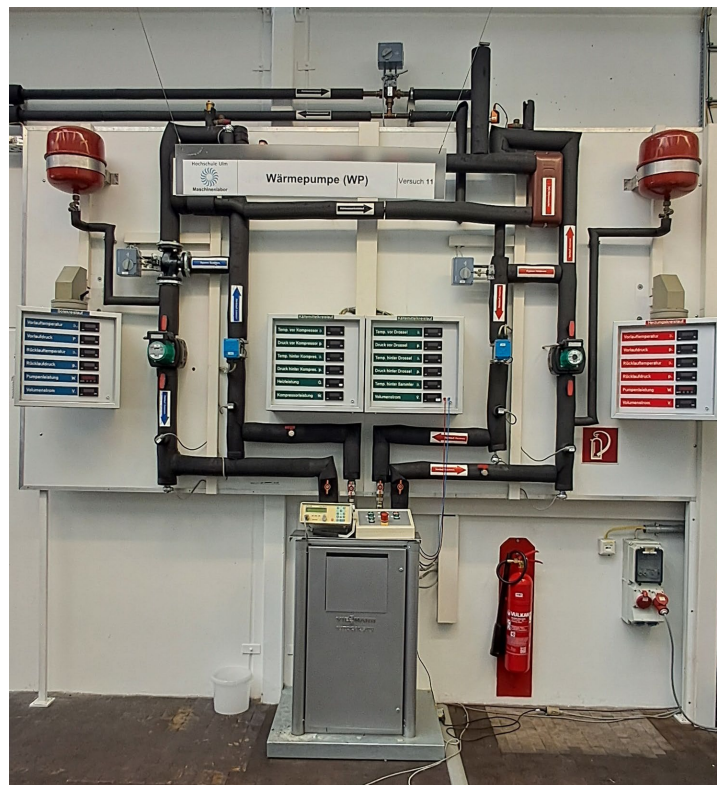
E-Learning



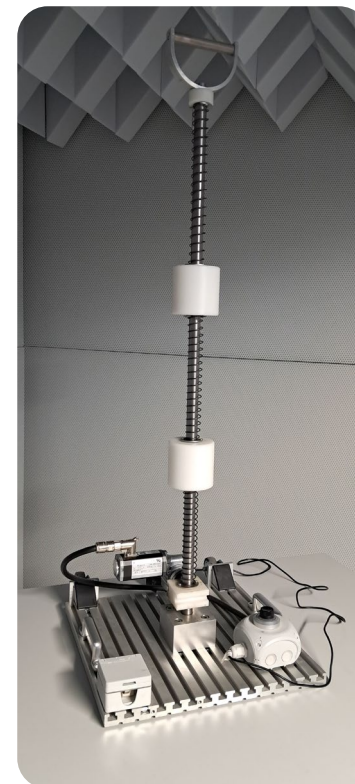
Laboratory Experiments

- 1 Introduction
- 2 Web-based UI
- 3 EL Applications
- 4 Mixed Reality
- 5 Conclusions

Heat Pump

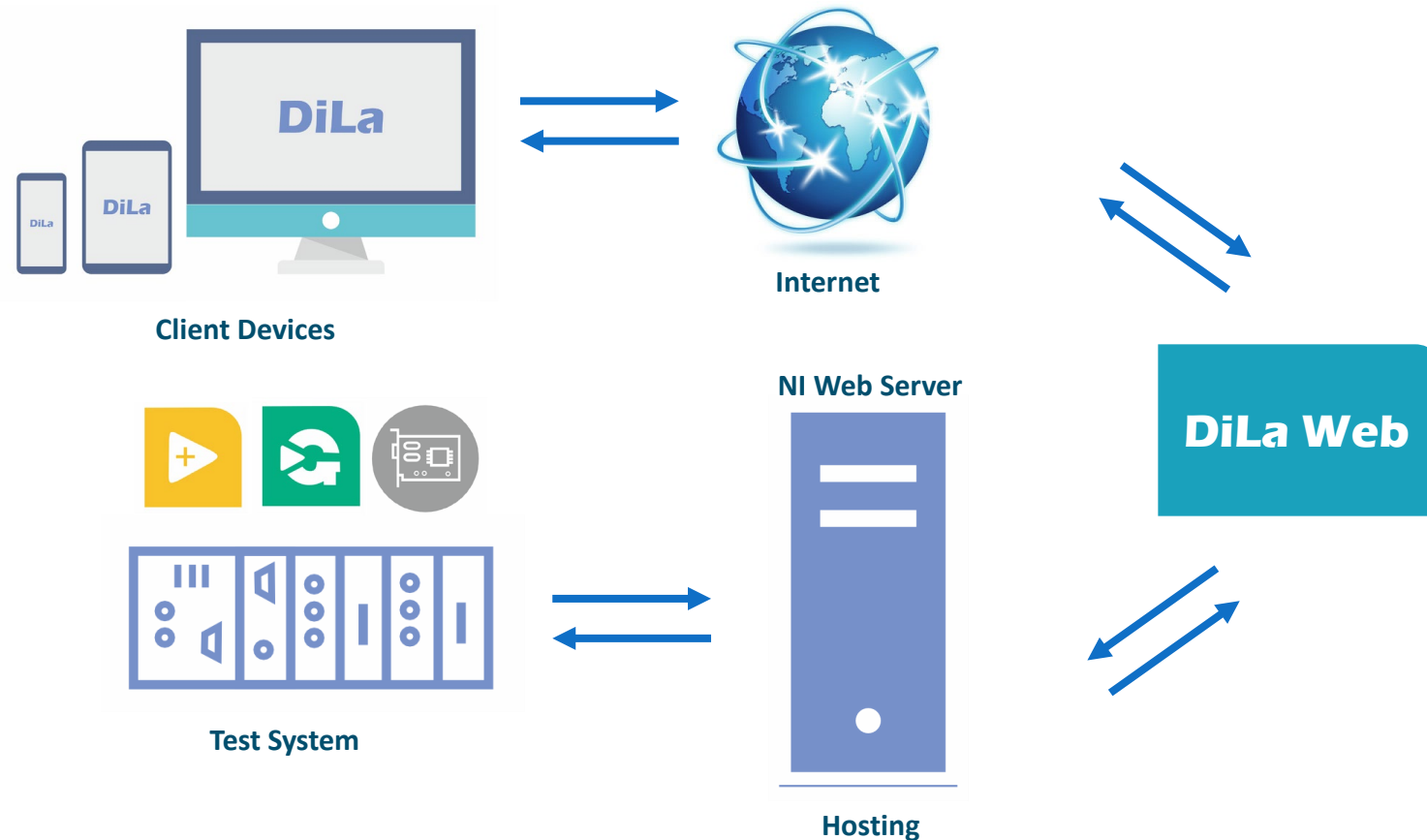


Forced Vibration



Architecture of Web Application

- 1 Introduction
- 2 Web-based UI
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Architecture of Web Application

