Description of the Fabric/Yarn Design Program

The Fabric/Yarn Design Program is an interactive program with a Graphical User Interface programmed in Rebol. The starting screen of the program, where the user chooses the appropriate module:

- Yarn Production Technology
- Yarn Hairiness
- Yarn Diameter
- Area Porosity
- Air Permeability
- Young Modulus of Fibres
- Mean Fibre Length
- Friction Coefficients
- Fibre Density

It is an interactive program for computer aided textile design. The purpose of the program is to help a fabric designer to optimize the properties of the fabric/yarn.
- Strength
- Fibre Ductility
- Hygrometric Properties of Fibres
- Mass Nonuniformity of Yarn
- Yarn Twist
- Creasing Resistance
- Interlacing Angle
- Thickness
- Areal Weight
- Areal Cover
- Roughness
- Bending Modulus
- Shear Modulus
- Initial Modulus
- Shortening
- Elongation
- Drapeability

Sample input screen:

![Textile design interface](image)

**Textilní design**
- **Model:** Tkanina
- **Osnovní příze**
- **Skála:** Jednoduchá
- **Technologie:** Protějšková, tkaná
- **Komponenty:** 2. bavlna, hml. pedl. 50%, uva, hml. pedl. 50%
- **Umělá příze**
- **Skála:** Jednoduchá
- **Technologie:** Kompaktní, vykojená
- **Komponenty:** 2. bavlna, mla, tyčinka, PEN, PAN
- **POP**

**Individual inputs of the program**
Prediction of the fabric properties in the line fibre – yarn - fabric is based on the combination of the mathematical modelling as well as experimental research, including the development and application of the new, non-standard measuring methods designed to express fabric structure and structural mechanics.

Yarn hairiness prediction is based on a function graphed in Fig. 1. The value of the function
depends on fibre count and on the technology of yarn production. Values of this function correlate well with values obtained by measurements using the Uster Tester 4.

Visualization of the longitudinal view of the yarn with defined yarn diameter and yarn hairiness is based on the yarn hairiness function – see Fig. 2.

Prediction of the yarn strength is based on material properties of fibres as well as on the yarn construction and production technology.

The Fabric/Yarn Design System can be used for evaluation of properties of a one- and two-component single- as well as two-ply yarn; a 2D visualization is shown in Fig. 3.

The visualization is based on the yarn count and the twist of the two-ply yarn. For example visualization of a yarn cross-section is based on yarn count and number of the fibres as well as yarn packing density (i.e. ratio of the fibre volume to the yarn volume).

Approximation of the binding wave in the weave repeat for fabric construction is based alternatively on Fourier series or on an approximation using hyperbolic segments. Prediction of the air permeability of the woven fabric [4] follows from the definition of the structural interlacing elements. Structural interlacing models including the fabric thickness define final roughness of the woven fabric. In this case fabric thickness depends on relative waviness of the warp and weft in the fabric as well as warp and weft diameter. Input parameters of the yarn and fabric influence the final 2D visualization see Fig. 4-5.
Fig. 4 Influence of the weave on dobby fabric visualization – from the left hopsack, twill, satin

Fig. 5 Influence of the areal cover of the fabric on dobby fabric visualization – from the left 100 %, 80 %, 60 %

**Outputs of the system for textile design**

Inputs to the system are individual tables/values of parameters characterizing fibre, yarn and fabric. The software computes mean values of individual properties and their validity intervals. A user can replace the computed values by specific values (for example value from experimental measuring).

Outputs of this system are tables with predicted properties as well as comparative graphs for properties evaluation and 2D visualization of individual textiles. Above-mentioned outputs system users can use for final evaluation of the fibre-yarn-fabric properties see Fig. 6-7.

<table>
<thead>
<tr>
<th>FIBERS</th>
<th>YARNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass density</td>
<td>one and two component yarn</td>
</tr>
<tr>
<td>fineness</td>
<td>single</td>
</tr>
<tr>
<td>mean length</td>
<td>two ply</td>
</tr>
<tr>
<td>UHM</td>
<td>fineness</td>
</tr>
<tr>
<td>tenacity</td>
<td>diameter</td>
</tr>
<tr>
<td>elongation</td>
<td>porosity</td>
</tr>
<tr>
<td>initial modulus</td>
<td>twist</td>
</tr>
<tr>
<td>friction coefficient</td>
<td>twist</td>
</tr>
<tr>
<td>moisture regain</td>
<td>tenacity</td>
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<tr>
<td></td>
<td>initial mod.</td>
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<tr>
<td></td>
<td>elongation</td>
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<tr>
<td></td>
<td>hairiness</td>
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<tr>
<td></td>
<td>initial modulus</td>
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<td>hairiness</td>
</tr>
</tbody>
</table>

Fig. 6 Final predicted properties of the fibre-yarn-fabric
This work was supported by the research project LN00B090 of Czech Ministry of Education.

References: