

The new generation of carpet weaving machines combines flexibility and productivity

Stefaan Demey

NV MICHEL VAN DE WIELE

M. Van de Wielestraat 7 - B-8510 MARKE

phone: +32 56 243 211 ▪ fax: +32 56 243 540 ▪ info@vandewiele.com

For a long time, high production and high speed were the most important factors in carpet weaving. Recently, a new aspect in the production has become important: flexibility. Carpet weavers want to weave different styles, qualities,... and change quickly. Flexibility is as (or even more) important as productivity.

The developments in raw materials contribute positively to this new trend. New dyeing techniques, chemical compounds, treatments,... improve the quality and increase the choice of raw material.

Another definite contributor are the new developments and technical improvements of the weaving machines. The use of electronics, microprocessors, networking,... help fulfilling the increasing demand for more colours and flexibility in style. The carpet designers can now use their full creativity.

The aim of Van de Wiele is to keep fulfilling, as much as possible, the demands of the carpet industry. The Van de Wiele machinery covers a broad range of applications and carpet styles (see table 1 & 2). This article will handle more in detail the different carpet weaving techniques and machines.

1. FACE-TO-FACE CARPET WEAVING

With the face-to-face technique, carpets with cut pile are woven. Carpets with cut pile are the most

known kind of carpets. They are especially characterised by the design and the number of colours. Ancient style as well as modern style carpets and rugs are woven with this weaving technique.

nique, two identical carpets are woven at the same time: a bottom and a top carpet. To obtain this, two superimposed ground fabrics are woven, interlaced by the pile warp ends. The so produced fabric is cut in the middle on the weaving machine by a cutting motion into top and bottom carpet. So a three dimensional fabric is obtained: a ground fabric with pile tufts standing straight on that ground fabric (see figure 1).

To bring in the fillings a shed is formed. For weaving rugs the shedding for the ground yarns is done by a cam disc machine while the shedding for the pile ends is done by a Jacquard machine (depending on the design). The use of a cam disc

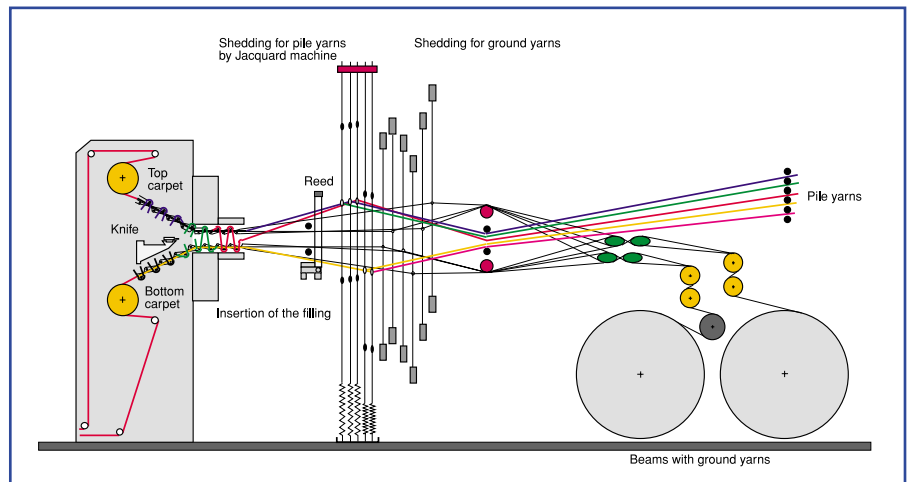


Figure 1: Principle of the face-to-face carpet weaving technique (with two rapiers)

1.1 The face-to-face carpet weaving technique

According to the face-to-face tech-

machine allows to regulate the timing of the crossing of the heddle frames independently. This is neces-

Area rugs	cut pile	economical quality medium quality high quality	CRT82 CRT82, CRT83 CRT82, CRT83 CLP81 SLC83, CLP81
	loop pile sisal look		
Wall-to-wall carpet	cut pile only	economical quality medium quality high quality	CRT82, CRT83 AWM51, Axminster AWM51, Axminster AWM51, CLP81 AWM51 SLC83, CLP81
	loop pile only		
	cut & loop pile		
	sisal look		

Table 1: overview of the carpet applications and accompanying weaving machinery

sary to weave carpet qualities with thick pile yarns, even in reed 500 with 6 or 8 frames. After a filling is brought in, it is beaten-up by the reed motion. The ground yarns driven by the same heddle frame have all the same consumption and are thus coming from beams. The consumption of pile yarns depends on the design. That's way the pile yarns run from bobbins in a creel.