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Client Devices

Browser-based UI



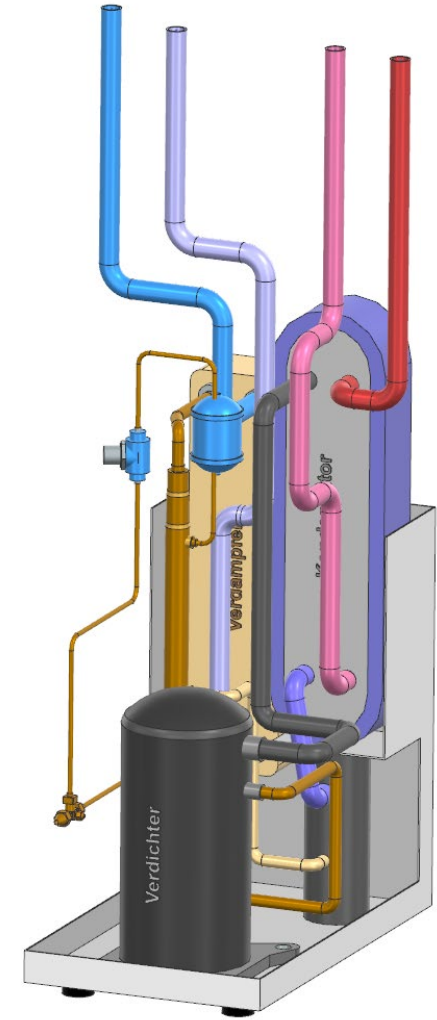
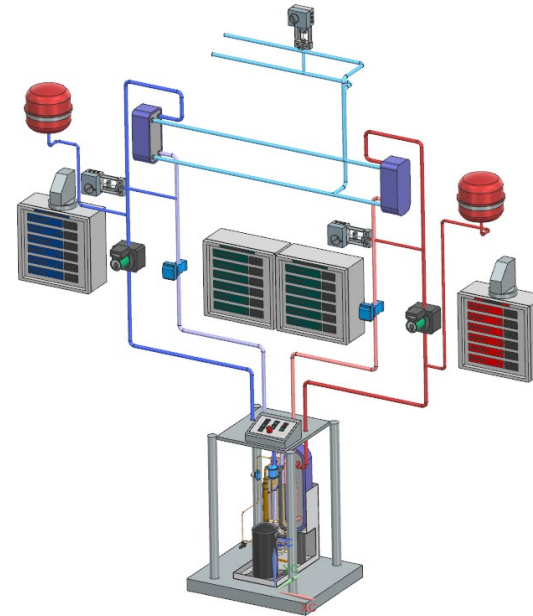
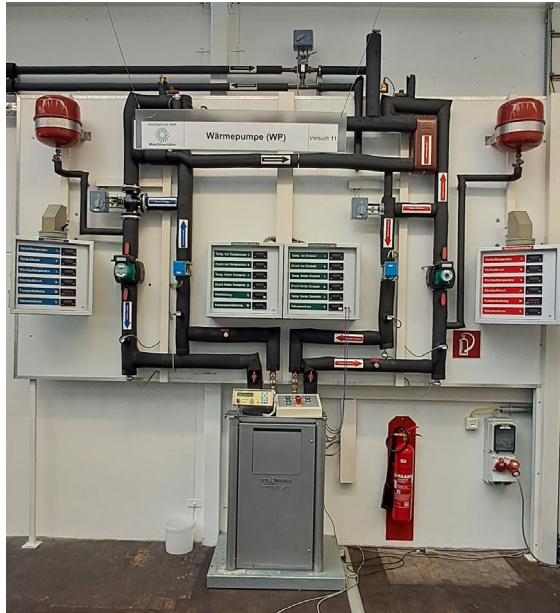
User Interface

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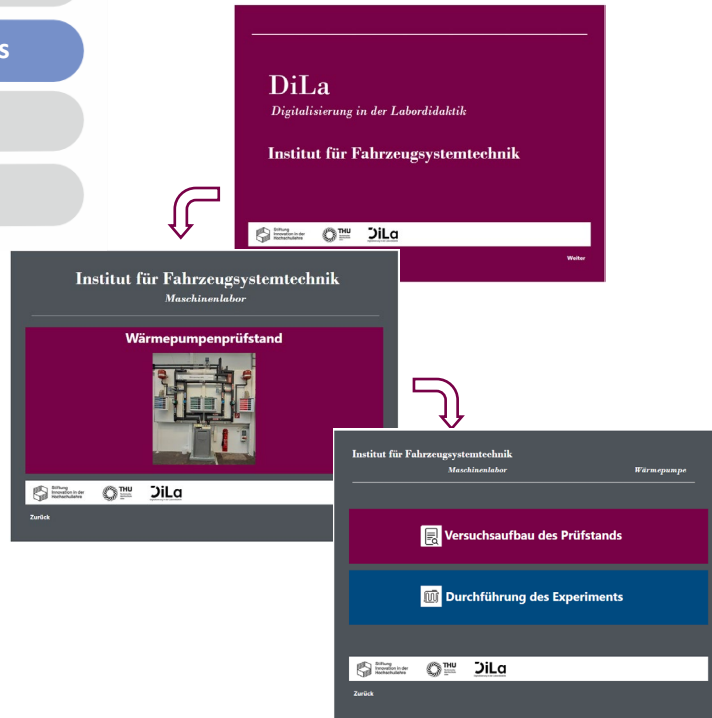
3D CAD Models – Heat Pump

- 1 Introduction
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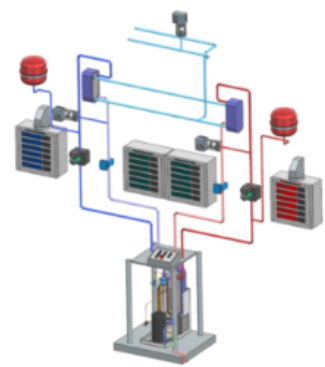
User Interface – Heat Pump

