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Sewing Speed Control Software in Conditions of Operator-Machine Interaction

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Abstract
The functionality of the programmable drive control system of a sewing machine with open cycle technology was tested, built according to the author's earlier work. It was found that the feeding mechanism of the sewing machine is sensitive to the textiles and to the machine's rotation speed. The application of the sewing speed programmable control system created conditions for proper reflection of parameters for the technological tasks proposed. Creating a programming algorithm and machine learning of the operator based on sewing speed control software is, as studies have shown, an important step in building a new generation of sewing machines.

Key words: *manipulation actions, technological efficiency, feeding mechanism, control software, sewing speed, sewing process, tachogram.*

Introduction

In the current phase of industrial development of the material goods production, there are such distinctive features as flexible manufacturing systems known as Quick Respond Technology (QRT) [1]. These systems are characterised by the ability to quickly respond to changes in both the product line as well as quantitative variation in the production volume, despite the technical sophistication. This property of QRT systems transferred into the clothing production area leads to an increase in the mechanisation and automation of technological processes, with the final stage leading to robotization. Here specific requirements are placed for the control. While in the past high production efficiency was associated with specialisation and standardisation, which entails the use of specialised machinery due to the massive nature of clothing production, nowadays current development trends are related to the presence of the new generation of machines i.e. universal structure machines, software-controlled with the support of logical systems [2- 4]. Thus the present way of automation and specialization can be described as software controlled type.

The work carried out on QRT systems in the field of robotisation, despite the huge forces and resources involved, face many difficulties. Moreover, the planned completion date of these robotisation programs passed a long time ago [5, 6]. This raises the questions: why did the initially expected quick progress of robotisation for the clothing technology not happen and why was the use of opportunities created by progress in other fields of technology not entirely possible? Diagnoses are not clear in this case. Some people say that the hands of seamstresses are more efficient and cheaper than robots, others believe that the cause lies in the fashion variability or complex properties of textile materials. W. Więźlak [7] states that the diagnoses are simplified, and the reason for the failures is the over-simplifying of these analyses. The issue can be looked at retrospectively through the prism of robotisation usefulness, for example the Institute for Manufacturing and Automation in Stuttgart carried out an evaluation of the susceptibility of organisational and technical production processes to robotisation. According to the 117 - JPA-point scale [8], the process of "sewing" was attributed the 18-th position with 48 points, among the twenty different manufacturing processes.

The reason for this state of affairs is in the particularity of the solid, usually complex, textile object that is clothing. The current structure of clothing, despite some transformations carried out due to the demands of the manufacturing process, is outdated in terms of the nature of its layer structure, which goes back to the nineteenth century. New capabilities in this regard are created by the concept of Chebyshev [9] using the properties of textile materials as a flat network, developed by Kobza and Więźlak based on digital techniques [10, 11].The concept provides a starting point for a new division of the shell patterns, and for restructuring some clothing nodes [12]. The creators of these robotozation programs seem not to notice this phenomenon.

Indispensable are also the far-reaching changes in the design of sewing machines, mainly within the stitch forming mechanism [6, 13]. Repeated attempts at automatic spool exchange in the shuttle sewing machine [14], or at improving the feeding mechanism, [4, 15] still based on the friction phenomenon, have been unsuccessful. However, significant progress has been made in the sewing machine drive. The more and more widely used energy-efficient clutchless drives [16] make it possible to program a series of operations, examples of which are the positioning of the needle, the number of machine cycles divided into sequences, bar tacking realization, thread cutting off and the other opportunities created by the use of logical support systems. These logical support systems also offer the use of a programming function in the test machine during technical task realisations taking into account the technological transformation of textiles and sewing process control parameters [4]. With the programming function in the test machine during technical task realisations it is possible to seek the machine parameters necessary for the correct realisation of the seam designed. For example, for carrying out the easing of the seam, it is set as an independent feeding mechanism, including switching the settings in the technological cycle with the logical system.

The imperfect stitch forming mechanism previously emphasised generates sensitivity to the properties of textiles and to changes in the machine's rotation speed. The previous programming function in

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the test machine during technical task realisations allow to solve this problem correctly in the range of made up properties of textiles. The diverse nature of the rotational speed of the machine in the programming phase and the phase of task realisation may therefore continue to cause a deviation in the actual parameters established for the seam in the programming stage [17]. Therefore it appears that the sewing speed control software in conditions of operator-machine interaction can make significant progress in drive sewing machines, which means the extension of existing support programming systems by means of the programming function of drive in the test machine during technical task realisations. This requires a training operator who submits the machine control drive through all activities carried out on the textiles.