The reed is divided into reed dents. Per reed dent only one pile yarn is working (making the pile tufts between top and bottom piece), namely the pile yarn with the colour one likes to see on this particular position on the carpet. The remain-

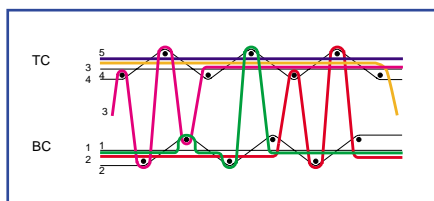


Figure 2a: 1/1 V weave structure with incorporated dead pile (ground structure $4x(1/1)$)

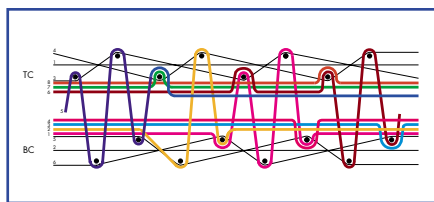


Figure 2b: 1/1 V weave structure with incorporated pile floatings (ground structure $4x(2/2) + 2x(1/1)$)

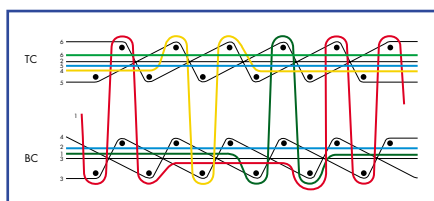


Figure 3a: 1/2 V weave structure with incorporated dead pile woven through to the back

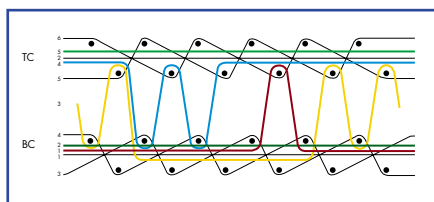


Figure 3b: 1/2 V weave structure with incorporated dead pile not woven through to the back

ing colours are woven in the two ground fabrics, we call this technique 'incorporated dead pile'. In old techniques, the remaining pile yarns floated on the back of the bottom carpet and were then removed on another machine. The new technique of incorporated dead pile has numerous advantages:

- Top and bottom carpet are completely similar. In case of floating dead pile, on a colour change one pile tuft was lost resulting in a different top and bottom carpet.
- No supplementary operation is required to remove the floating pile yarns.
- There is no loss of yarn: all non-working pile yarns are woven in the back of the carpets
- The extra weight of the incorporated pile results in a heavier carpet. It enables to decrease the pick density (and so increase production accordingly) to compensate the extra weight of the incorporated pile yarns.

1.2 Weave structures

Depending on the number of fillings which are each time inserted in the sheds, the motion of the pile yarns (programmed by the Jacquard machine) and the motion of the ground yarns (determined by the cams of the cam disc machine), different weave structures can be obtained. The most important weave structures are summarised here after.

1.2.1 Single rapier weave structures (single shot)

For single rapier weave structures, one filling is brought in every cycle. The fillings are inserted alternatingly in the top and bottom carpet. This way, a pile tuft is formed on every filling. This weaving technique is well adapted to weave very dense carpets (from 200.000 to 1.000.000 pile tufts/m²). On the latest model of the CRT82 it is even possible to weave carpets with 2.500.000 points.

