HACKTEX VIRTUAL TRAINING MATERIALS
Mooc on ADVANCED TEXTILES MANUFACTURING INDUSTRY
Learning unit 3 Technologies for functional and smart textiles
Lesson 1

Technologies for production of 2D and 3D smart textiles

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TECHNOLOGIES FOR PRODUCTION OF 2D AND 3D SMART TEXTILES

LU 3.1

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3. Technologies for 2D and 3D textile structures
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4. Lesson summary

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1. FUNCTIONAL AND TECHNOLOGICAL DESIGN OF TEXTILES USED FOR SMART APPLICATIONS

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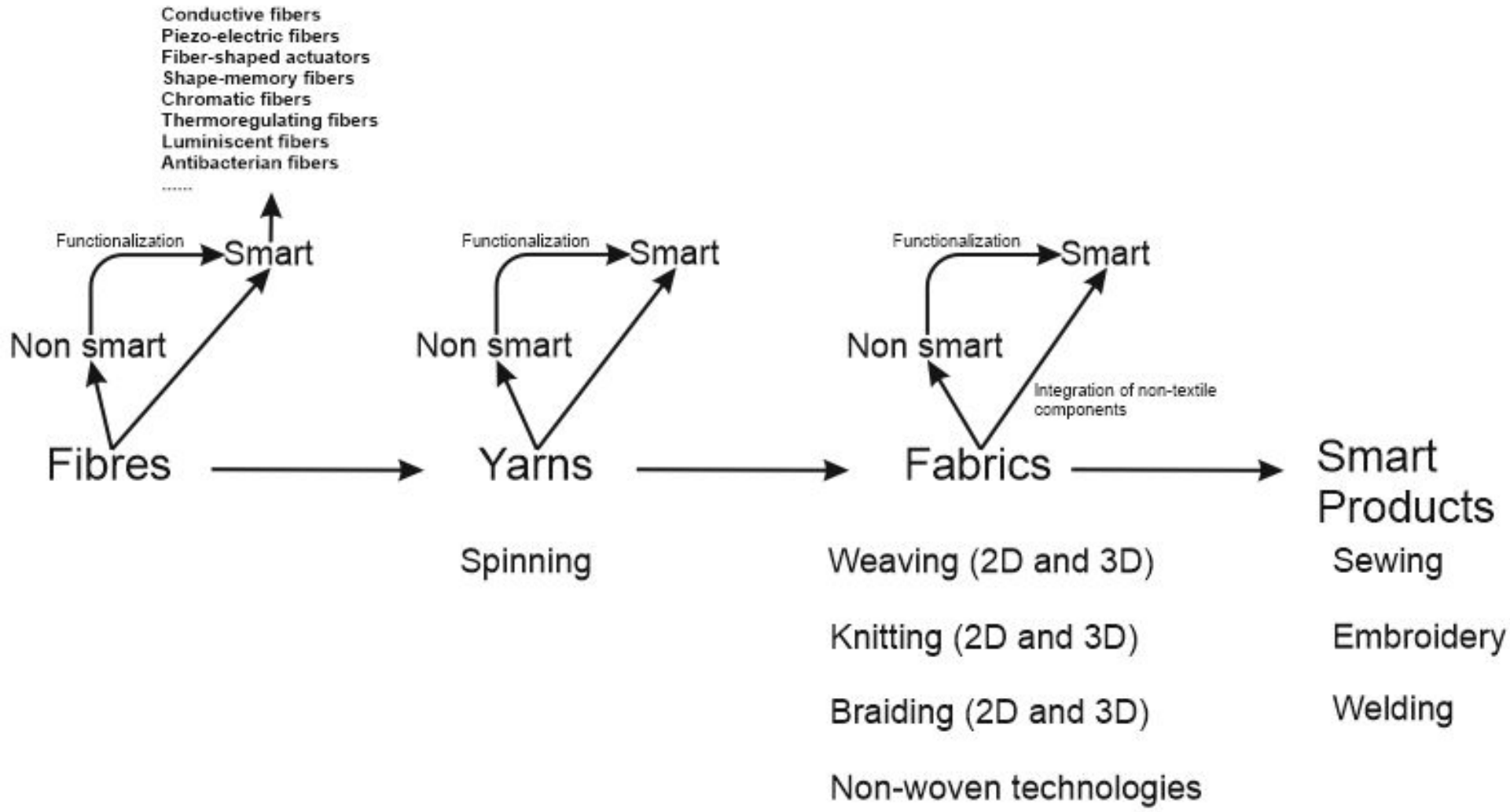
Textile value chain



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- Type of textile materials
- Integration of smart functions in a material/product?
- Available raw materials

Textile design for smart product

Properties of textile materials

Smart product functions

Functional design

Structure, structural parameters and shape

Technological design

Technological processes; textile machinery, technological parameters

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2. TECHNOLOGIES FOR 1D TEXTILE STRUCTURES (YARNS)

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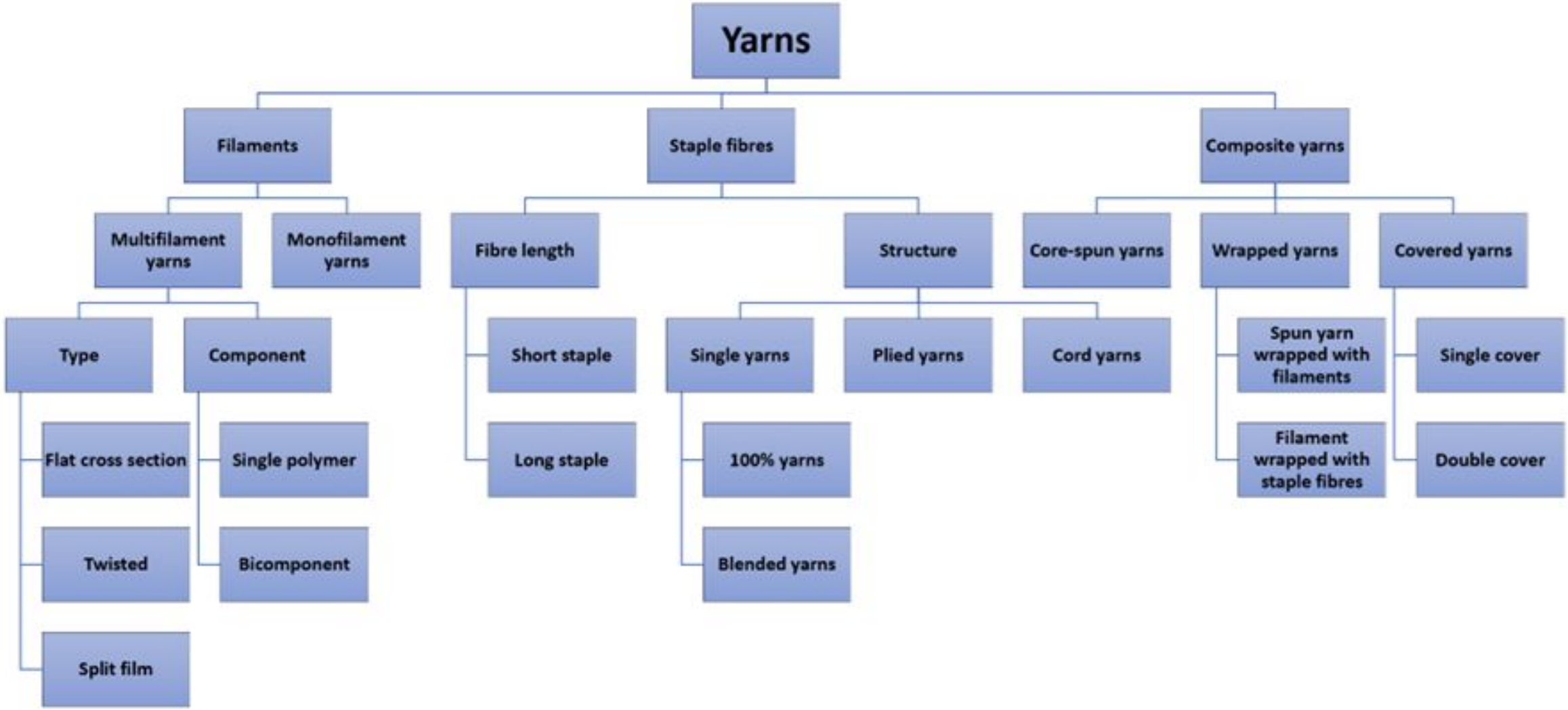

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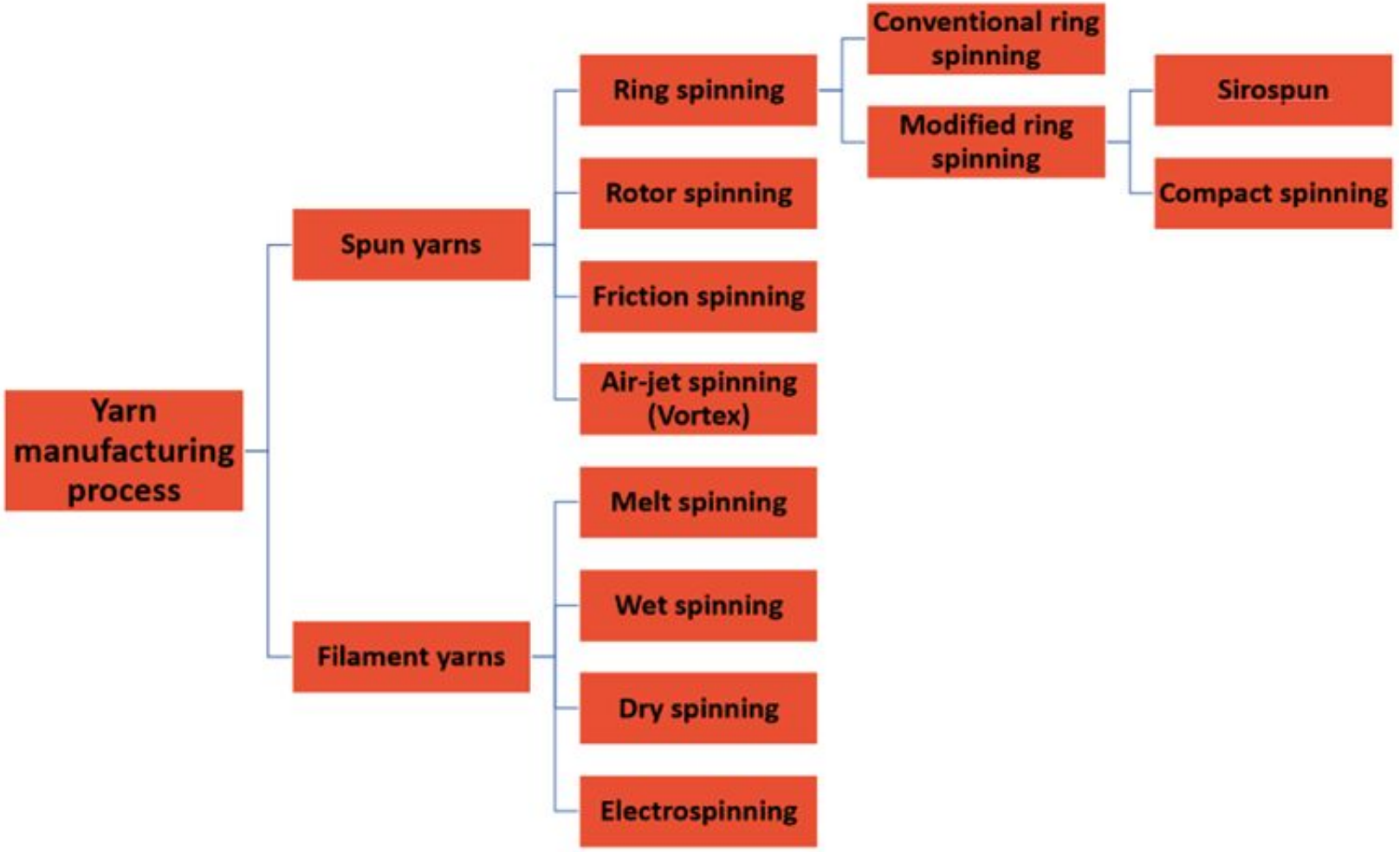
Spinning technologies