This type of system was built [18] and the tachogram modelling was conducted [19]. In this article we will present the research results for the functionality of programmable drive control system of a sewing machine. The process of machine programming in test realisations should include matching the tachogram to the content of technological tasks and operator adaptability. Studies have shown that the tachogram should be built as a polygonal curve [18, 19].

Efficiency of the technological machine feeding mechanism in easing actions

The sensitivity of sewing machine elements, which are responsible for manual manipulation on the properties of textiles, requires the examination of machine technological parameters ensuring the effect desired. For example, with respect to technological tasks that require positioning and so-called easing textile items, the problem comes down to establishing the setting of the machine, i.e., the jump of the work link of the feeding mechanism responsible for the easing level $S_{g/i}$ and the corresponding number of the chain link of stitches N_i. In the new generation of machines, i.e., the support of logical type, the process is realised with the help of the function of the machine programming in sewing test realisations. The schematic diagram shown in ***Figure 1*** illustrates this situation and the corresponding functional diagram of an action chain: the operator - machine - task (***Figure 2***).

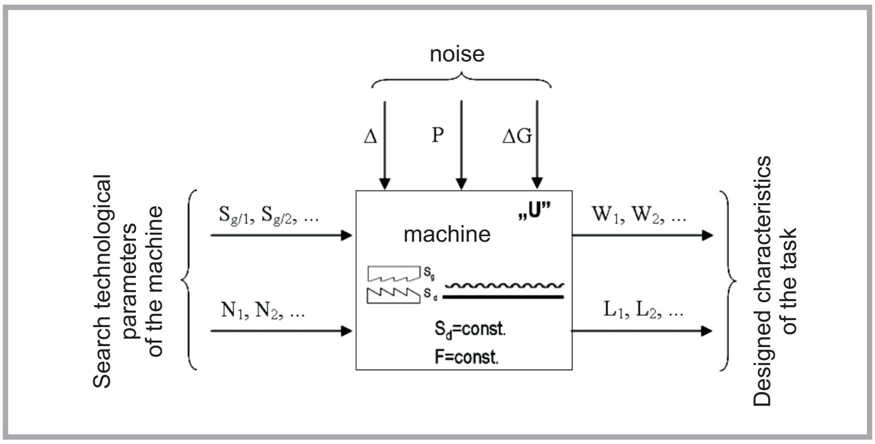


Figure 1. *Schematic diagram of the easing programming steps during test realisation of the technological task;* ***Designation****: S_d – jump of cell feeding mechanism responsible for length of chain link stitches, in mm, $S_{g/i}$ – jump of cell feeding mechanism responsible for level of easing, in mm defined by easing degree W_i, N_i – the number of chain link stitch corresponding to $S_{g/i}$, W_i – designed (expected) degree of easing, in %, L_i – designed path length of the stitch, in mm corresponding to W_i, F – force in the feeding mechanism system of the machine, in N.*