As we have one pile row per filling, single rapier weave structures are called 1/1 V. The most used weave structures are the 1/1 V with incorporated dead pile (see figure 2a) and the 1/1 V with dead pile floatings (see figure 2b). Both weave structures are also woven according to the 'incorporated dead pile technique' as the dead pile yarns remain in the carpet and no back scraping is necessary.

For each of these weave structures, the ground structure can be $4x(1/1)$ or $4x(2/2) + 2x(1/1)$. The last one is used for higher pick densities as the fillings can slide slightly above each other.

1.2.2 Double rapier weave structures (double shot)

In the double rapier weaving technique, two rapiers insert two fillings at the same time in two sheds, one shed for the top carpet and one shed for the bottom carpet. This way, a pile tuft is formed every two fillings and the weave structure is called 1/2 V. As two separate sheds are formed, crossing between the ground warp ends of the top and bottom carpet are avoided. On a double rapier weaving machine gauges can be used to have an excellent pile height control. These gauges are put in each reed dent according to the desired pile height.

In 1/2 V, two main weave structures can be distinguished: the 1/2 V woven through to the back (see figure 3a) and the 1/2 V not woven through to the back (see figure 3b). Both are again possible with the ground structure $4x(1/1)$ or $4x(2/2) + 2x(1/1)$.

Most carpets have the weave structure 1/2 V woven through to the back. With this structure, the design is visible at the back of the carpet, a good pile fixation is possible and a wide range of qualities can be woven (from 80.000 to 500.000 pile tufts/m²).

The 1+1/2 V is a new weave structure that is a combination of 1/1 V

(single shot) and 1/2 V (double shot). Figure 4 is showing this weave structure. The incorporated dead pile lies completely at the inside of the carpet and this ensures a very good pile fixation and a nice backside of the carpet. With the ground weave structure $4x(4/4) + 2x(3/1)$ it is possible to weave high pile row densities. The same ground weave structure can also be used for 1/2 V.

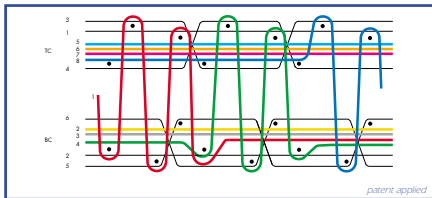


Figure 4: 1 + 1/2 V weave structure with incorporated dead pile in separate layer (ground structure: $4x(4/4) + 2x(3/1)$)

1.2.3 Three rapier weave structures (three shot)

Three rapier weave structures are woven on a weaving machine with three rapiers. Per cycle, up to three fillings can be inserted. As two carpets are woven at the same time, two sheds are formed: one for the top

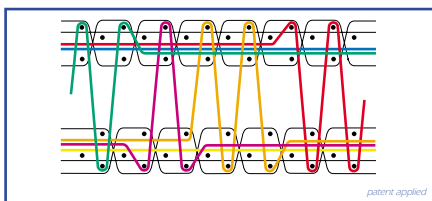


Figure 5a: 2/3 V weave structure with incorporated dead pile

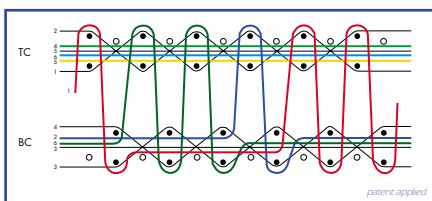


Figure 5b: 2/2 V weave structure with incorporated dead pile

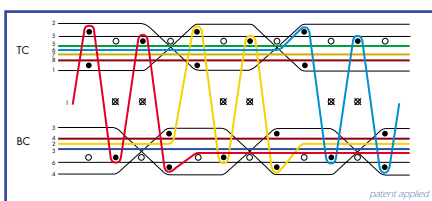


Figure 5c: 1+2/3 V weave structure with incorporated dead pile

and one for the bottom carpet. The most used three rapier weave structures are:

- 2/3 V

Every cycle three fillings are inserted. During the first cycle two fillings are inserted in the top shed and one in the bottom shed, the next cycle one in the top and two in the bottom shed. This way a pile tuft is formed around 2 fillings (see figure 5a). Sometimes a thinner filling is used for the middle rapier to obtain a better pile surface and pile fixation.