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Maschinenlabor
Wärmepumpe

Wärmepumpe



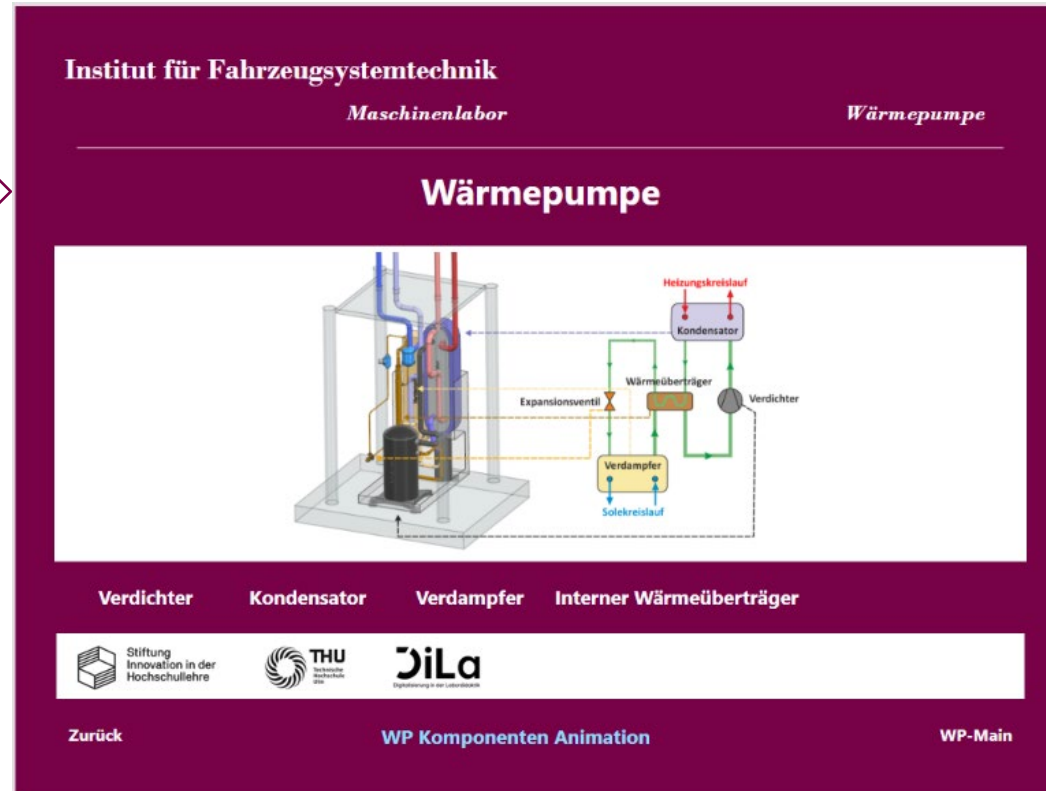
Wärmepumpen entnehmen die von Ihnen benötigte Energie direkt oder mit Hilfe eines Wärmeüberträgers der Umgebung. Diese Energie wird von einem Kältemittel aufgenommen und durch Verdichtung auf ein „höheres Niveau“ angehoben. Anschließend wird diese Energie an das Heizungs- oder Brauchwasser wieder abgegeben. Wärmepumpenanlagen unterscheiden sich in der Art der Wärmequelle und der Wärmesenke.