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3. TECHNOLOGIES FOR 2D AND 3D TEXTILE STRUCTURES

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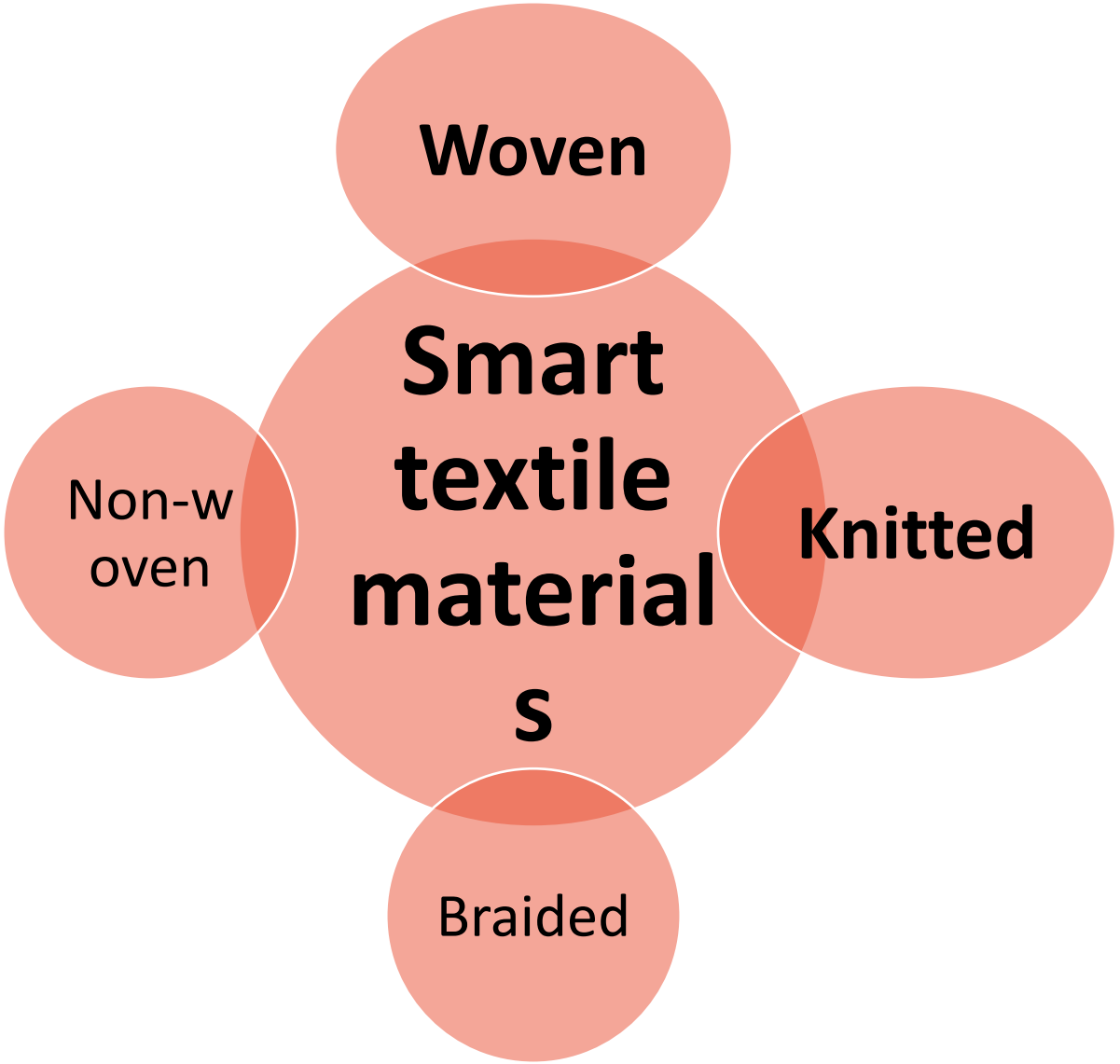

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3.1. 2D and 3D weaving

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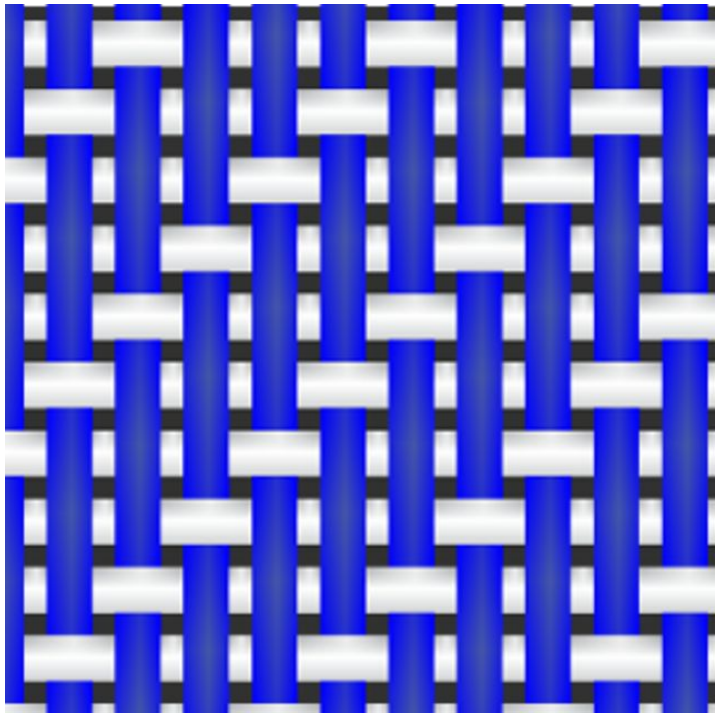
Weaving **is a textile process in which two perpendicular sets of yarns (warp and weft) are interlaced to form a fabric.**

- Large range of structures, with controlled properties
- Excellent dimensional stability, low deformability
- Good mechanical behaviour
- Large range of 3D shapes, with the possibility of extending the dimensions
- Possibility of using more yarn systems



Credit: David C Todd, source Wikimedia https://commons.wikimedia.org/wiki/File:Twill_weave.png

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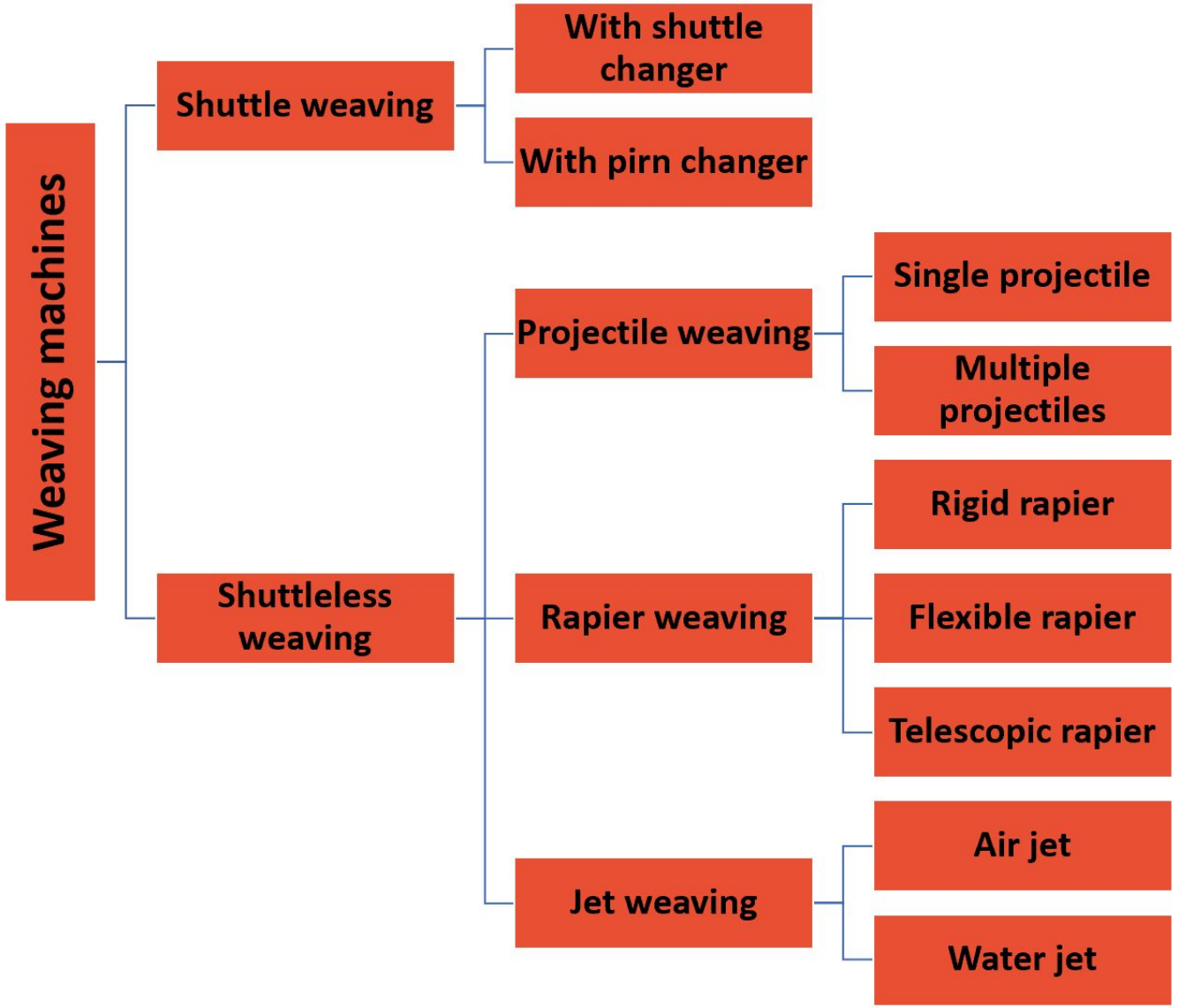
Classification of weaving machines based on the picking mechanism