This weave structure has 50 % more production than the old three shot weave structure woven with two rapiers: two machine revolutions are now needed for one pile tuft where before three machine revolutions were necessary.

- 2/2 V

Every cycle two fillings are inserted: one cycle two fillings are inserted in the top shed and the other cycle two in the bottom shed. For this, the exterior rapiers are alternatingly not inserted. This way a pile tuft is formed around 2 fillings (see figure 5b).

- 1+2/3 V

The 1+2/3 V is a new weave structure where a pile tuft is formed once around two fillings and once around one filling (see figure 5c). The incorporated pile yarns lay in a separate layer above the tight warp and each pile tuft comes to the back of the carpet so they can be fixed very well and the back of the carpet is very clear. The 1+2/3 V is especially suited for higher pile densities (to 1.000.000 pile points/m²).

1.2.4 Special weave structures

A special kind of carpets are carpets with a combination of cut pile and ground effects (visible pile floating effects). This carpet (see figure 6) contains areas with cut pile and areas without cut pile but where the

design is made by pile yarns which float over the ground structure.

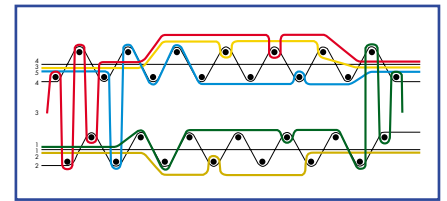


Figure 6: 1/1 V with visible pile floating effects

The weave structure with the pile yarns working in counterphase (see figure 7) is industrially less useful as it increases the price of the carpet per m². A carpet woven in this weave structure contains the double of incorporated yarns. It is more favourable to weave this carpets in 1/2 V with less pile rows per square metre.

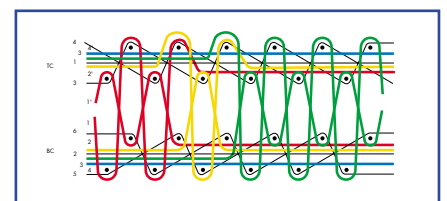


Figure 7: 1/2 V in counterphase with pile on every pick but with double number of incorporated dead pile

1.3 Face-to-face carpet weaving machines

The Carpet & Rug Tronic (CRT) is the newest generation of weaving machines to weave face-to-face carpets with cut pile. The machines are controlled by a powerful microprocessor and Jacquard controller. This makes the machines very versatile. Extended stop motions of the filling, ground and pile yarns make the machine stop from the moment a yarn is broken. This way no mistakes are woven. The Carpet & Rug Tronic exists in two versions: the CRT82 which is a double rapier carpet weaving machine and the CRT83, a three rapier carpet weaving machine. Both machines can handle all kind of pile yarns (wool, polypropylene, acrylic,...).

1.3.1 Double rapier face-to-face carpet weaving machine

The CRT82 (see figure 8 and table 2) is controlled by a microprocessor with menu driven display allowing a detailed production follow-up and permits to adjust the speed of the machine, the pick density, the machine settings, etc.



Figure 8: The Carpet & Rug Tronic CRT82, a double rapier face-to-face carpet weaving machine equipped with Piletronic, an electronic Jacquard machine

The filling (mostly jute) is inserted by two sets of rigid rapiers. The filling is brought in the shed by the insert rapier to the middle and then transferred to the receiving rapier which takes it to the other side (Dewas principle). The filling yarns come from bobbins on an inclined bobbinstand, programmable pneumatic brakes on the weft optimise the take-over and reduce the waste

ends to a minimum.

To cope with the increasing weft dust resulting from the higher speed, the weft accumulators and weft tensioners are installed in boxes to be connected to a central dust cleaning system. The knife motion is driven by a 3-dimensional cam drive, designed for optimal cutting across the full width at high speed.