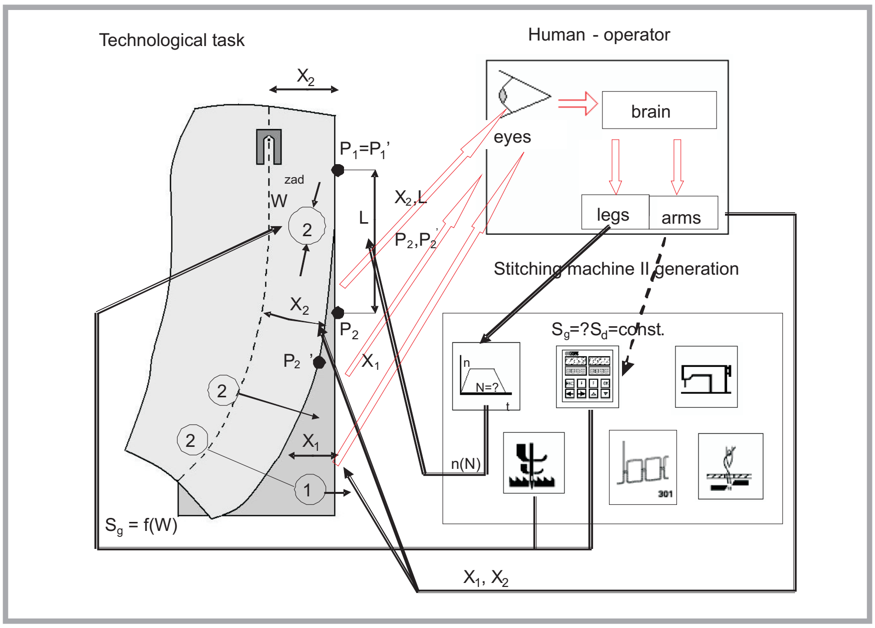


Figure 2. *Functional diagram of the chain of action, in the programming process of the easing action.* ***Characteristics of technological task****: 1; 2 – Seamless construction elements, L – sewing length, P_i – meeting points, X_1 – allows to keep track with the prediction, X_2 – seam width, ⇒ streams of information, ➡ energy currents, - - - -▸ searching settings of machine, →◯← symbol of easing the stitch element structure.*

Disturbances in the seam which accompanied the process of machine programming (***Figure 1***) result in a shorter stitch (Δ), layer offset (P) and deviation in the seam stitch counts from the set point (Δ G). These limitations require force optimisation in the feeding mechanism system of the machine.

The sewing process using a sewing machine with the support of logical type occurs in conditions of the programed switch of machine parameters ($S_{g/1}$, N_1); ($S_{g/2}$, N_2); ...; ($S_{g/i}$, N_i); ...; responsible for characteristics of technological tasks (W_1, L_1); (W_2, L_2); ...; (W_i, L_i); ... (***Figure 3,*** see page 136).

The natural diversity of the machine rotational speed changes in the programming phase of the manual task and in the task carrying out process with fixed settings on the one hand, and the sensitivity of the feeding mechanism of the machine to the rotational speed changes on the other, make the convenient programming function of these operations limited. With a task

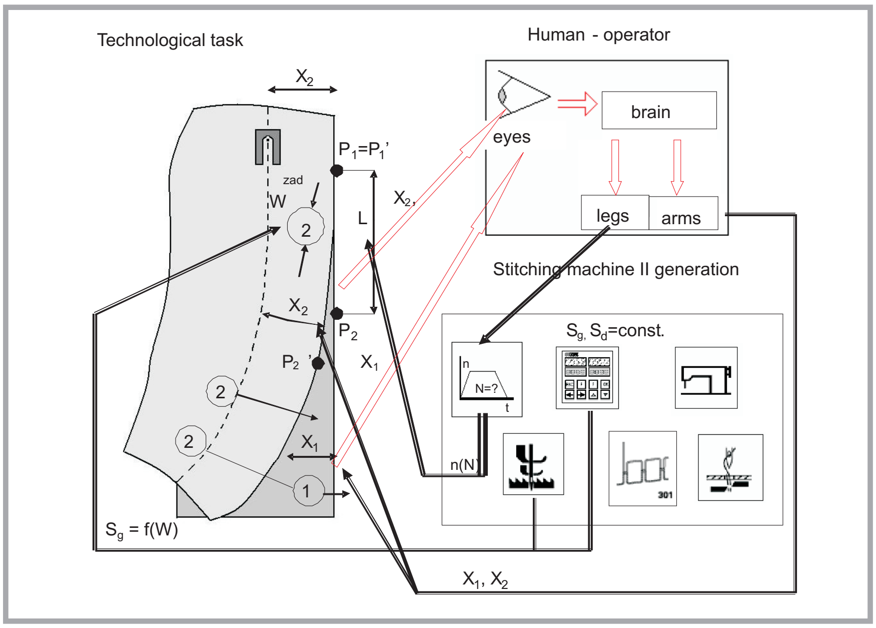
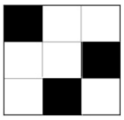
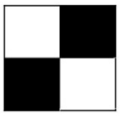


Figure 3. *Functional diagram of the action chain in the sewing machine using the machine supported with a logical type during the easing action.*

Tabela 1. *Textile material characteristic applied to the studies.*

Textile designation	A	B	C
composition	cotton	PA	cotton
weave	twill	plain	double-right
report	 1/2 Z	 1/1	 2/2
density G, dm^{-1} warp/columns Go; Gk, weft/rangesGw;Grz	 283 230	 425 235	 240 160
surface mass m, g	168	76	268
thickness, mm	0.62	0.14	1.24
friction coefficientμ, -	0.54	0.23	0.67

of high quality requirements, this function can be quite unhelpful. It depends on drive control technology by means of an operator and on the scope of the rotational speed changes of the machine.