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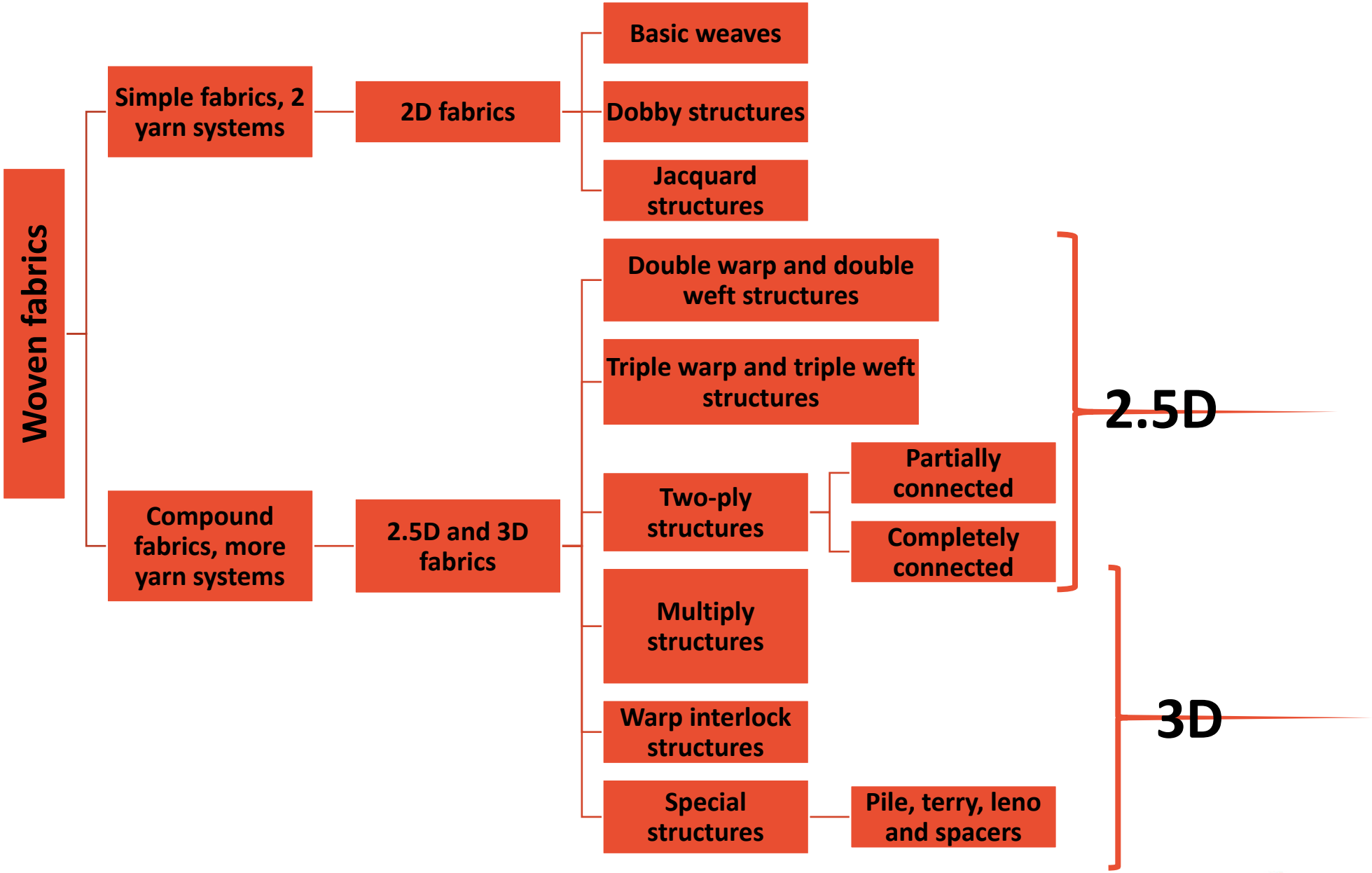

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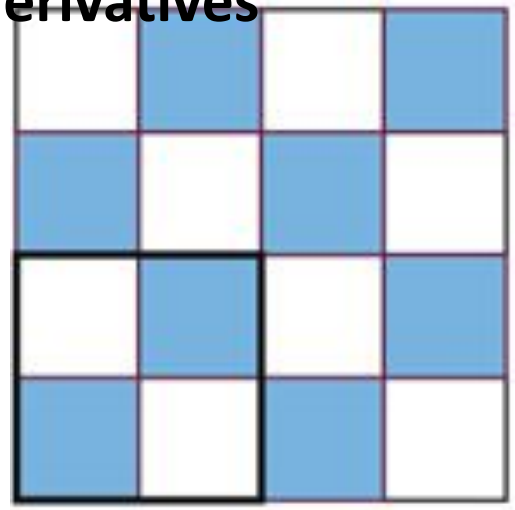
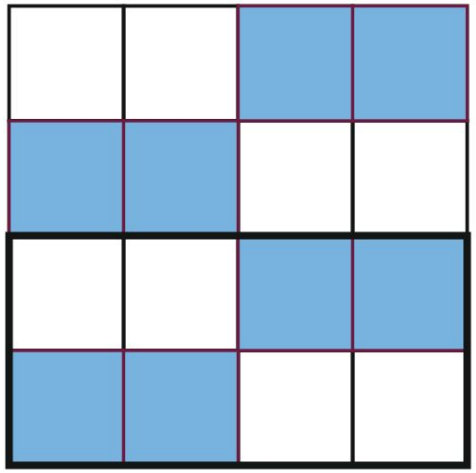
3.1.1. 2D woven structures – basic weaves

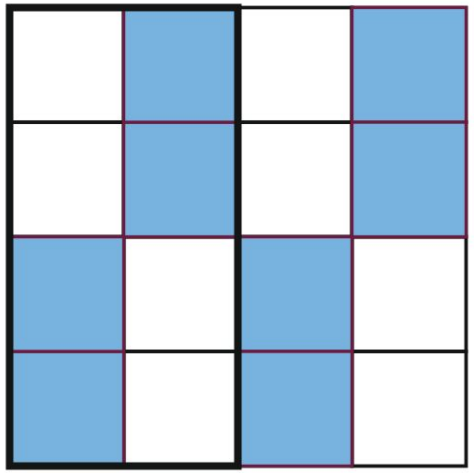
Plain weave and derivatives



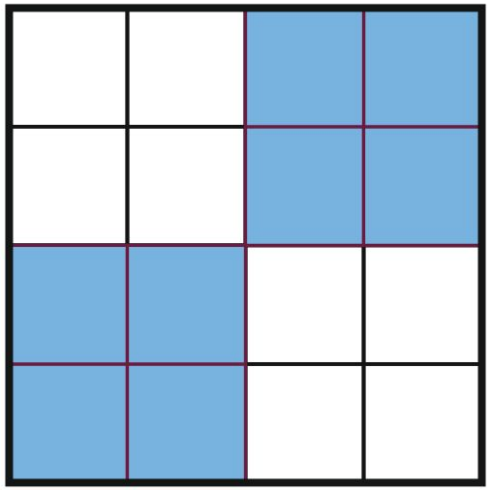
Plain weave



2/2 weft rib



2/2 warp rib



2/2 Basket weave

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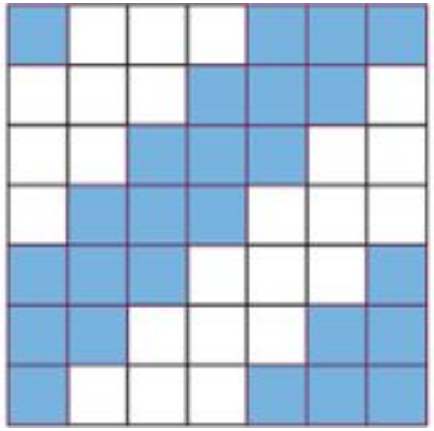
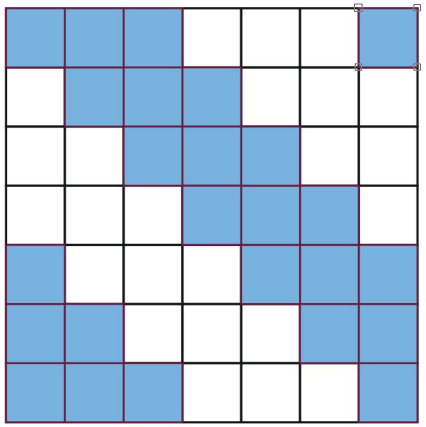
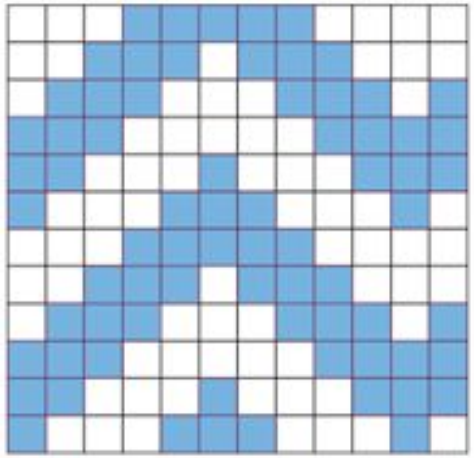
Twill weave and derivatives



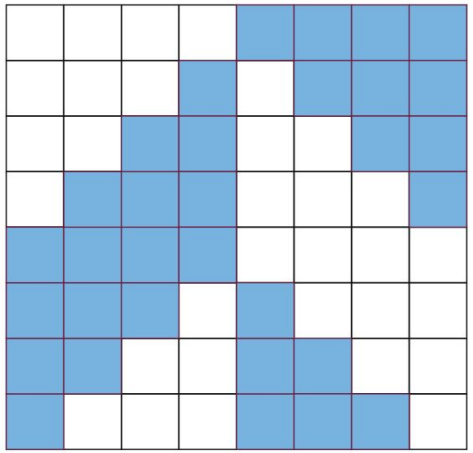
3/3 Z twill



3/3 S twill

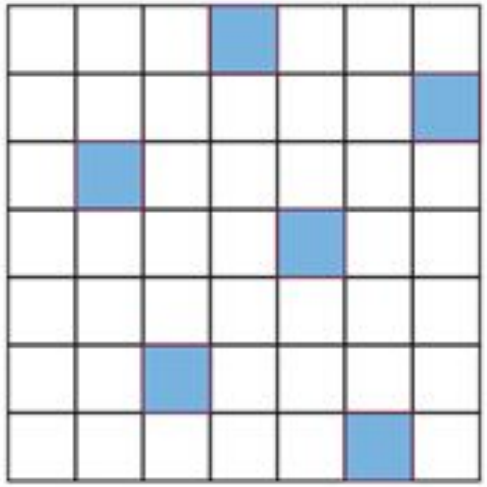


3/3 zigzag twill



4/4 broken twill

Satin weave and derivatives



8 harness weft satin

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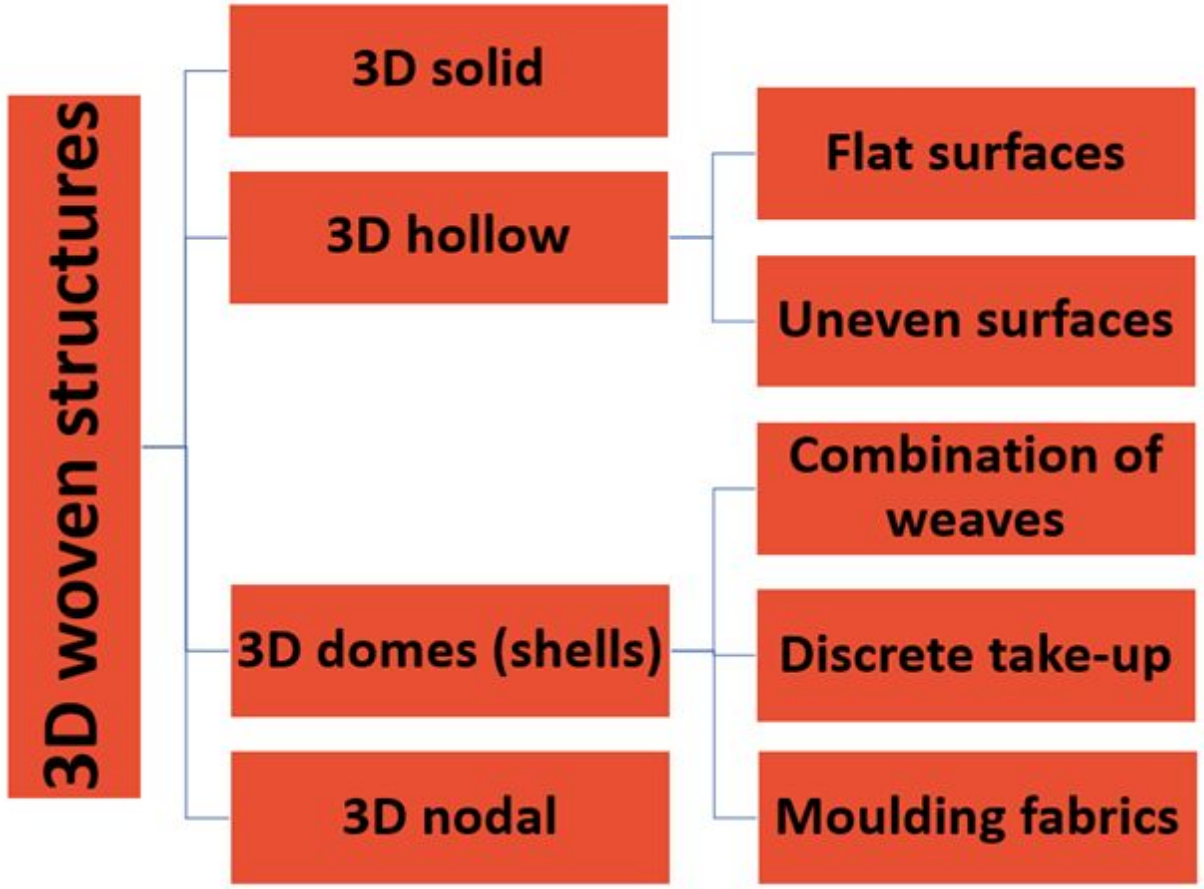
3.1.2. 3D woven fabrics