A powerful parallelogram reed beat-up produces at high speed a clean back and a nice pile aspect. The ergonomics of the machine have also been taken into account: pile height adjustment, positioning of the warp stop motions and exchanging the beams are easy.

The pile yarns are controlled by an electronic Jacquard machine: the Piletronic PTX. A reliable and simple selection mechanism without springs, pivots and pistons allows to obtain, with only one solenoid per harness band, the three positions that are needed for double rapier face-to-face carpet weaving (under, between and above the rapiers). The full width of the machine can be



Figure 9: a weave schedule that can be woven with a Piletronic without machine stop during transition

divided in several paths weaving side by side and one after another different designs without machine stop during transition (see figure 9). The Piletronic PTX Jacquard controller has a capacity of 9 Gb and designs can be loaded with common ZIP floppies or in network. The controller checks automatically the Piletronic with autodiagnostic facilities. The PTX exists in capacities of 4480, 5520, 6720 and 8400 solenoids. The big Jacquard capacities allow to weave carpets with up to 12 colours on a width of 4m20 (reed 320 dents/m) or 8 colours in reed 500. For weaving double rapier weave structures, both rapiers are inserted each cycle. The CRT82 can also weave single rapier weave structure

	CRT82	CRT83	SLC83	AWM51	CLP81	AXMINSTER
name	Carpet & Rug Tronic	Carpet & Rug Tronic	Sisal Look Carpet	Advanced Wire Master	Carpet Loop Pile weaving machine	Axminster
weave structure	cut pile (single or double rapier weave structure)	cut pile (single, double or three rapier weave structure)	sisal look	loop and/or cut pile	loop pile (or sisal look)	cut pile
woven pieces	2	2	2	1	1	1
control of the pile	Piletronic PTX (3 positions)	Piletronic PTX (4 positions)	Piletronic PTX (2x3 positions)	Piletronic PTX (3 positions) or dobby machine	Piletronic PTX (3 positions)	Jacquard
filling insertion	2 rigid rapiers	3 rigid rapiers	3 rigid rapiers	1 flexible rapier	2 rigid rapiers	1 flexible rapier
max. weaving width	4.2 m	4.2 m	4.2 m	4.1 m	4.2 m	4.2m
max. industrial speed	2 x 160 rpm (on 4.2 m for PP carpets)	3 x 140 rpm (on 4.2 m for PP carpets)	3 x 140 rpm (on 4.2 m for PP carpets)	75 rpm (on 4.1 m depending on quality of the yarns)	140 rpm (on 4.2 m for PP carpets)	150 rpm (on 4.2 m)

Table 2: technical characteristics of the Van de Wiele carpet weaving machines

res. In this case, a rapier switch-off system is installed. With this system only one rapier is inserted per cycle (alternatingly the top and bottom rapier) and one rapier is 'switched off'. This system uses a minimum of moving parts and as no rapier without filling is going into the shed it is very reliable and it ensures high weaving efficiencies.

1.3.2 Three rapier face-to-face carpet weaving machine

The Carpet & Rug Tronic CRT83 (see table 2) is the three rapier version of the Carpet & Rug Tronic. The CRT83 is technically similar to the CRT82, but with the CRT83 three rapiers (see figure 10) are used. The Piletronic Jacquard machine is equipped to obtain four positions.



Figure 10: The Carpet & Rug Tronic CRT83 is equipped with three rapiers

The CRT83 can weave single, double as well as three rapier weave structures and is thus the most versatile (1/1 V, 1/2 V, 1+1/2V, 2/2 V, 2/3 V, 1+2/3 V, ...) During weaving the incorporated pile yarns are stationary, only the pile yarns that make pile move. This means a more clean back, less use of incorporated pile yarns, less breakage of pile yarns and a higher weavers efficiency.

2. SISAL LOOK CARPET WEAVING

Sisal look carpets are a new kind of carpets that follow the increasing tendency towards the nature: carpets with a natural look and natural colours like beige, brown, black, white,... Sisal look carpets have mostly a pile surface in polypropylene or wool, but it looks like natural sisal. Sisal-look carpets are well suited for area rugs as well as wall-to-wall carpet.