Zurück>Weiter

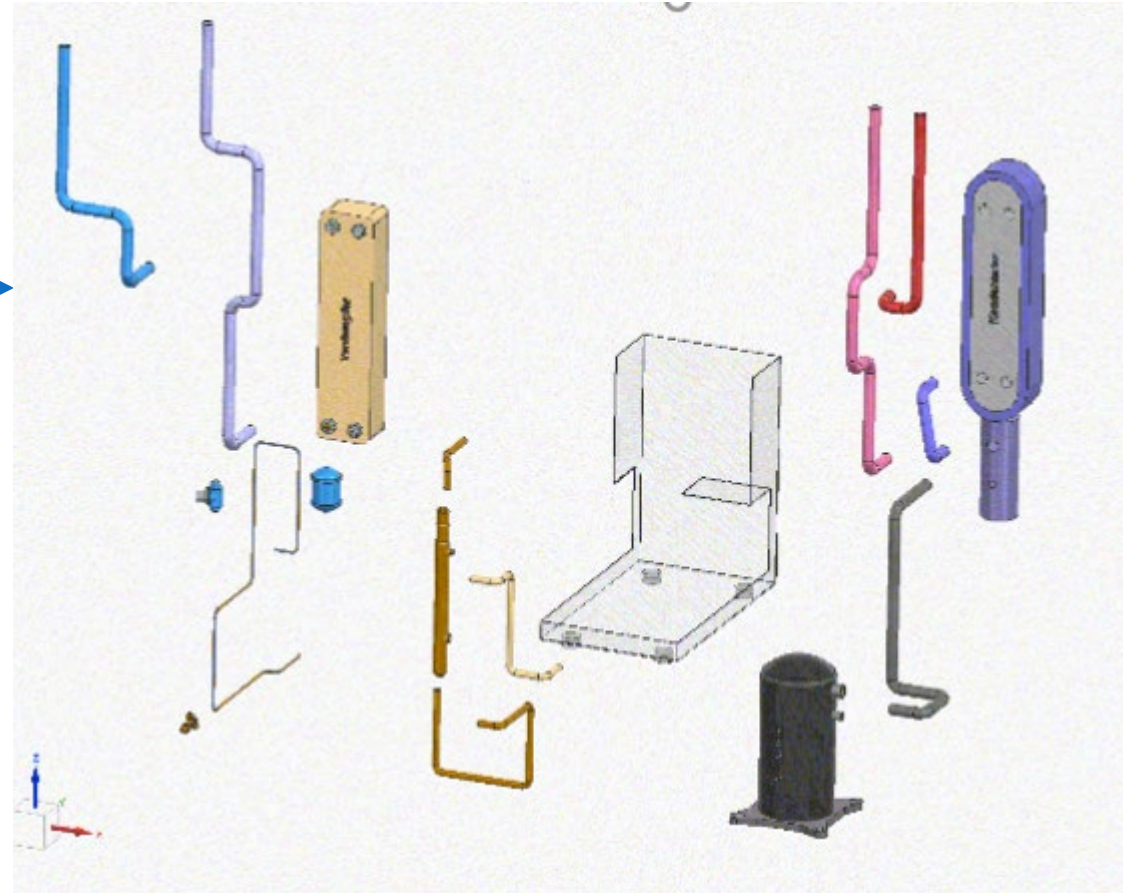
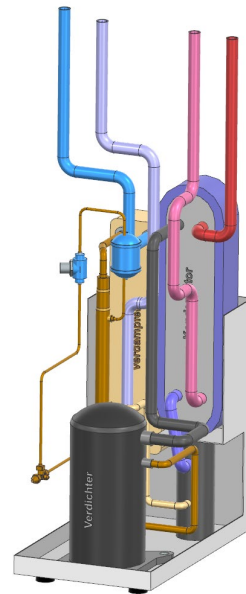
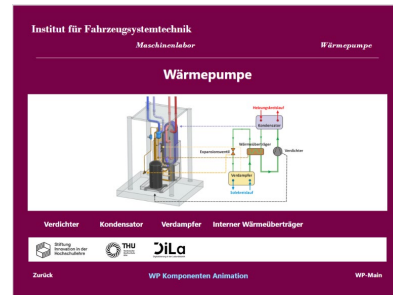
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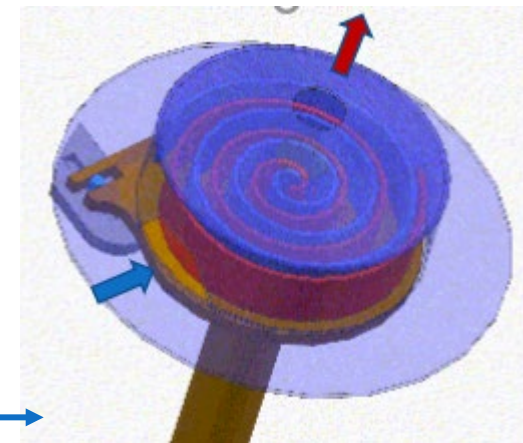
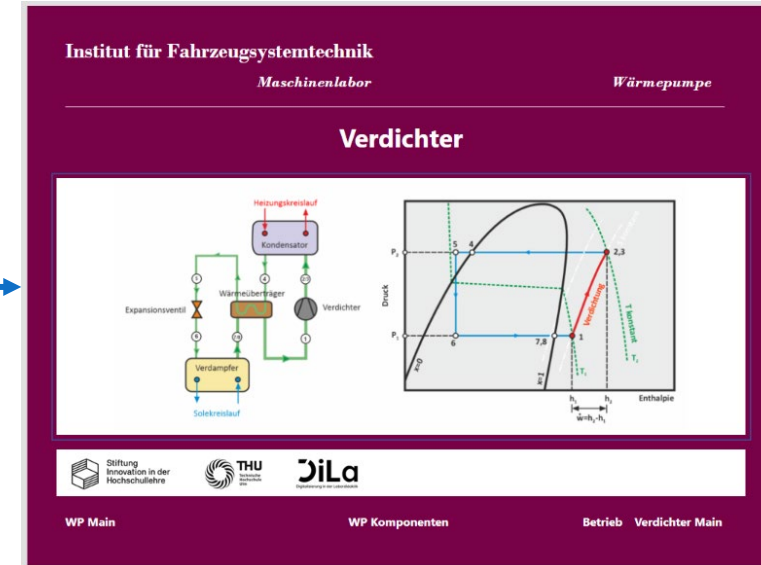
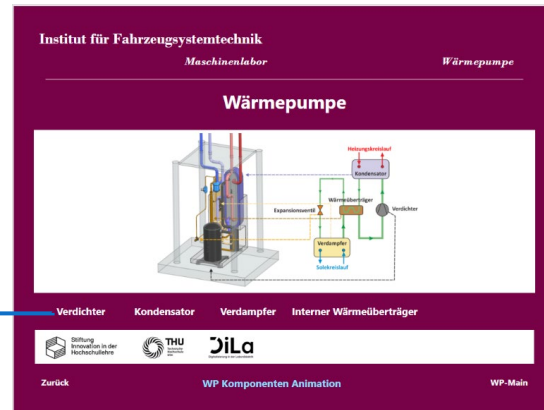
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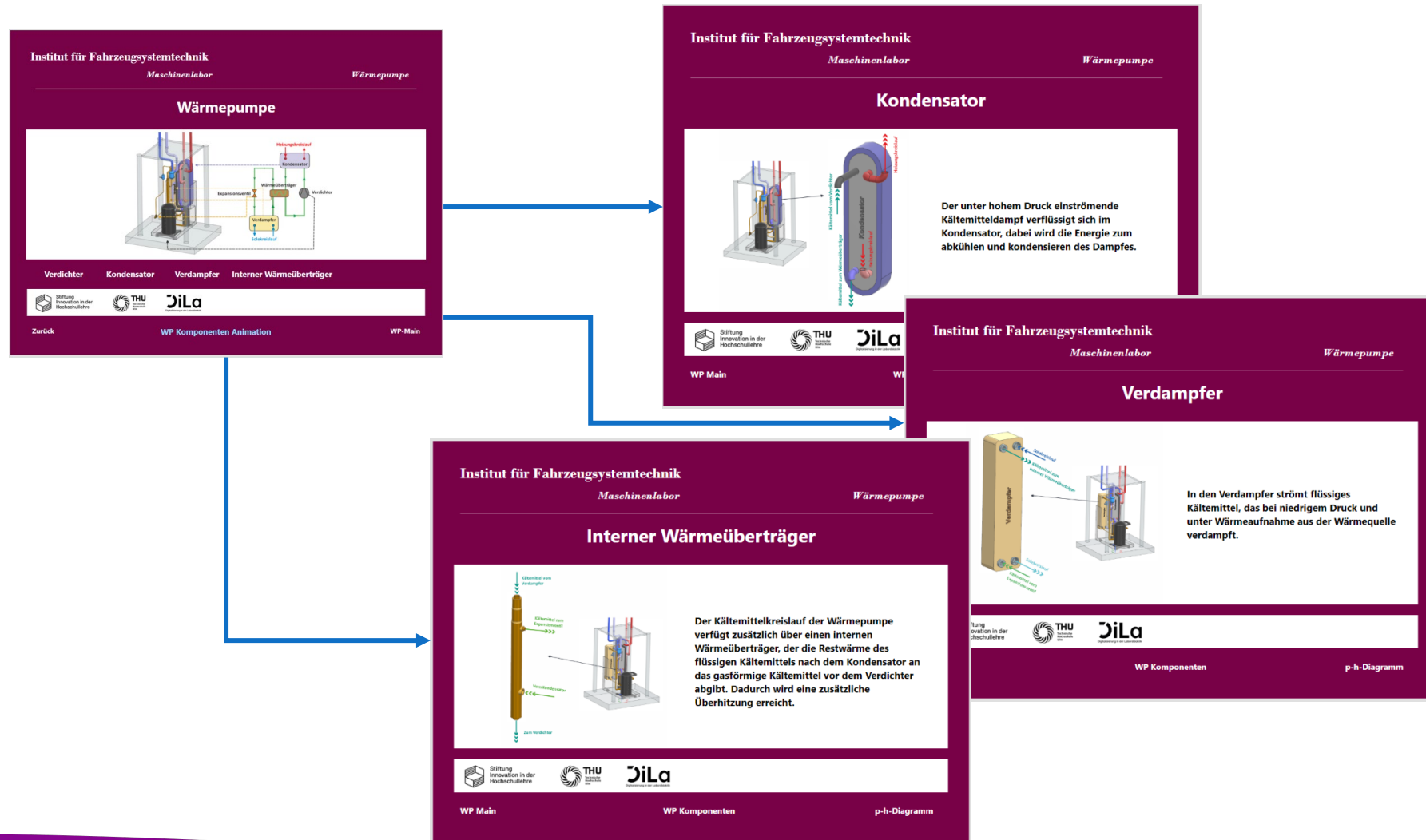