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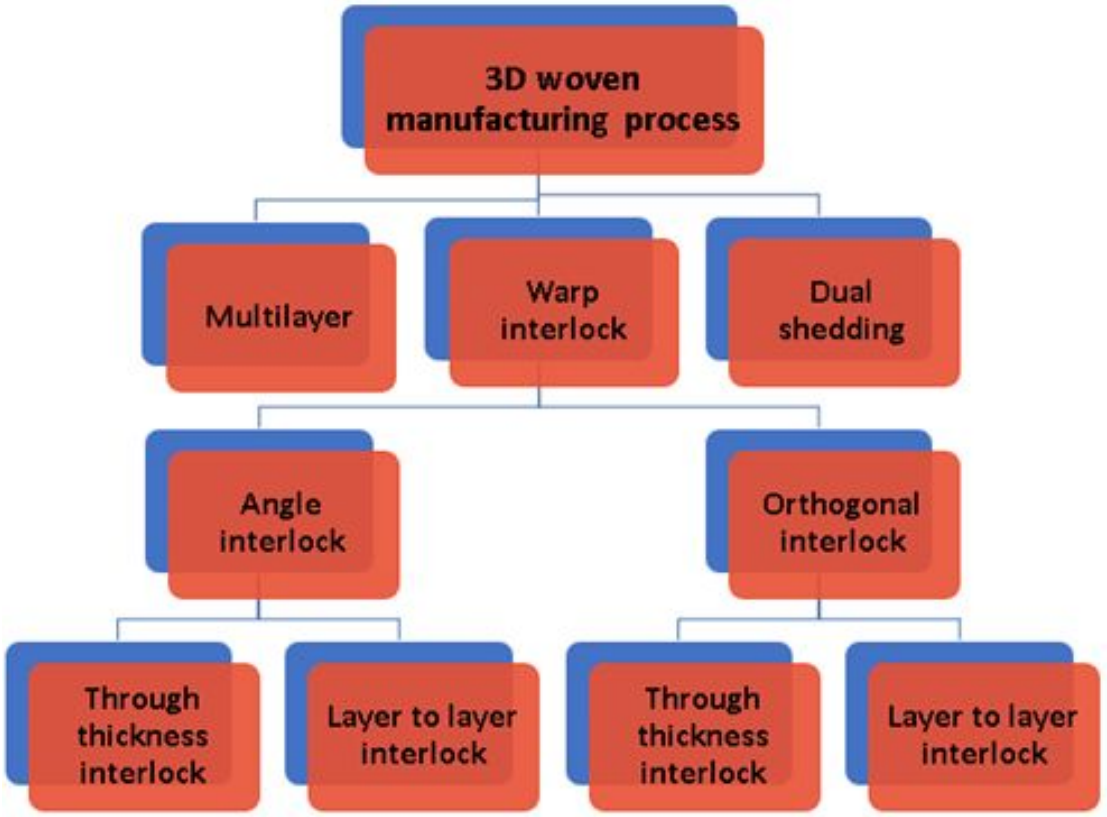

Multilayer (or multi-ply) structures

- ✔ several warp and weft yarn systems,
- ✔ the warp yarns acting as binders from place to place, connecting the fabric layer to layer,
- ✔ when completely connected will generate solid shapes (flat or profiled) and when partially connected, generating hollow fabrics.

Dual shedding

- ✔ Warp yarns shed not only vertically, but also horizontally,
- ✔ Interlacing of the warp interlock structures at layer level.

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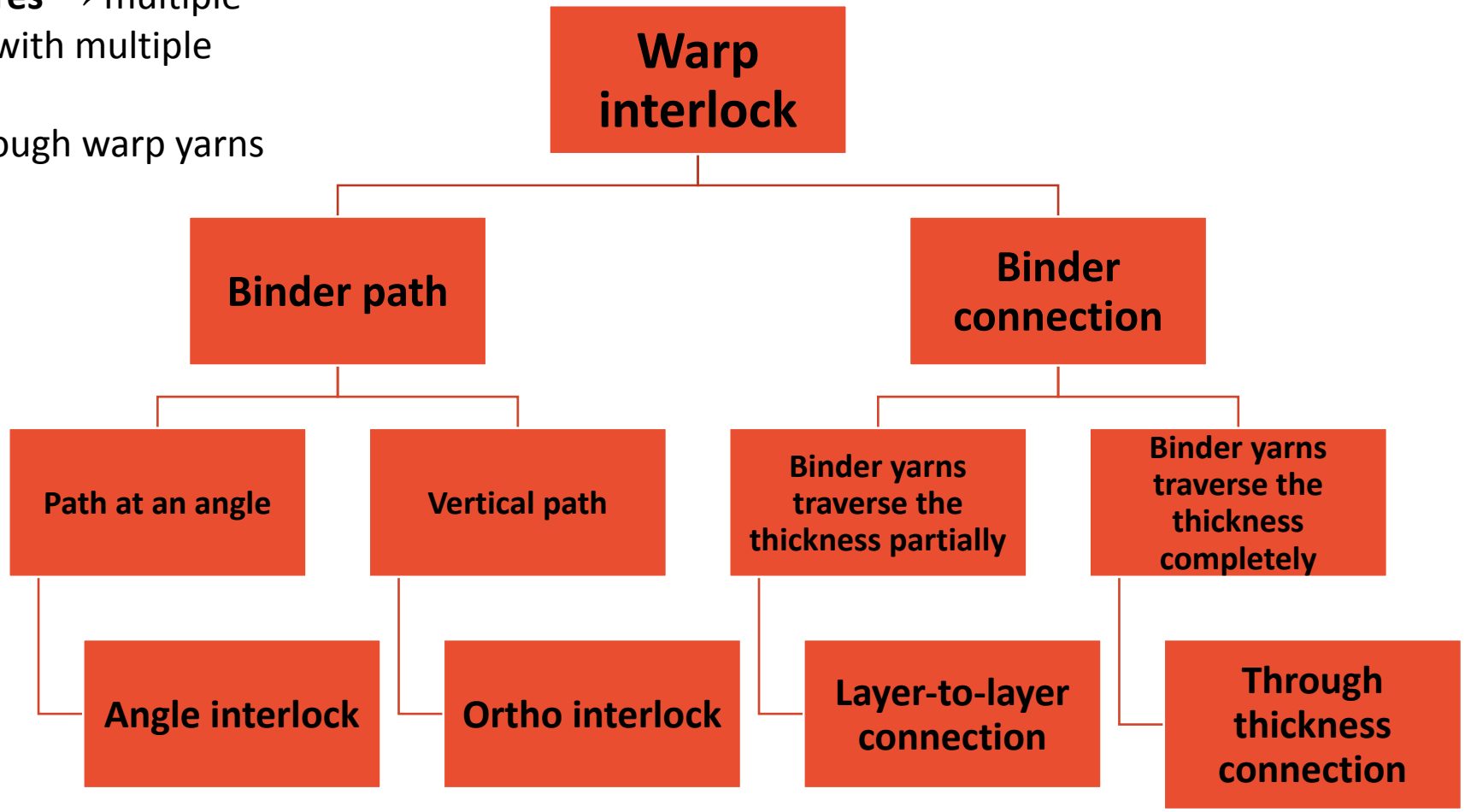
The **warp interlock structures** → multiple systems of weft interlaced with multiple systems of warp.
The fabric is connected through warp yarns called binder yarns.



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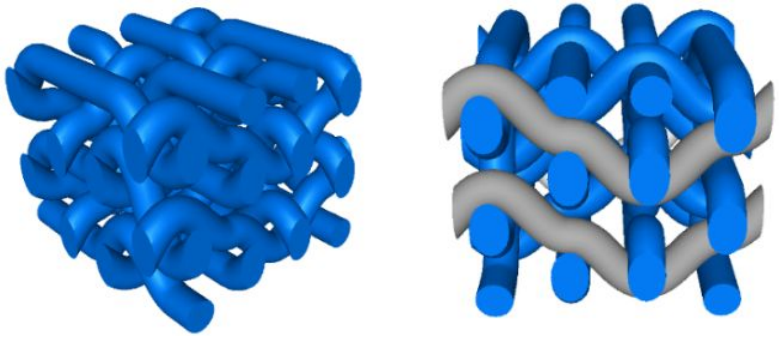
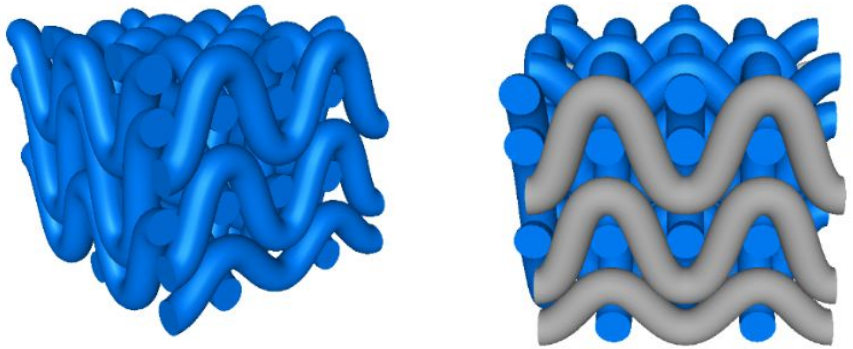
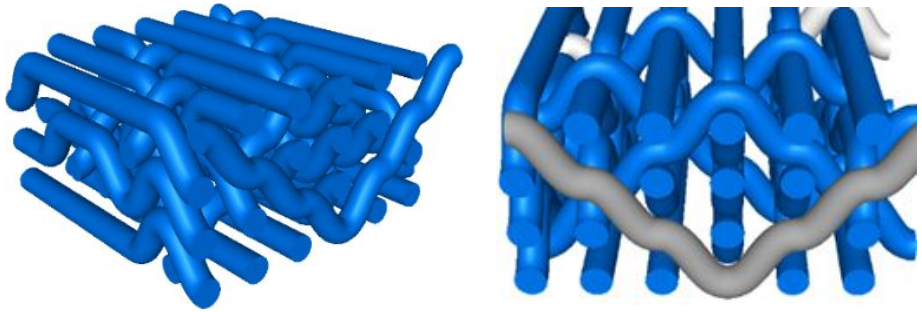