2.1 The sisal look carpet weaving technique

Sisal-look carpets have a structured pile surface and contain usually a small number of colours. The structured surface is formed by pile yarns which form loops over one or more thick fillings (see figure 11). These thick fillings give a relief to the carpet.

The carpet can have an additional colour and special effect by using a coloured filling. The pile yarns can be polypropylene, acrylic, wool,...

The sisal look carpets are woven on a three rapier weaving machine according to a technique similar to the face-to-face technique (see figure 12). Top

and bottom piece are not connected and no cutting motion is needed. Three rapiers insert three fillings at the same time. The top rapiers insert a filling for the backing of the

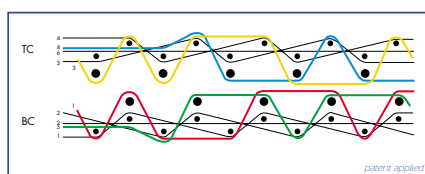


Figure 12: The three rapier sisal look carpet weave structure



Figure 11: In sisal look carpets pile yarns form loops over one or more thick fillings

top carpet, the bottom rapier one for the backing of the bottom carpet and the middle rapiers insert a thick filling that is alternatingly woven in the top and the bottom carpet to give the relief to the carpets. This way the special patented three rapier sisal look weave structure is obtained.

2.2 Sisal look carpet weaving machine

The Sisal look carpet weaving machine, SLC83, is a three rapier weaving machine especially developed for weaving sisal look carpets (see figure 13 and table 2). The SLC83 has following main characteristics:

- a high production rate due to the three rapier weaving technique
- stability and robustness even at high speed
- user-friendly thanks to the use of a menu-structured microprocessor
- easy to maintain thanks to the use of gearboxes in oil bath
- an extended number of automatic control functions
- ergonomic design: all yarns are within an easy reach of the weaver
- an electronic Jacquard machine, the Piletronic PTX, with user-friendly controller.

When sisal look carpets are woven on the SLC83 on a weaving width of 4.2 m, the production is more than 120 m²/hour for sisal look carpets in polypropylene or in 3 shifts up to 90.000 m²/month.

The controller of the Piletronic allows to weave different designs



Figure 13: The Sisal Look Carpet weaving machine SLC83 equipped with Piletronic

one after the other and one next to the other in different paths. Moreover, the design and the colours of the top and the bottom carpet can be totally different. This makes it possible to weave for instance at the same time wall-to-wall carpet of 4.2 m and two carpets of 2.1 m width in a different colour. On the field of designing, the designer has with the SLC83 a machine with a weaving width of 2 times 4.2 m or 8.4 m. Logos and company names can be easily woven in sisal look carpets. Sisal look carpets can also be woven single face on the Carpet Loop Pile weaving machine CLP81 (see 4.2).

3. WIRE CARPET WEAVING

The wire weaving technique is one of the most versatile weaving techniques. It is used to weave high quality wall-to-wall carpet with loops, cut pile or a combination of both.

3.1 The wire weaving technique

In the wire weaving technique loops of pile are formed over metal wires (inserted every two picks in filling direction in the pile shed) which are

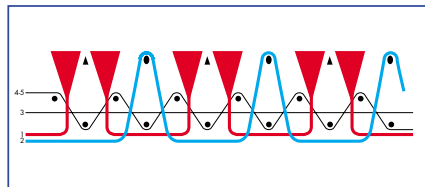


Figure 14: a typical wire weave structure with cut and loop pile

later extracted (see figure 14). During extraction of the wire the pile is cut if a knife is fixed on the wire, if not the pile remains a loop.



Figure 15: The Advanced Wire Master AWM51, equipped with dobby to weave plain or dobby-designed wire carpets

Wire weaving is single face. When equipped with a Jacquard machine, texts and company logos can easily be woven. Wire carpets are especially used for the contract and the residential market. With the wire weaving technique, the pile aspect is completely equal over the complete width of the machine and for carpets woven in several shifts. Several weave structures are possible: woven through or not through to the back, long or short loops, high-low effects, different ground weave structures, cut and/or loop pile,...