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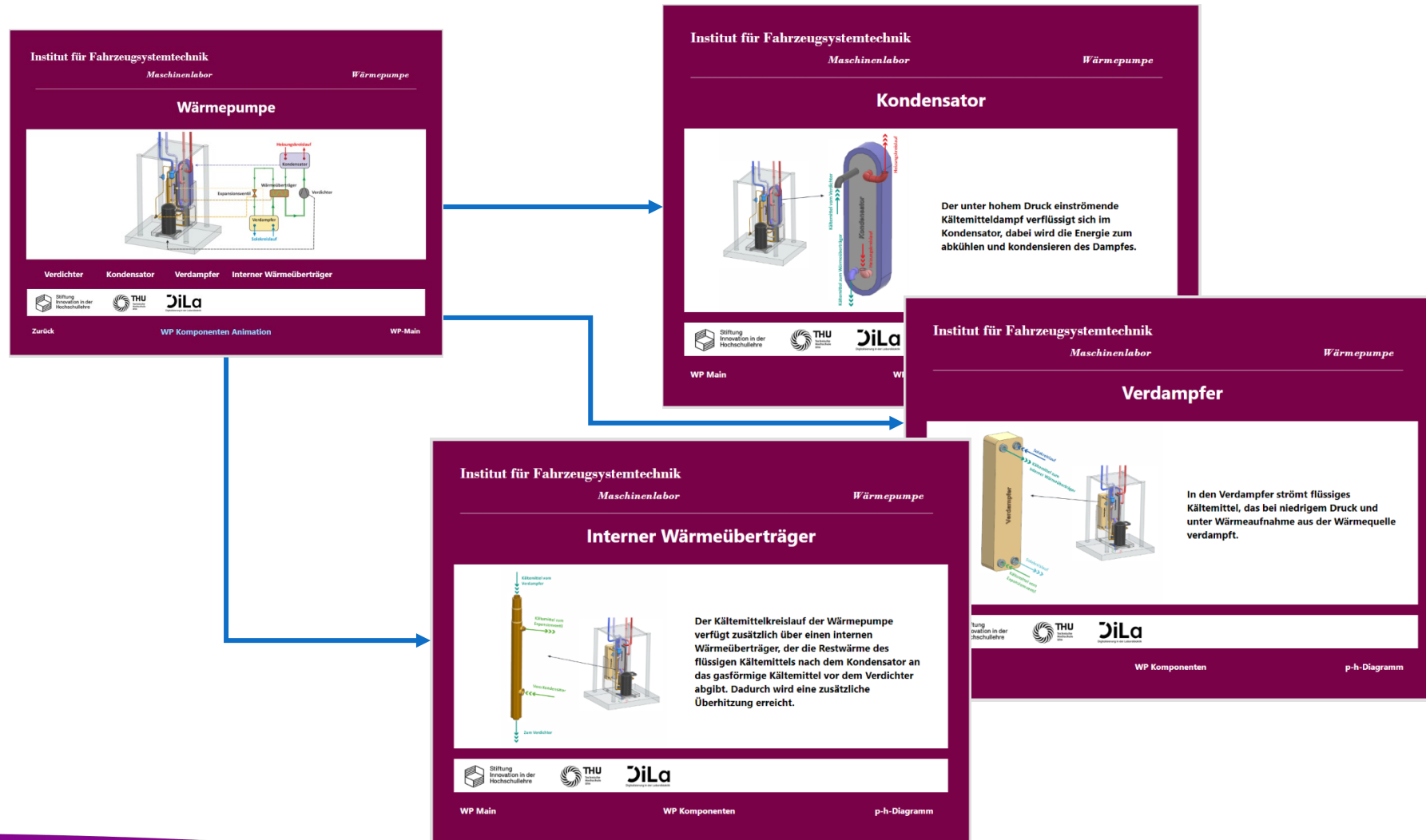
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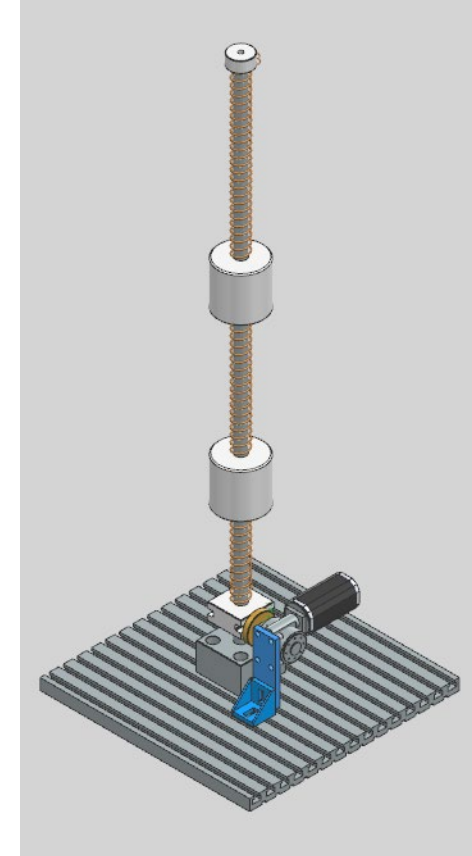
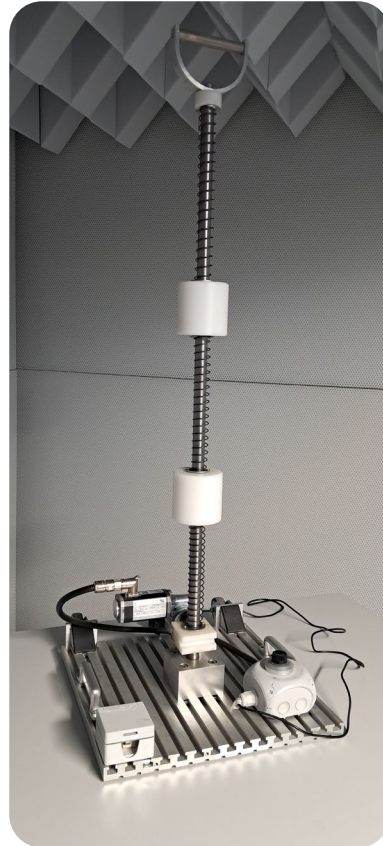
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3D CAD Models - Forced Vibration