Studies on the directional susceptibility of textiles to easing (the angular position relative to the direction φ of seamless warp/columns in the textile material) for selected textile materials, (***Table 1***) showed a significant effect of the seam position and the rotational speed of the machine on the easing degree W (***Figure 4***).

To assess the efficiency of the feeding mechanism in easing actions, the indicator expressing the ratio of the easing degree (designed) required was introduced. The theoretical easing degree Wtheoretical, which was set assuming 100% efficiency for the feeding mechanism, takes into account the required jump of the cell feeding mechanism responsible for easing. This ratio expresses the relationship:

$$\vartheta = \frac{W}{W_{theoret}} = \frac{\Delta S_{g/ef}}{\Delta S_g} \quad (1)$$

where:

ΔS_g in mm – difference in the jumps of the cell feeding mechanism S_g and S_d,

$\Delta S_{g/ef}$ in mm – effective easing length of the segment in the packet textile layer, attributable to the one chain link stitch length S_d.

The theoretical easing degree $W_{theoretical}$ is calculated from:

$$W_{theoret} = \frac{L_g - L_d}{L_d} = \frac{S_g - S_d}{S_d} \quad (2)$$

where:

L_g, L_d in mm – the length of the upper and lower layer in the textile package, respectively.

The speed jump from n = 200 min^{-1} for n = 4000 min^{-1} for the textile materials studied produces a multiple increase in the efficiency of the feeding mechanism for the easing action. Speed changes in the range of 200 ÷ 800 min^{-1} did not cause significant changes in the technological efficiency of the feeding mechanism in this range.

It should be emphasised that the efficiency of the feeding mechanism ϑ in the easing actions for the test materials varied depending on the type of material; the seam angular position (φ) and the rotational speed of the machine (n) is between 0 ÷ 40% and increases with the growth of the rotational speed of the machine (***Figure 4***).

The sensitivity of the feeding mechanism to the rotational speed of the machine was the basis for the thesis that its verification required to build a programmable room unit tachometric [18].

Reflection of the stitch path length in conditions of programmable drive control system

Evaluation of the reflection of the path length stitch was carried out on a test post, illustrated in ***Figure 5***.

The study was developed in the course of testing different speeds. The first two tests (T_1, T_2) were performed for three segmental tachograms {1 0 -1} at a fixed speed at levels n_u = 900 min-1 and n_u = 3500 min^{-1} , respectively. Two further tests (T_3, T_4) were performed by varying the speed of n ∊ < 0, 3500 min^{-1}. For these tests the tachogram are related (T_{set}) to the following configurations:

T3 - {1 0 -1 0 1 0 -1} number of responses r = 7

T4 - {1 0 -1 0 1 0 -1 0 1 0 - 1 0 1 0 -1} number of responses r = 15.

The tachograms are composed of three types of foot reaction [19]:
1 - increase, 0 - fixed gear, -1 - a decrease.

For each test set:

- the number of working cycles N_{set} and the corresponding average rotational speed – $n_{av/set}$ - calculated by the ad-