3.2 Wire weaving machines

The Advanced Wire Master AWM51 is a wire weaving machine (see figure 15 and table 2). The filling is inserted by flexible rapiers, driven by dustfree gearboxes. A timing belt and conjugated cams in a dustfree gearbox drive the wire. This limits the development of heat and enables a higher speed. Positive opening of the wire hook guarantees a stable wire extraction. The position of the wires during insertion and extraction is monitored by a light sensor. This prevents inap-

appropriate wire handling and guarantees the quality of the carpet. The speed can be steplessly adjusted. Exact machinestop, pickfinding and slow motion are possible. Changes in pick density to the required carpet quality and length are easily adjusted by using a servo motor controlled pick regulator.

The AWM51 equipped with Piletronic PTX permits to weave different weave structures with only one solenoid per harness band.

The AWM51 is also built in a plain or dobby execution. In this case, the pile yarns as well as the ground yarns are controlled by heddle shafts.

4. LOOP PILE CARPET WEAVING

The loop pile weaving technique is a recently developed technique to weave at high speed carpets with looppile. Thanks to the electronic Jacquard machine, high-low effects (sculptured rugs), short or long loops, names and company logos can be woven. Loop pile carpets are used as area rugs as well as wall-to-wall carpet. A new application is airplane carpet.

4.1 The loop pile weaving technique

The loop pile carpets are woven on a double rapier weaving machine. Figure 16 shows the most common weave structure. The bottom rapiers insert the fillings for the ground structure of the carpet. The top rapiers insert every two picks dummy fillings above gauges. These gauges determine the loop height. The pile yarns form loops around these

dummy fillings. After the loop formation, the dummy fillings are cut in the middle and removed on both sides of the machine during weaving.

Other weave structures are also possible: not woven through to the back, with high-low effects, with different ground structures,...

As with the loop pile weaving technique, no wires are inserted, the industrial speed is up to three times greater than on a wire weaving machine. Any type of natural or man-made yarn can be used, also heatsensitive yarns: polypropylene, polyamide, acrylic, cotton, wool,... On a wire weaving machine, no heat sensitive yarns can be used as the heating of the wires (caused by the friction during extraction) would melt the yarns.

4.2 Loop pile weaving machine

The Carpet Loop Pile weaving machine CLP81 (see figure 17) is a double rapier weaving machine especially developed for weaving loop pile carpets according to the technique mentioned under 4.1. The basic machine of the CLP81 is the Carpet & Rug Tronic, equipped with a rapier switch-off system for the top rapier to insert the dummy filling every two picks. When equipped with a Piletronic Jacquard machine controlling the

ped with a cam disc or dobby machine to control the pile yarns for weaving plain and dobby carpets. When leaving out the gauges, the CLP81 can weave sisal look carpets.

5. AXMINSTER MACHINE

In the line of weaving machines for contract qualities, Van de Wiele is developing an Axminster gripper weaving machine to weave cut pile carpets.

In the Axminster technique a fabric with fillings and ground yarns is woven. The Jacquard machine presents per reed dent the coloured pile yarns, the grippers take these and bring them into the woven fabric. In Axminster carpets, only the visible pile yarn is used and no yarns are incorporated. Figure 18 shows a typi-



Figure 17: The Carpet Loop Pile weaving machine CLP81 with dobby for weaving loop pile carpets at high speed

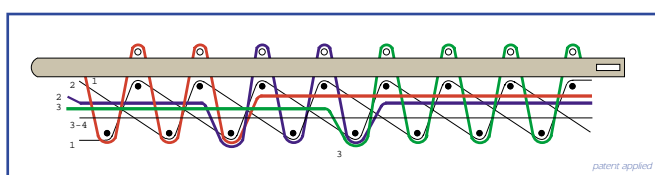


Figure 16: a typical loop pile weave structure, the loops are formed over dummy fillings that are supported by gauges