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User Interface - Modalanalyse

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Institut für Fahrzeugsystemtechnik

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Erzwungene Schwingung

Modalanalyse



Bei der Experimentelle Modalanalyse werden die dynamischen Eigenschaften einer Struktur untersucht, indem die Eigenfrequenzen, Eigenformen und die Dämpfung, d.h. die modalen Parameter einer Struktur, ermittelt werden. Diese charakterisieren die Schwingungsantwort einer Struktur.

Bewegungsgleichung Eigenfrequenzen Eigenformen

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Main

User Interface - Forced Vibration

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Erzwungene Schwingung

Matrixform der Bewegungsgleichung

$$\begin{pmatrix} m & 0 \\ 0 & m \end{pmatrix} \cdot \begin{pmatrix} \ddot{y}_1 \\ \ddot{y}_2 \end{pmatrix} + \begin{pmatrix} 2k & -k \\ -k & 2k \end{pmatrix} \cdot \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} + \begin{pmatrix} 2c & -c \\ -c & 2c \end{pmatrix} \cdot \begin{pmatrix} \dot{y}_1 \\ \dot{y}_2 \end{pmatrix} = \begin{pmatrix} F \\ 0 \end{pmatrix}$$

$M \cdot \ddot{y} + K \cdot y + C \cdot \dot{y} = f$

Massenmatrix

 $M = \begin{pmatrix} m & 0 \\ 0 & m \end{pmatrix}$

Dämpfungsmatrix

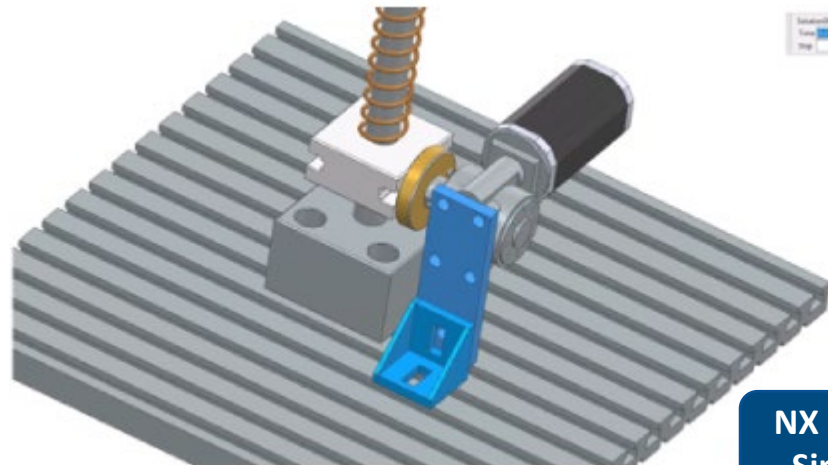
 $K = \begin{pmatrix} 2k & -k \\ -k & 2k \end{pmatrix}$

Steifigkeitsmatrix

 $C = \begin{pmatrix} 2c & -c \\ -c & 2c \end{pmatrix}$

Exzenter Motor
 $s(t) = s_0 \cdot \cos(\Omega t)$
 Ω : Anregungsfrequenz

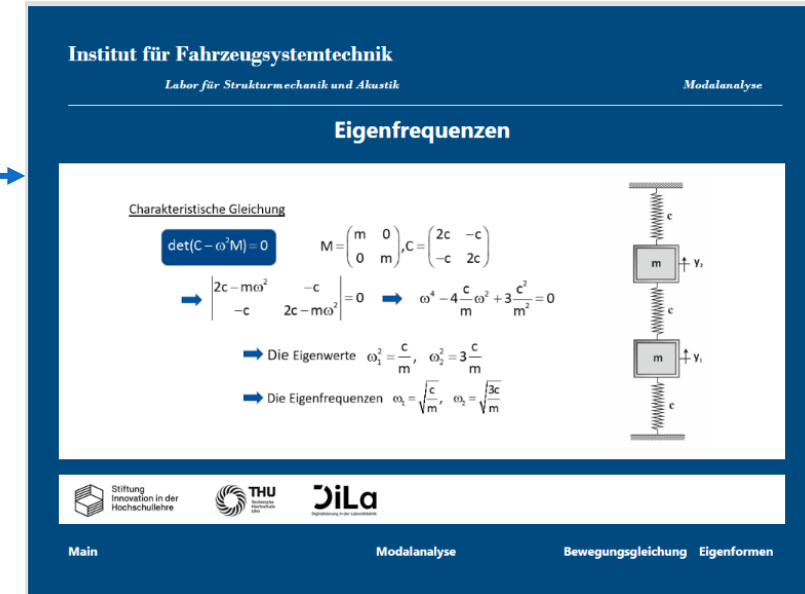
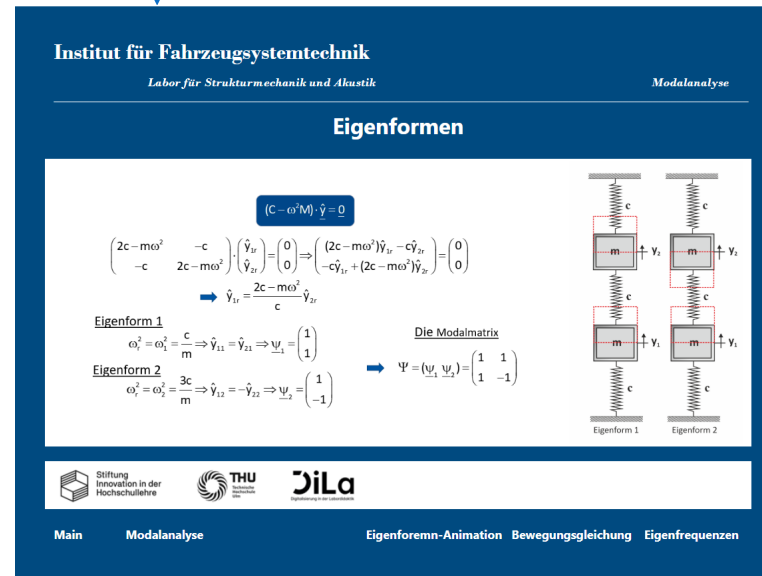
Main
Modalanalyse
Erregung
Eigenfrequenzen
Eigenformen



NX Siemens
Simulation

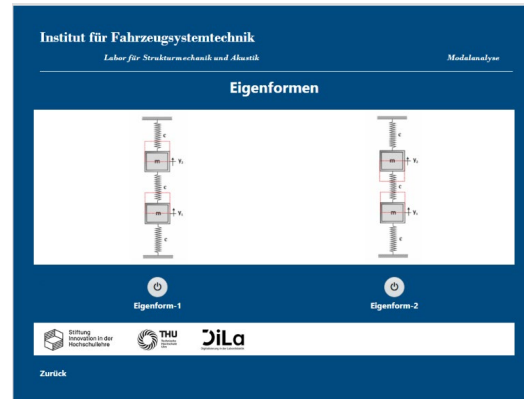
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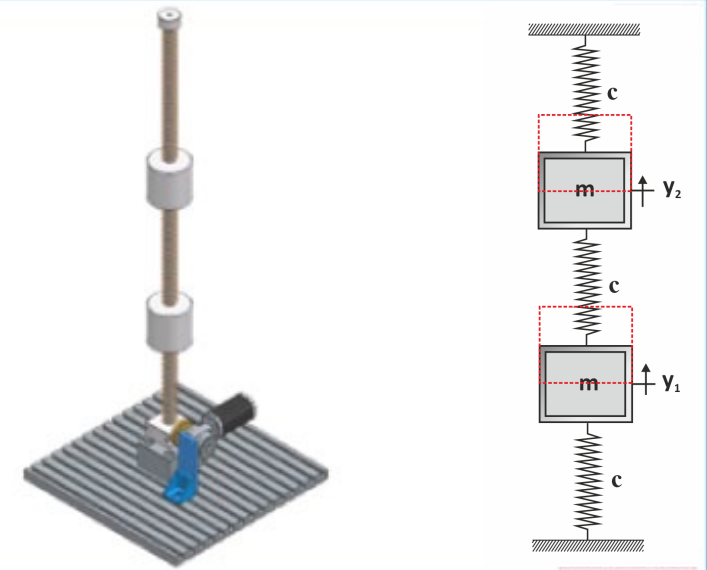