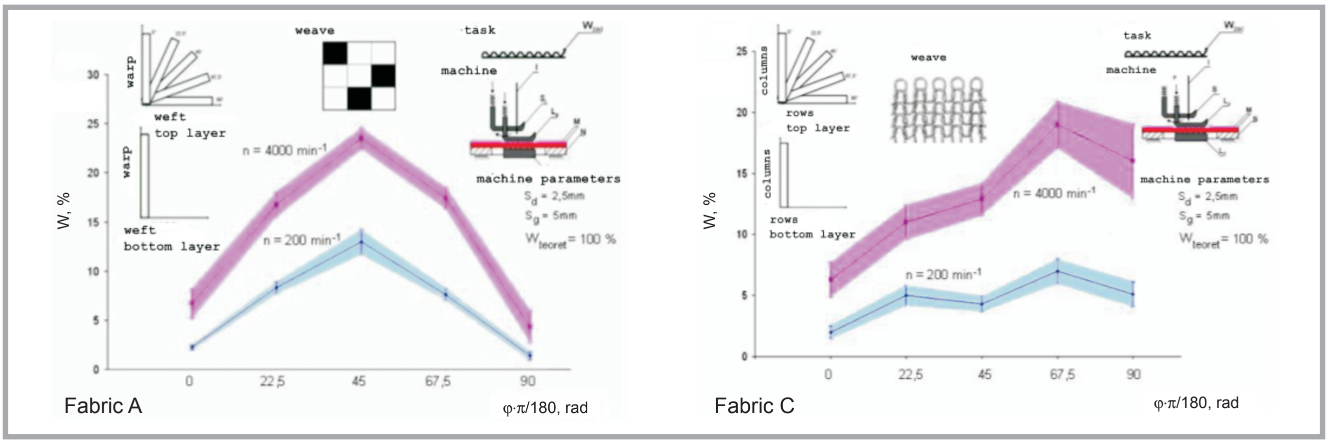


***Figure 4.** Easing degree depending on the seam angular position relating to the direction of the warp / columns at constant machine settings (Sg, N), for selected levels of the rotational speed machine (the materials selected for study - **Table 1**).*

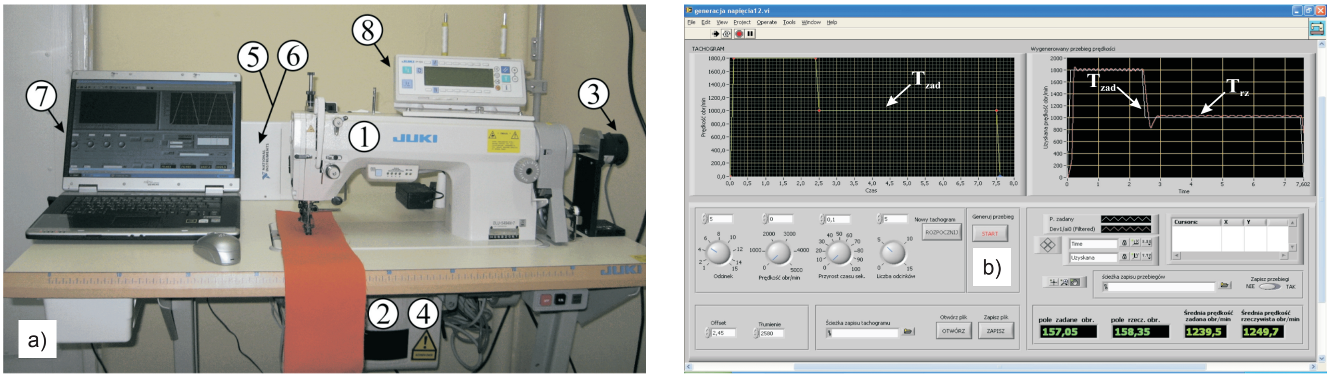


***Figure 5.** Test post with the programmable drive control system of the sewing machine: a) general view of the test post distinguishing the members of the control system, 1 - sewing machine, 2 - positional drive, 3 - tachometric generator, 4 - power supply and control unit, 5, 6 - converter A / D and D / A, 7 - acomputer with programmable speed adjuster, 8 - Operator panel with programming function for manual actions b) operation panel tachometric adjuster T_{set} - tachogram given in the form of a polygonal curve, T_{real} - a real tachogram.*

juster tachometer program based on the set tachogram
- the number of machine working cycles $N_{cal/real}$ and the corresponding average rotational speed nav/set- calculated by the adjuster program based on the real tachogram, measured by a tachometric generator;
- the path stitch length L_{real} and the corresponding number of chain link N_{real}.

Characteristics of the textile materials chosen are presented in ***Table 1***.

The strength in the system of the machine feeding mechanism (feeding mechanism, so-called ‘independent’) is assumed to be 50 N for both the feed dog and presser foot. The stitch jumps = 2.6 mm. The results of measurements (30 repeats) after the statistical treatment are summarised in ***Table 2***.

Figure 6 shows the discrepancy between the given tachogram in the form of a polygonal curve (T_{set}) and the actual process speed (T_{real}), measured with a tachogenerator. It depends on several factors and the following should be distinguished: non-linear characteristics of the programmable drive control system of the sewing machine, inertia of the machine and drive

***Table 2.** List of tachogram parameters and path stitch (stitching under the clutch less controls oft ware of the sewing machine); T_1 – tachogram W^3: {1 0 -1}, n_u = 900 min^{-1}, T_2 – tachogram W^3: {1 0 -1}, n_u = 3500 min^{-1}, T_3 – tachogram W^7: {1 0 -1 0 1 0 -1}, n_{max} = 3500 min^{-1}, T_4 – tachogram W^{15}: {1 0 -1 0 1 0 -1 0 1 0 -1 0 1 0 -1}, n_{max} = 3500 min^{-1}.*