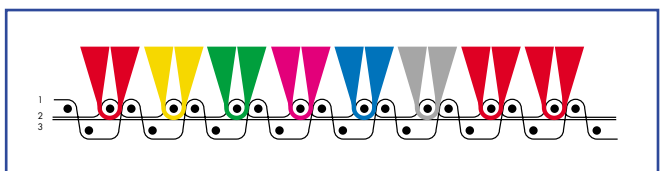


Figure 18: Axminster weave structure in 1/3V

cal Axminster weave structure. The new Axminster machine is foreseen to weave carpets in up to 16 colours at a speed of 150 picks per minute on 4m20. The angle of movement of the gripper has been minimised to obtain this high speed. In order to weave carpets in 16 colours, a Jacquard machine with 17 positions is required.

6. NETWORKING

In carpet weaving mills with numerous weaving machines, it can be difficult to schedule and monitor all the weaving machines. To cope with this, Van de Wiele has developed a network which makes it possible to control the carpet weaving machines from a central planning office.

The Van de Wiele network consists of the Piletronic controllers equipped with a network interface and communication software, a network server and network cables. On the powerful multi-tasking server, adapted software for carpet weaving is installed to (see figure 19):

- prepare the optimal planning and corresponding weave schedules in order to use the full width of the machine by weaving side by side different designs,
- send over the network, the weave schedules to the best adapted carpet weaving machines (with visualisation of the carpets before sending if wished),

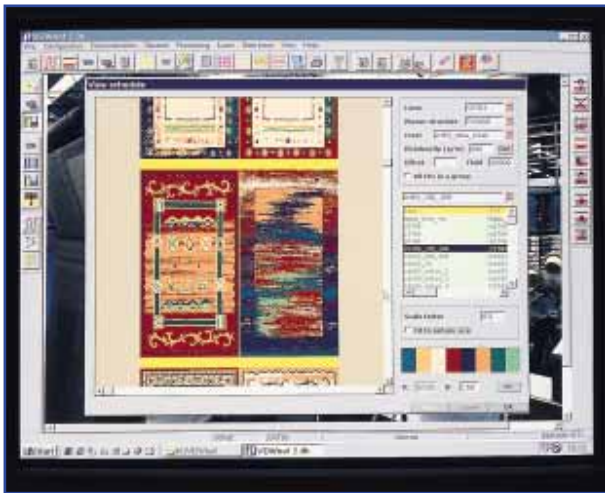


Figure 19: planning of a weave schedule on the server of the VDW network

- monitor the production by registering the woven schedules with corresponding efficiency,
- print out data of the actual woven rugs,
- queue numerous weave schedules for long runs for example during night shifts or weekends,
- control and adapt automatically the content of the hard-disk of each connected controller by erasing files that

are no longer needed to avoid an overloaded hard-disk,

- communicate with the existing CAD/CAM system and administration environment.
- weave with the incorporated pile names and logos in the back of the carpet both in the leno weave area between the carpets as well as on the back of the pile side.

The Van de Wiele Jacquard controller network saves a lot of time and money: no more running to the weaving machines with removable disks, accurate production information, easier planning,... As planning is done on a central computer, the complete flexibility of the machines can be used in an optimal way.

7. CONCLUSION

A wide variety of carpet styles and structures exist: carpets with cut pile (single, double and three rapier weave structures), sisal look carpets, carpets with loop pile and carpets with cut and

loop pile. Each kind of carpet has specific characteristics and applications (area rugs, wall-to-wall carpet).

Where before the carpet weavers wanted to offer quantity (high production), they now want also diversity in style and colours (flexibility). In this respect, the machinery of Van de Wiele fulfils their wishes. On the one hand Van de Wiele manufactures high-productive carpet weaving machines

for each kind of woven carpet. On the other hand, the machines are very versatile thanks to an advanced use of electronics, new working principles and networking.

Van de Wiele secures its position by a continuous development and research in new techniques to improve the performance and the quality of the carpet weaving machines and to find new applications for carpet.