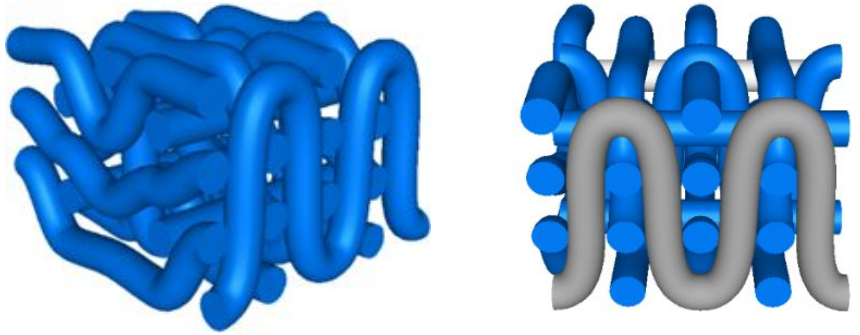
Angle interlock, layer-to-layer connection



Orthogonal interlock, layer-to-layer connection



Angle interlock, through thickness connection



Ortho interlock, through thickness connection

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3.2. 2D and 3D knitting

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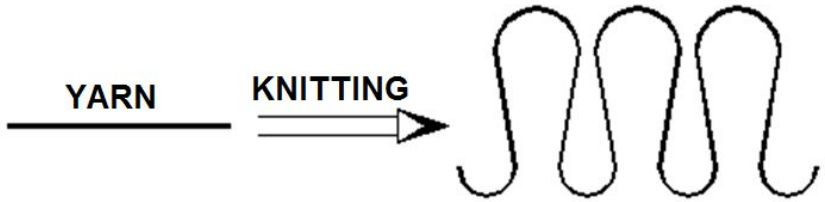
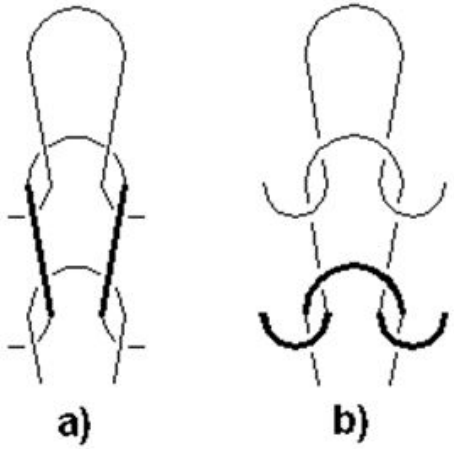
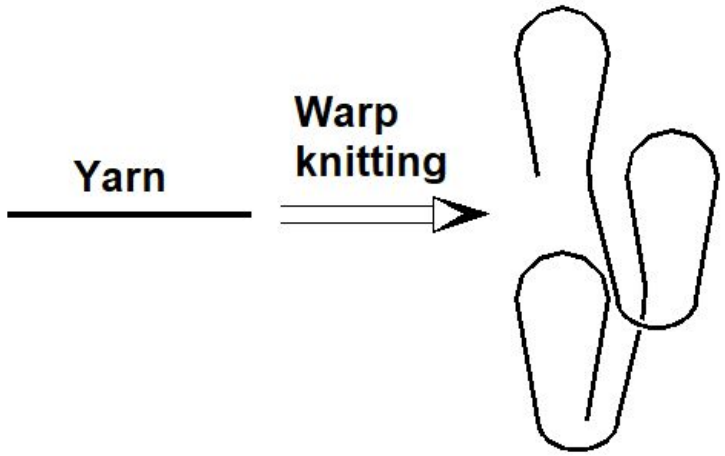
Knitting is the textile process where yarns are sequentially looped to form stitches



In weft knitting, the stitches are formed along the horizontal direction



Front (a) and back (b) stitches for weft knitted fabrics



In warp knitting, the stitches are formed along the vertical direction, only one stitch in each row.

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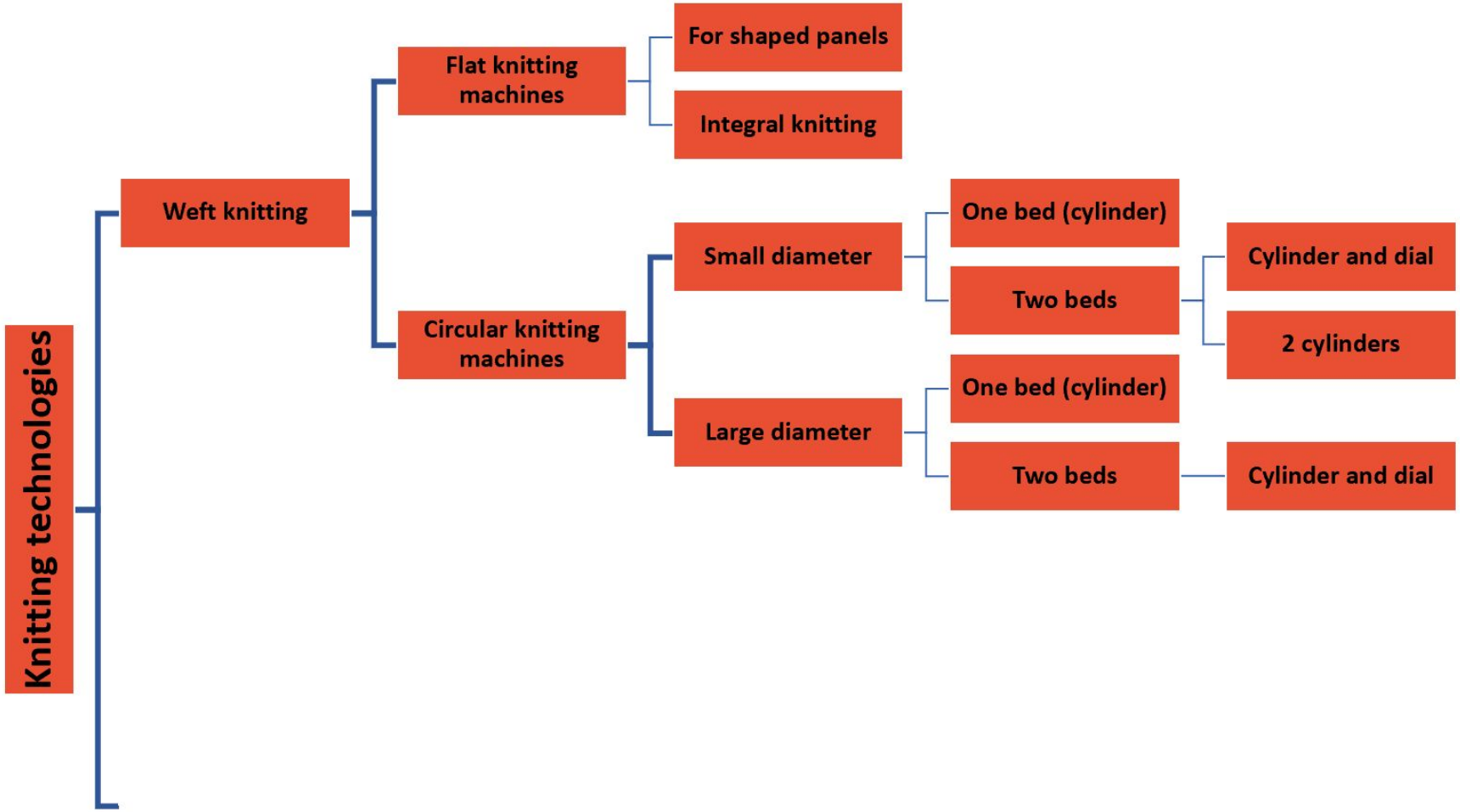

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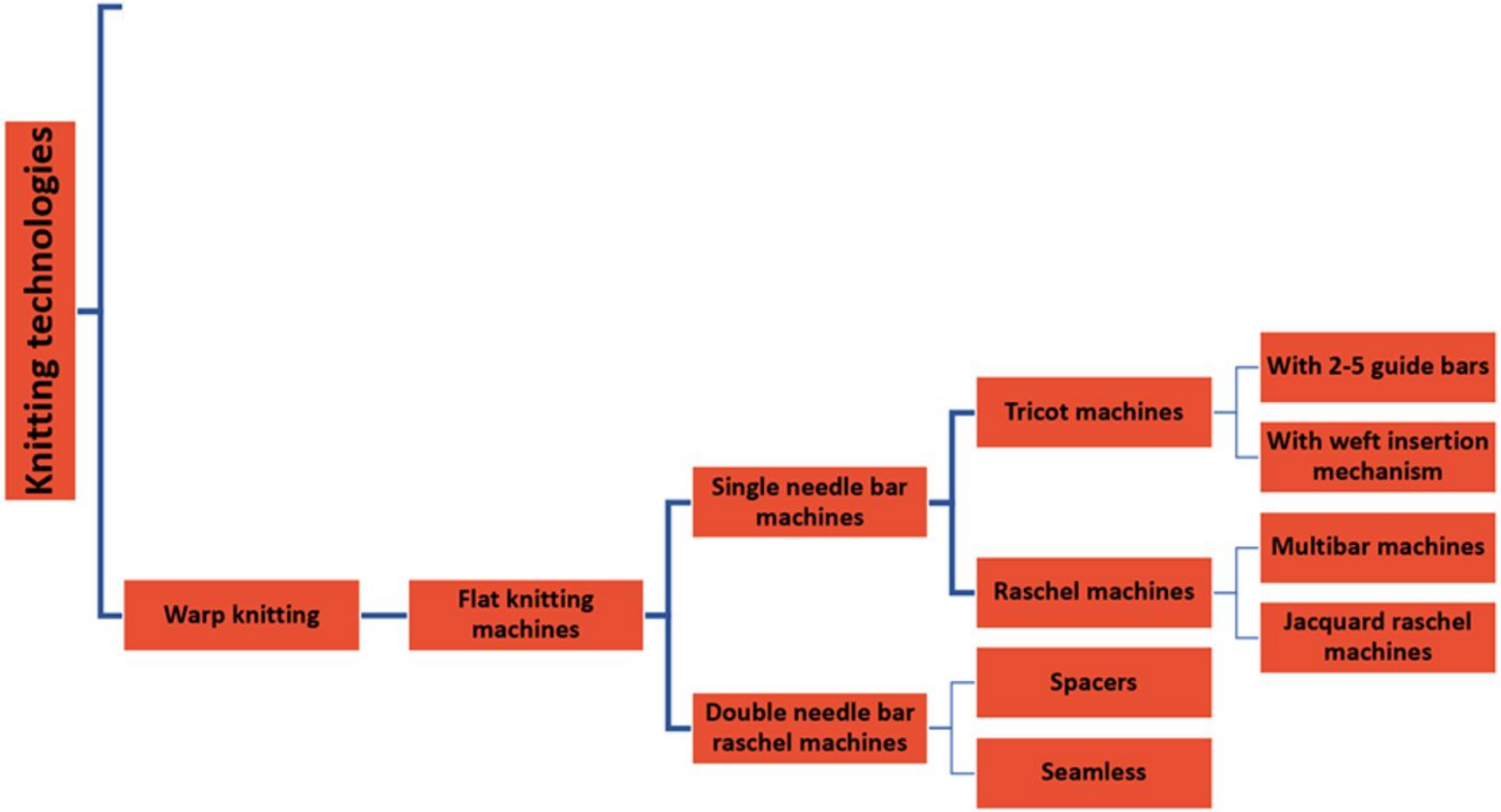