Fabric	Characteristic measured	T_1	T_2	T_3	T_4
A	N_{set}, –	79.83	79.42	70.66	163.39
	$N_{cal/real}$, –	81.15 ± 0.15	79.86 ± 0.15	71.25 ± 0.10	163.17 ± 0.25
	N_{real}, –	80.77 ± 0.27	79.77 ± 0.19	71.50 ± 0.21	161.27 ± 0.46
	L_{real}, mm	205.30 ± 0.41	207.70 ± 0.73	181.73 ± 0.68	421.37 ± 0.51
	$n_{av/set}$, min^{-1}	870.90	2647.20	1927.20	1999.10
	$n_{av/real}$, min^{-1}	885.19 ± 1.62	2661.08 ± 4.91	1942.58 ± 2.63	1936.11 ± 2.26
B	N_{set}, –	79.83	79.42	70.66	163.39
	$N_{cal/real}$, –	81.04 ± 0.17	79.92 ± 0.12	71.96 ± 0.08	164.32 ± 0.21
	N_{real}, –	80.43 ± 0.27	79.67 ± 0.18	72.10 ± 0.15	161.73 ± 0.50
	L_{real}, mm	208.37 ± 0.50	207.00 ± 0.39	190.53 ± 0.72	420.30 ± 0.42
	$n_{av/set}$, min^{-1}	870.90	2647.20	1927.30	1999.10
	$n_{av/real}$, min^{-1}	884.01 ± 1.84	2663.16 ± 3.86	1962.41 ± 2.27	2010.24 ± 2.55
C	N_{set}, –	79.83	79.42	82.33	163.39
	$N_{cal/real}$, –	80.58 ± 0.35	79.99 ± 0.10	82.26 ± 0.07	163.64 ± 0.19
	N_{real}, –	78.80 ± 0.32	76.73 ± 0.34	80.07 ± 0.37	159.43 ± 0.38
	L_{real}, mm	173.17 ± 0.55	171.10 ± 0.52	170.93 ± 0.48	344.70 ± 1.16
	$n_{av/set}$, min^{-1}	870.90	2647.20	2058.30	1999.10
	$n_{av/real}$, min^{-1}	878.96 ± 3.84	2665.31 ± 3.66	2055.83 ± 1.79	2001.96 ± 2.34

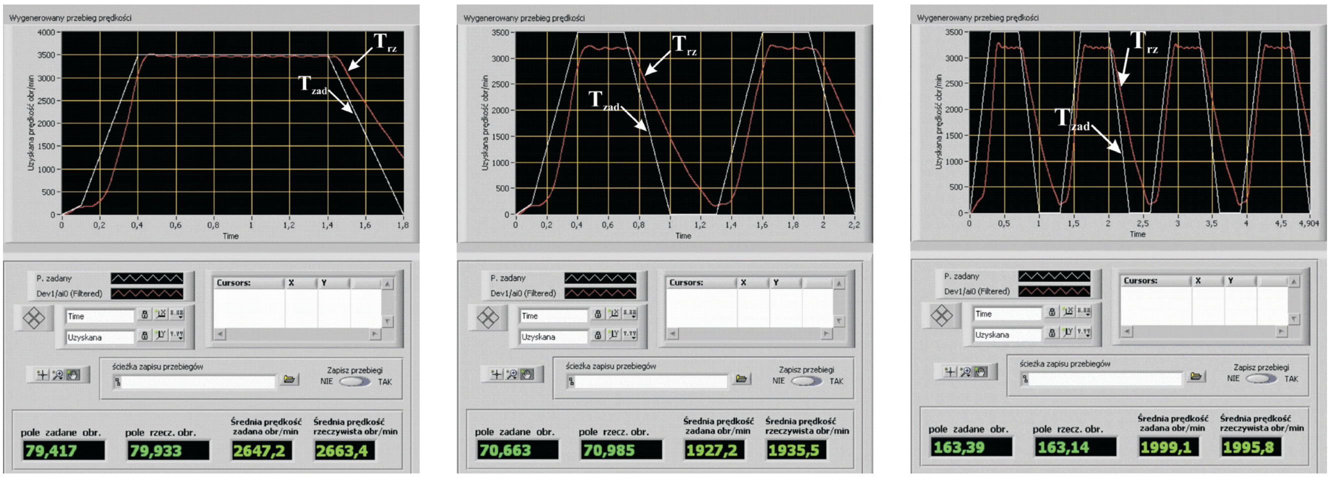


Figure 6. *achogram configurations used for evaluation of the path length of stitch reflected: a) test T_1; T_2, b) test T_3, c) test T_4*