User Interface - Modalanalyse

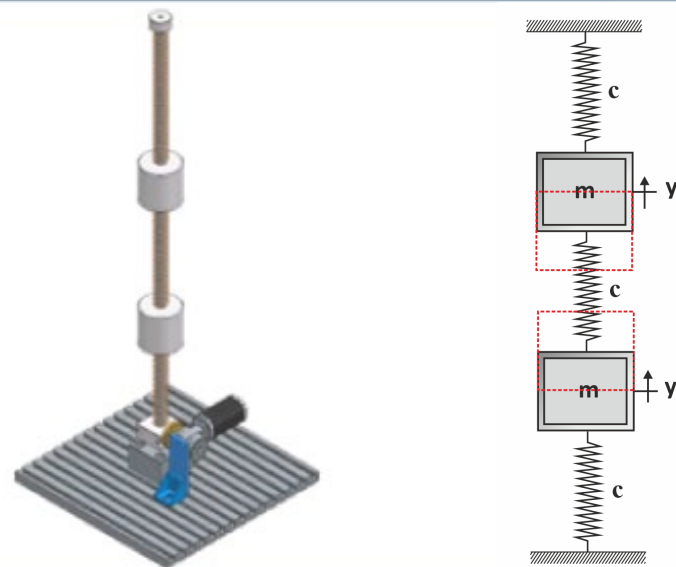
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Eigenform 1



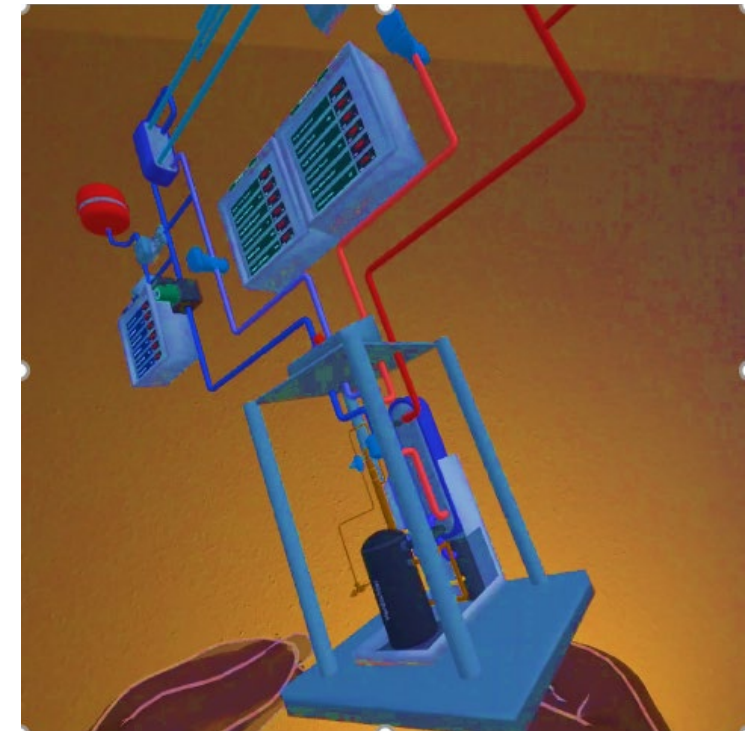
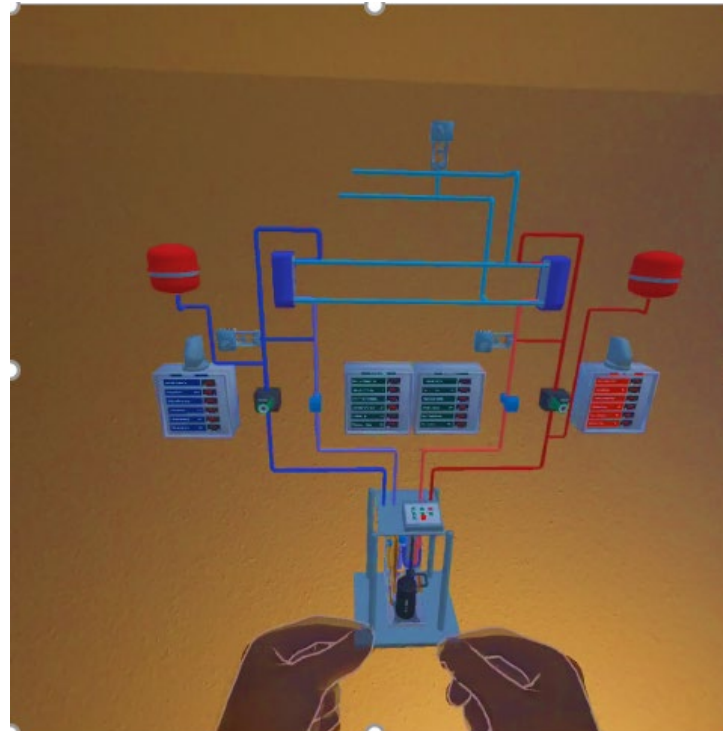
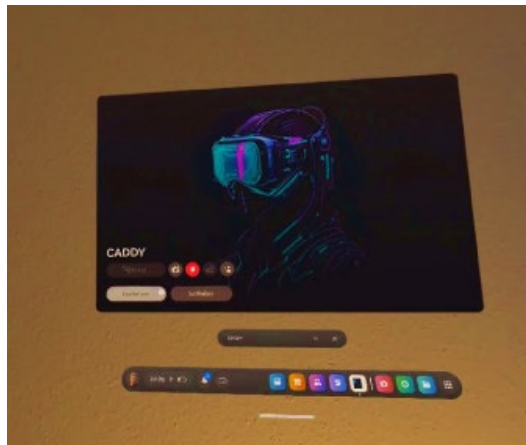
Eigenform 2



Meta CADDY Software

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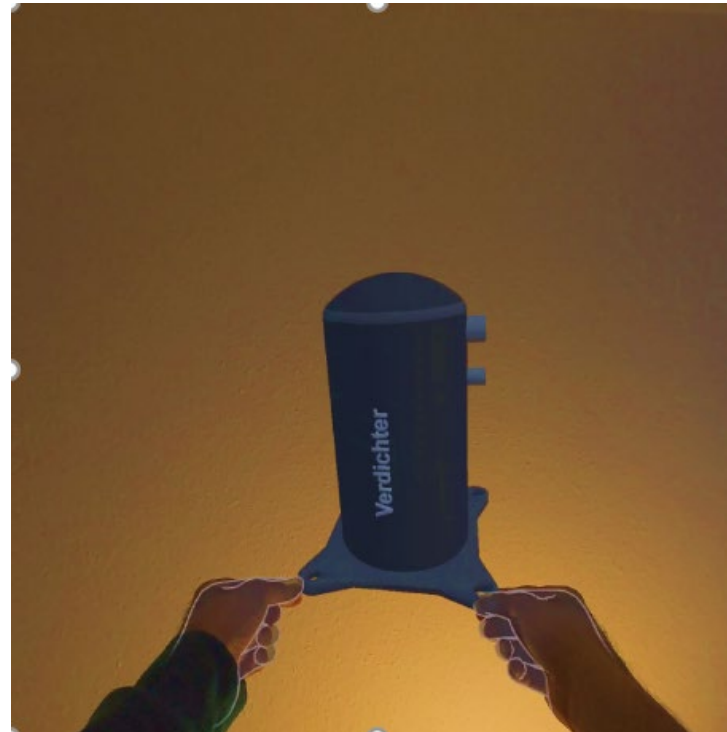
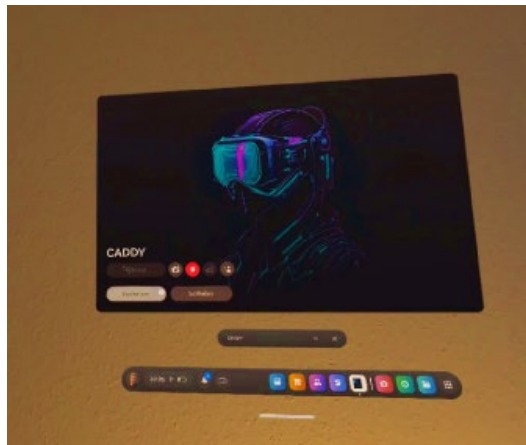
Meta Quest 3



Meta CADDY Software

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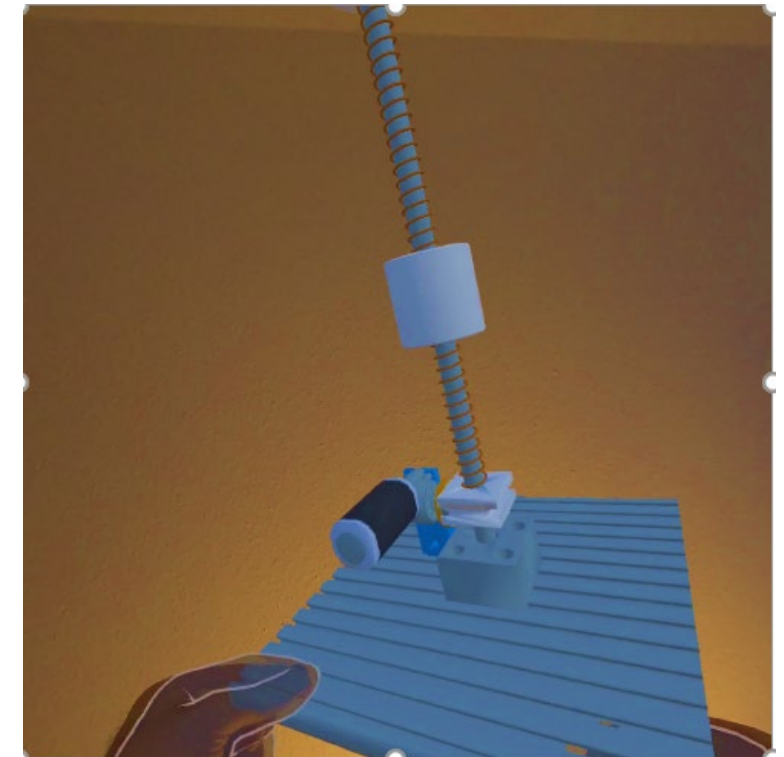
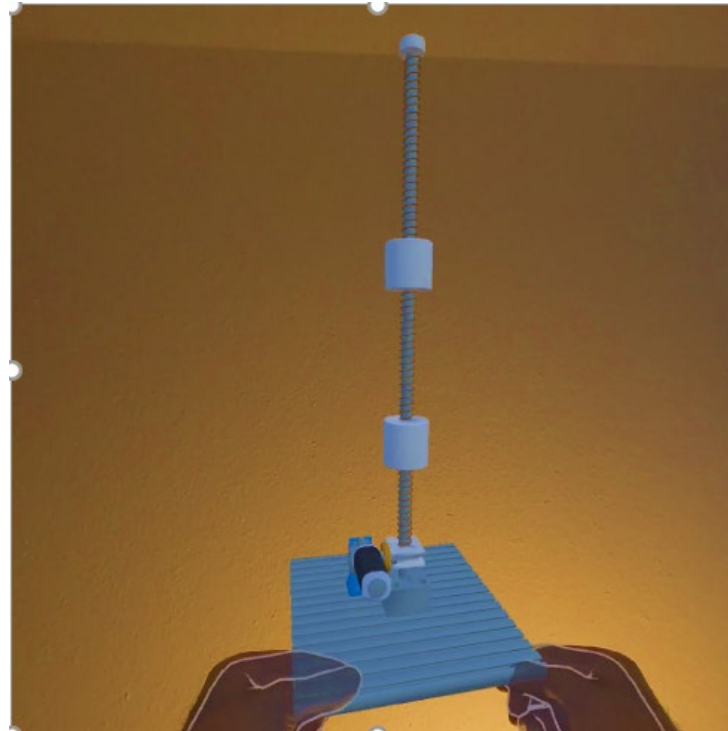
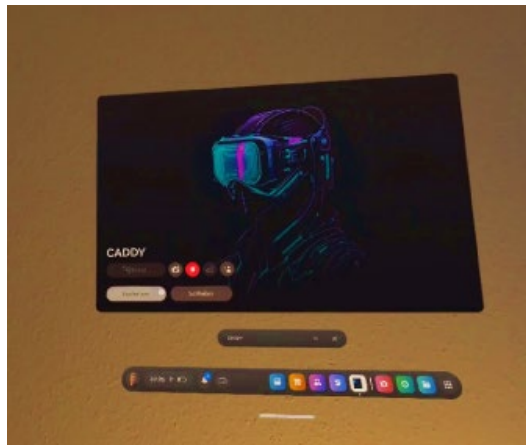
Meta Quest 3



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Meta Quest 3



Conclusions

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The transition to e-learning as an innovation that responds to the modern digital era is the solution to addressing the problems of laboratory education.

E-learning using extended reality environments has a positive impact on the effectiveness of the learning process.

Virtual lab, as one of the most innovative tools of digital education, has gained increasing importance in engineering education.