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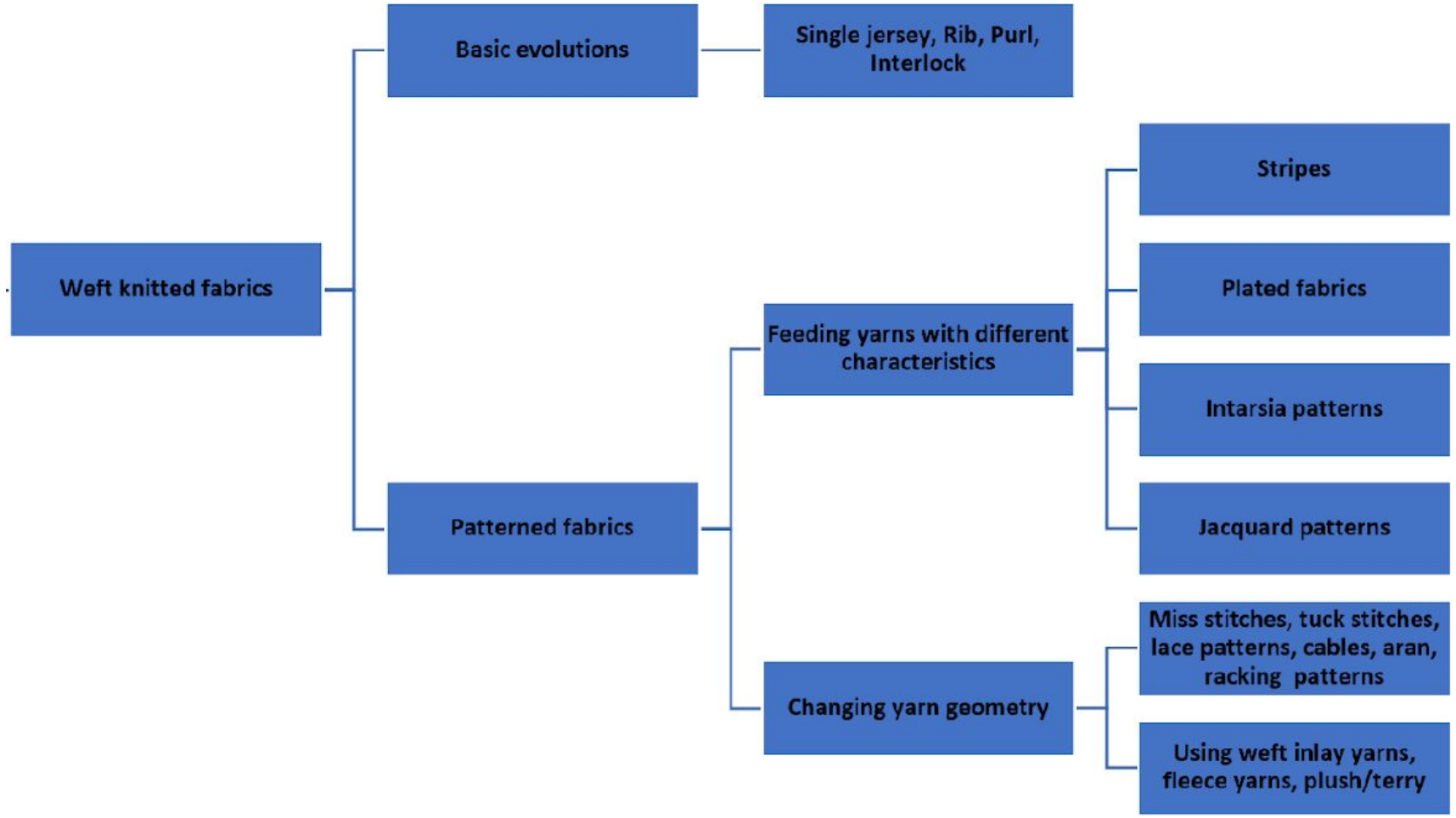
3.2.1. 2D knitted fabrics



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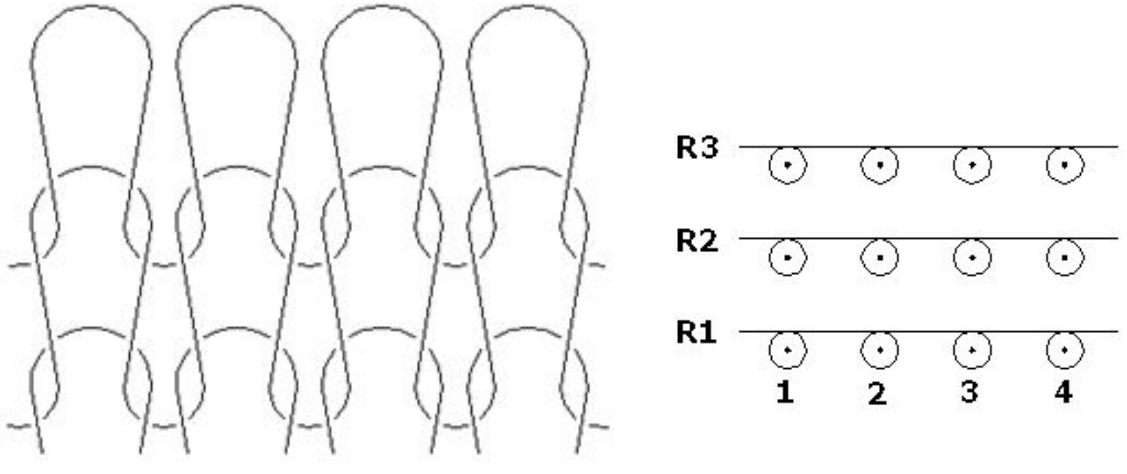
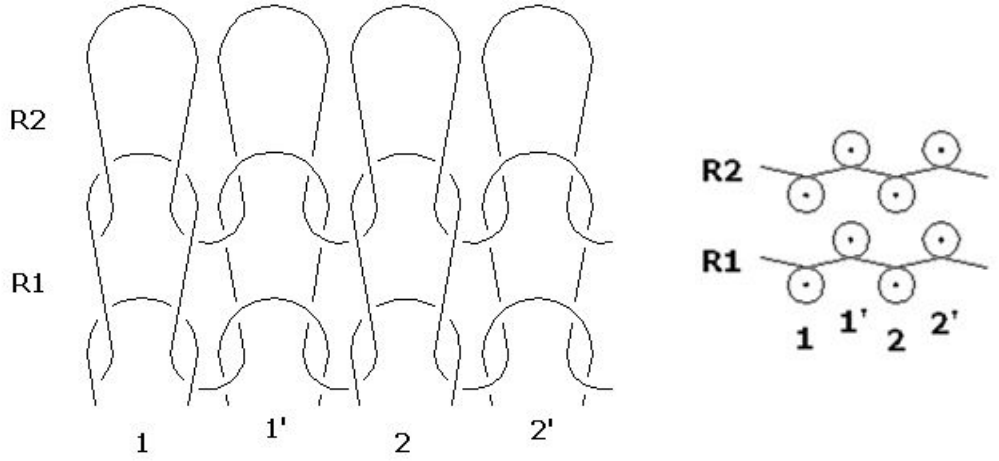
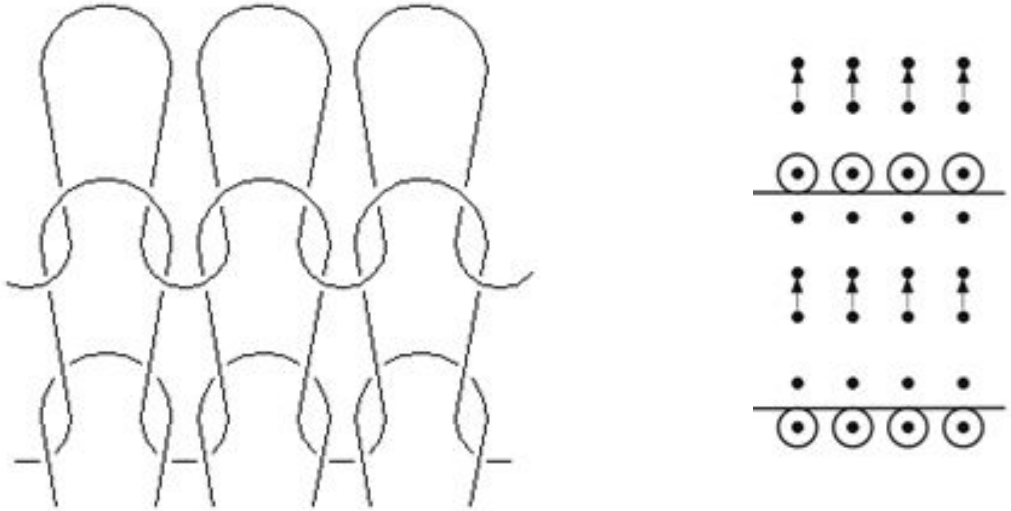


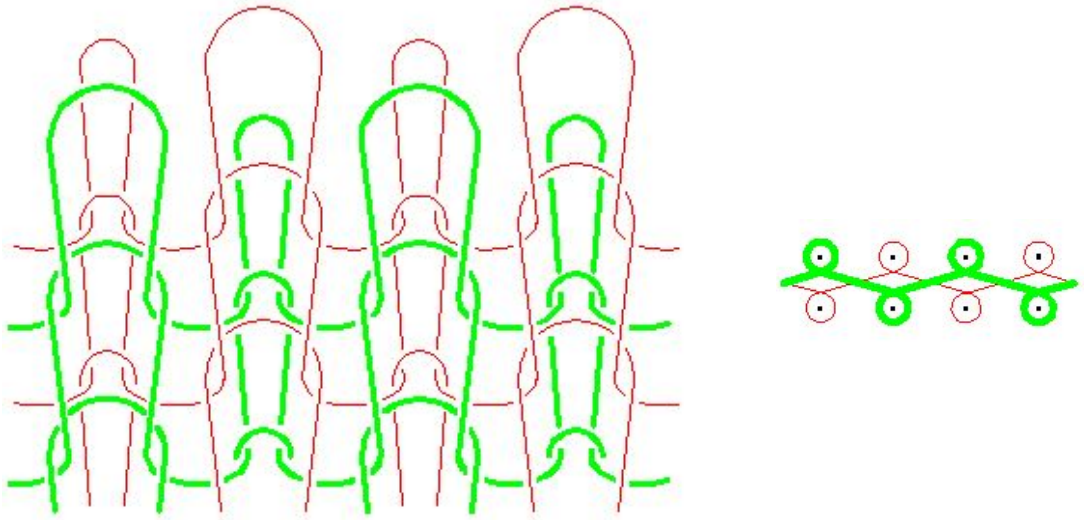
Single jersey



1x1 Rib (double jersey)



1x1 Purl



1x1 Interlock

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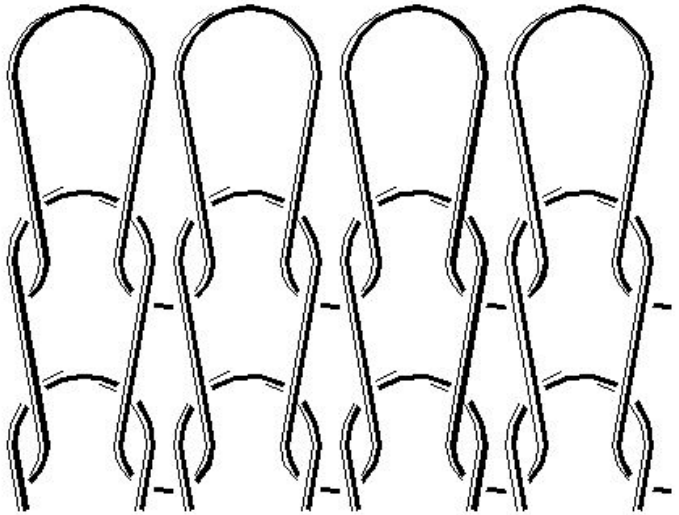
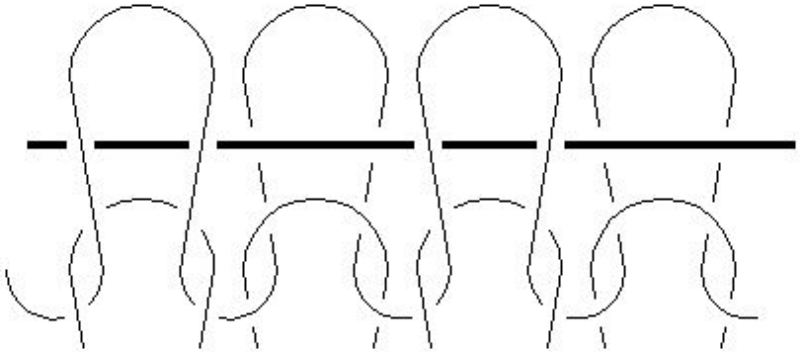
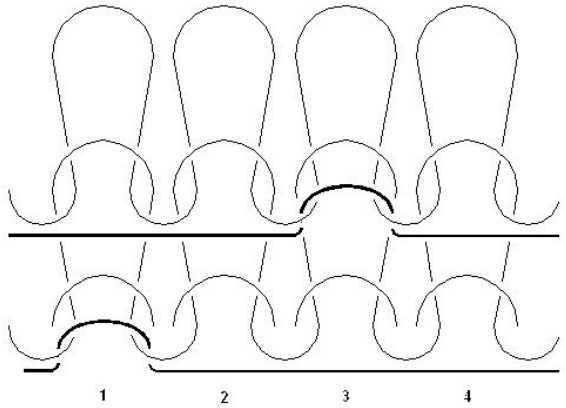
Patterning possibilities suited for smart functionalities



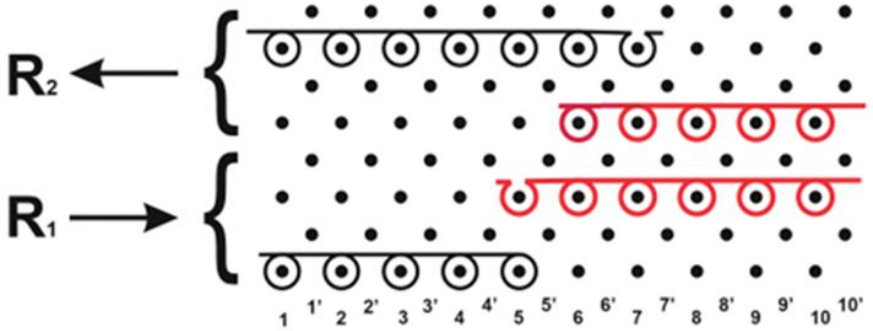
Single jersey plated



Weft inlay in 1x1 rib structure



Fleece pattern with 3x1 tucking repeat



Single jersey with intarsia pattern

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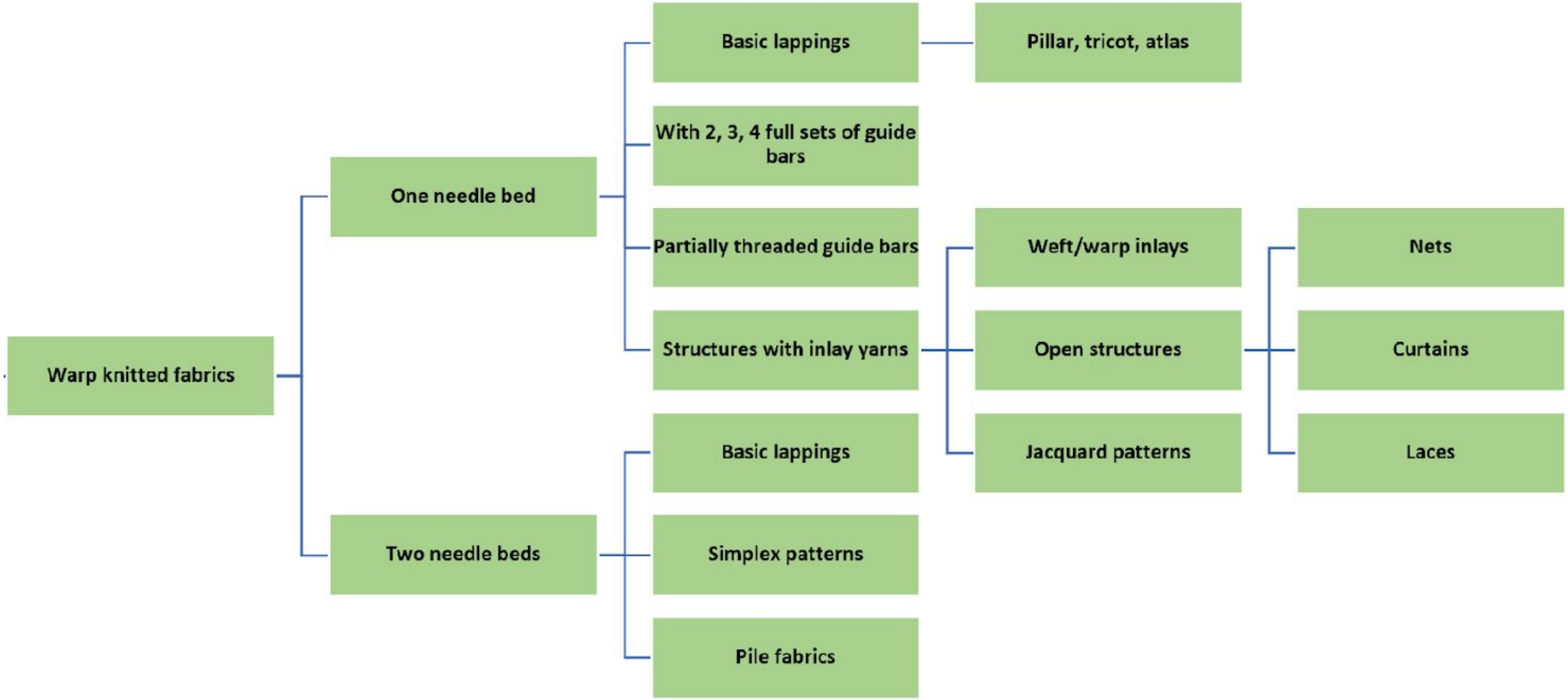

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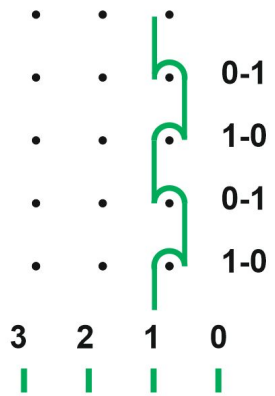
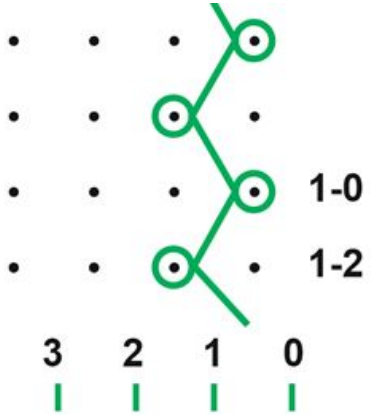
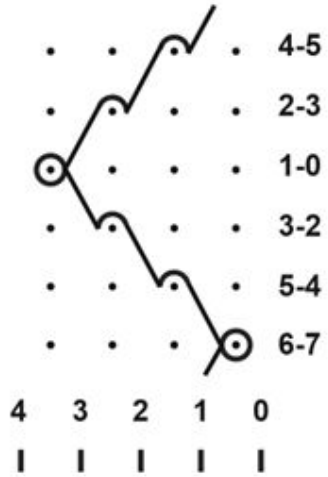
Warp knitted structures – basic lappings and derivatives



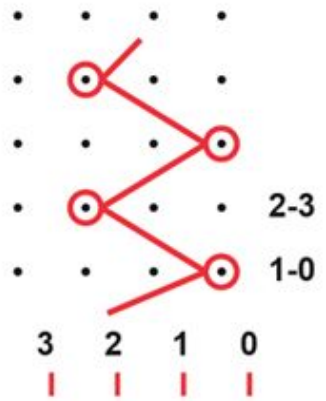
Pillar lapping



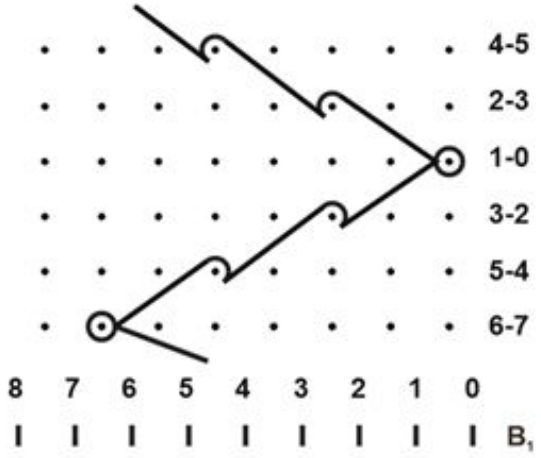
Tricot lapping



Atlas lapping



2x1 Tricot lapping



2x1 Atlas lapping

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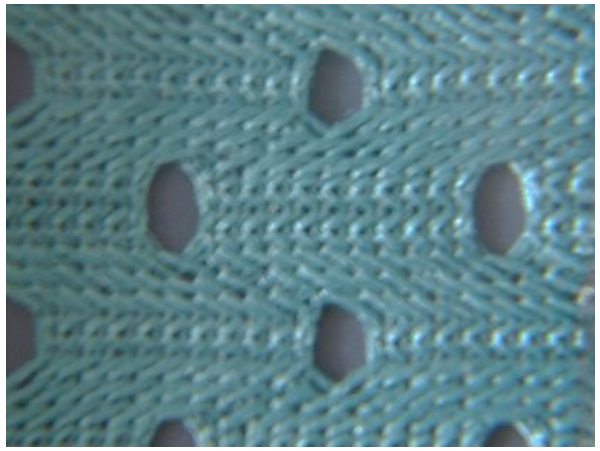
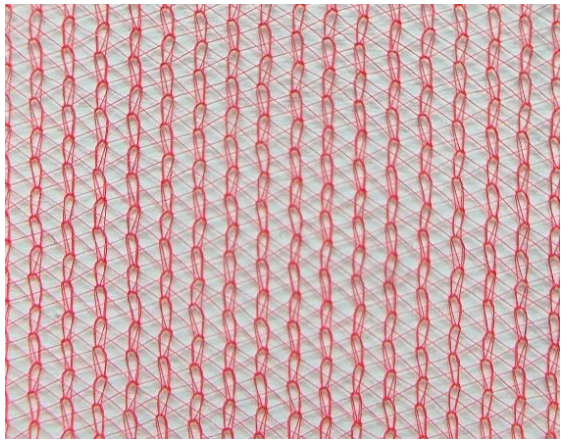
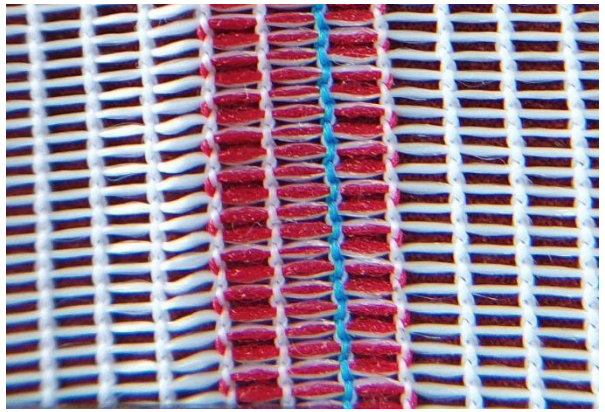
Patterning possibilities