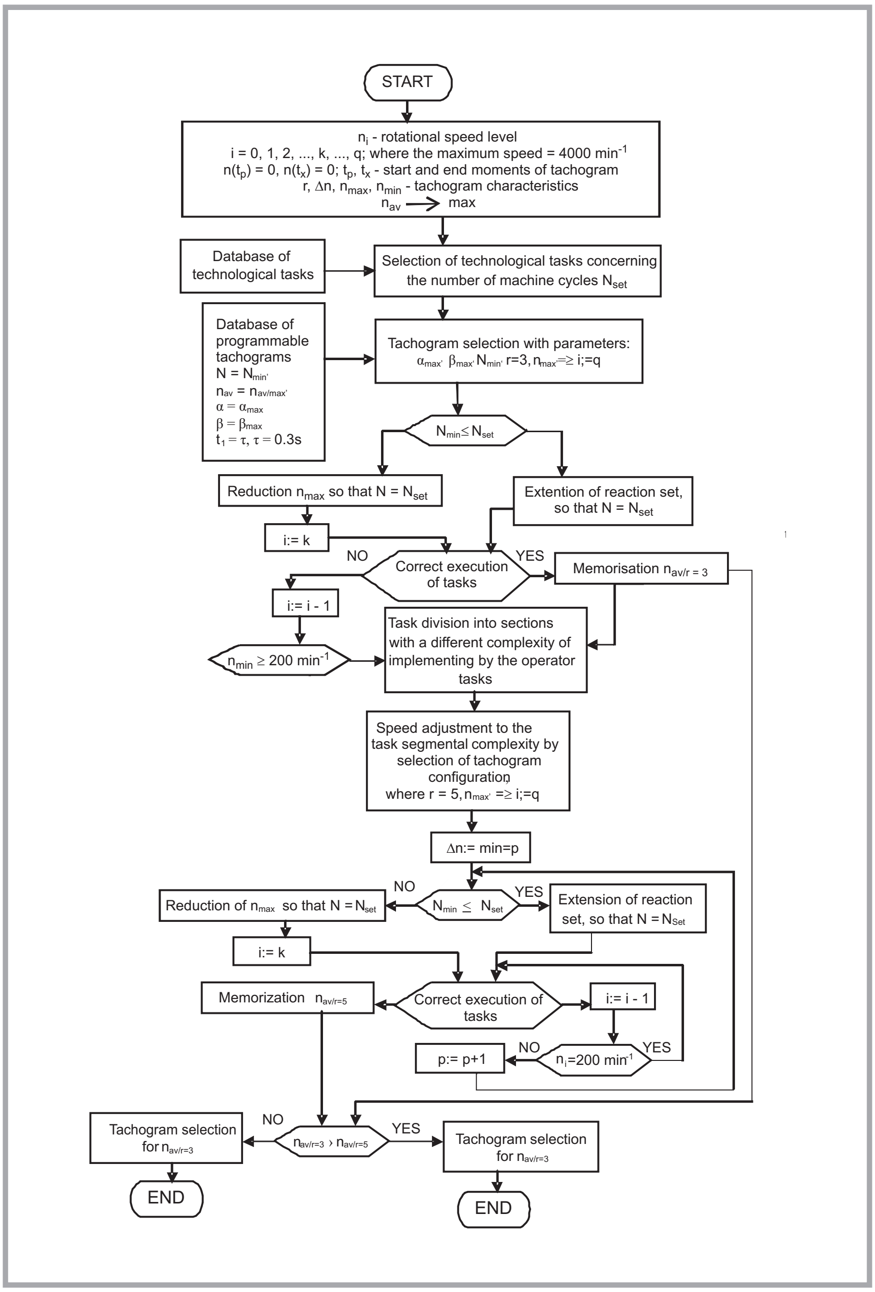


Figure 7. *Programing algorithm of machine drive and operator's learning during the sewing process (for foot reaction r = 3 and 5).*

mechanisms, the stiffness and backlash of the drive mechanism, and friction moment of the mechanisms of the whole machine and the motor. All these factors induced textile loading in the sewing process. These differences are transferred to the number of chain links of stitch set and measured in the reference stitch (***Table 2***). This is not essential to the task quality because the operator makes the decision to terminate the programming process and operator's learning, taking into account the evaluation of the correctness of the technological task realised. In contrast, the seamless parameter repeatability at a fixed tachogram has great significance because of the stitch path length (L_{real}). Here the average random error did not exceed 0.5% for the process of machine's rotational speed tested, which should be viewed positively.