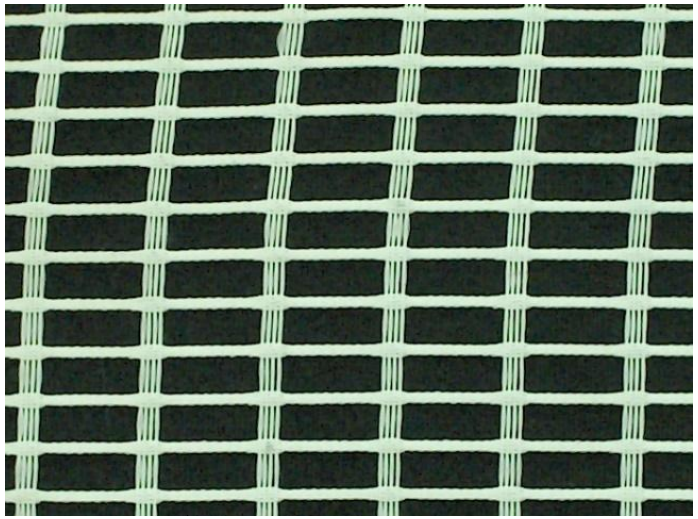
Partially threaded guide bars

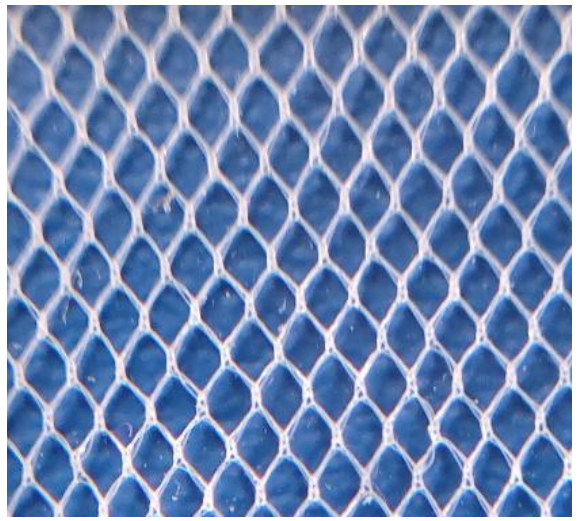


Two full guide bars – locknit, reverse locknit, satin



Yarn insertion - warp inlays (red) and weft inlays (blue)





Warp knitted meshes – rectangular, tulle

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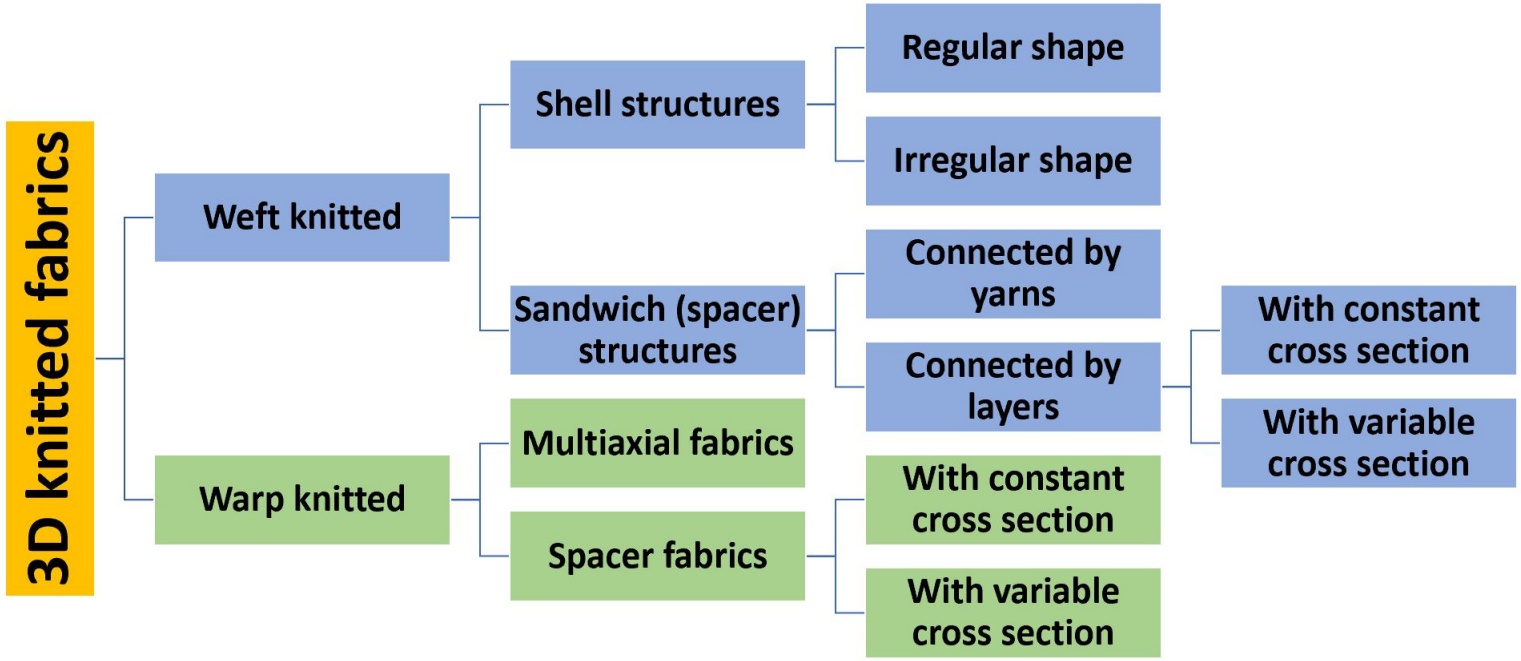
3.2.2. 3D knitted fabrics



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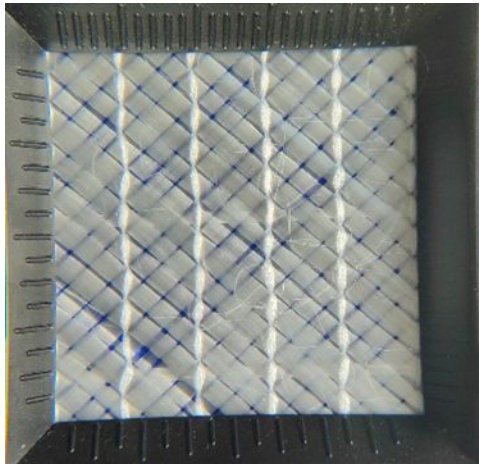
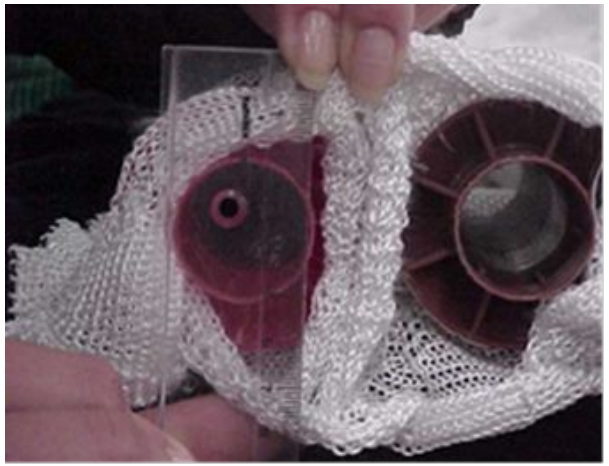


Multiaxial warp knitted fabrics

Weft knitted spacer fabric

Warp knitted spacer fabric



Weft spacer with connective double layers of constant length

Weft spacer with connective double layers of variable length

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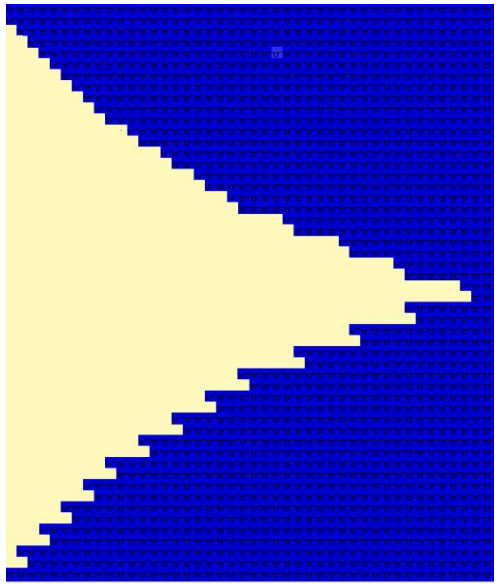
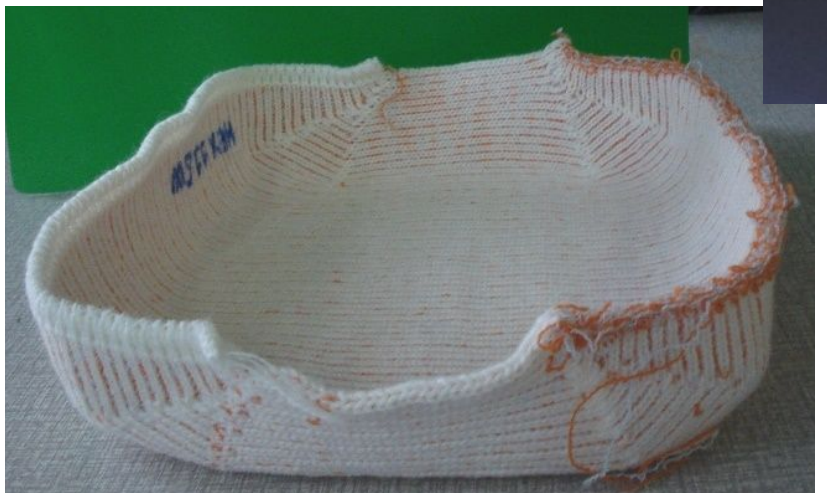


Principle of 3D fashioning line - flechage



Shell fabrics – box shaped, spherical

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Summary

- This lesson discusses the principles of textile processes used to manufacture yarns, woven fabrics and knitted fabrics.

- First chapter: concepts of functional and technological design of textiles, options a material/product designer must make and the criteria these options are based on; the textile value chain and its possibilities for smart functionalization.

- Second chapter: yarns, types and technologies used to produce spun yarns and filament yarns.

- Third chapter: structural specificities and technologies for the manufacturing of woven and knitted fabrics. For 2D fabrics, the basic weaves are presented and exemplified, while 3D woven fabrics are discussed according to two main criteria – shape and manufacturing method. For knitted fabrics, the basic evolutions for 2D fabrics are presented for weft knitting and warp knitting. Other types of patterns suitable for smart functionalization are also considered. The 3 main types of fabrics with 3D architecture are presented.

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Project:

Innovative smart textiles & entrepreneurship
2021-1-RO01-KA220-HED-000027527

Financial support:

Co-funded by
the European Union

Partners:

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Innovative smart textiles & entrepreneurship
Project 2021-1-RO01-KA220-HED-000027527

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