Programming of programmable drive control system of the sewing machine and operator's learning during test realisation of the technological task

In the process of sewing using machines with conventional open-cycle technology, the drive control by the operator is susceptible to the manipulative operations by him/her. The transfer of motor control activities to the machine tasks reverses this relationship and leads to searching a configuration and parameters of the tachogram accordingly to the task directed to the operator and its adaptability. Thus this process should be proceeded by measures which restrict operator participation in textile transformation activities. Easing and stretching the textile item can be transferred to the machine tasks. Bending and position-

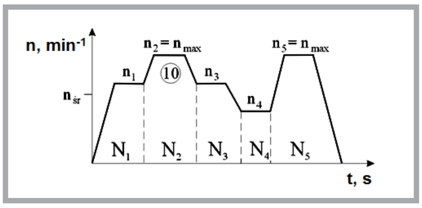


__Figure 8.__ Example of a tachogram as a broken curve, taking into account the segment division of varying complexity for the operator's execution.

ing operations are usually only partially transferred to the machine tasks (interaction with the operator is assumed), in rare cases totally.

Programming the programmable drive control system of the sewing machine and the operator's learning is proposed according to the algorithm shown in ***Figure** 7*.

The algorithm shown in ***Figure** 7* includes the tachogram with the reaction number r = 3 and r = 5. The increase in reactions in the tachogram creates opportunities for highlighting more of its segments (***Figure 8***), which are assumed to correspond to stitch sections of varying complexity for the operator's execution. It is assumed to use the tachogram database in the programming process of the machine drive. The tachogram database employed is auxiliary because of the need to adjust the configuration and tachogram parameters to the task content assigned to the operator and operator adaptability. Drive programming is aimed at the subordination of the operator's actions to the drive control by the machine. Fitting activities change the tachogram performance of a specified configuration.

$$T_{10}^{11}\{1\ 0\ 1\ 0 - 1\ 0 - 1\ 0\ 1\ 0 - 1\} \quad (3)$$

Tachogram indices when writing:

- the superscript - the number of reactions,
- subscript - the location in the tachogram database,
- N_1, N_2, N_3, … - tachogram segments

Figure 9 illustrates the process of sewing in conditions of the programmable drive control system of the sewing machine.

An attempt to program and test the machine drive and operator's learning using a tachometer adjuster was done according to the algorithm proposed in ***Figure** 7*, as an example of combining two textile items with different curvatures. For the test presented in ***Figure 10***, the complexity of the executive is characteristically differentiated into sections with the number of machine cycles N_1 and N_2. In section N_1, we have a task of type P, which requires the positioning of the entire textile package, while the section N_2 - PP task requires a different positioning of the package elements. This programming process was carried out in four steps: The first step uses a tachogram {1 0 -1} at an average rotational speed $n_{av/e}$ = 963 min^{-1}, the second - the tachogram {1 0 -1 0 -1} (***Figure 11***) from $n_{av/e}$ = 1136 min^{-1}; the reaction was raised in the third set to give a first segment of $n_{av/e}$ = 1249 min^{-1}; in the fourth set there was an additional reaction (***Figure 12***) which ultimately helped to achieve $n_{av/e}$ = 1332 min^{-1}.

Conclusions

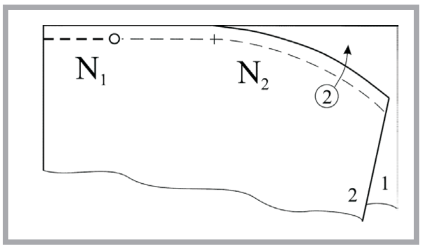


__Figure 10.__ Test of a trial to program the drive of the machine and learn the operator according to the algorithm presented in __Figure__ 7; N_1 = 72 stitch; N_2 = 84 stitch; s = 2.5 mm

1. In conventional machines, which are operated by the drive of the operator, the drive control by the operator is subjected to the content of the technological task in fuzzy and operator qualifications. The programmable drive control system of a sewing machine proposed reverses such submission. Adapting the operator to the new conditions requires operator training, which can be implemented in the programming process of the machine drive and teaching the driven machine operator.
2. The test system of the programmable drive control system of a sewing machine makes it possible to obtain good reproducibility of the actual speed

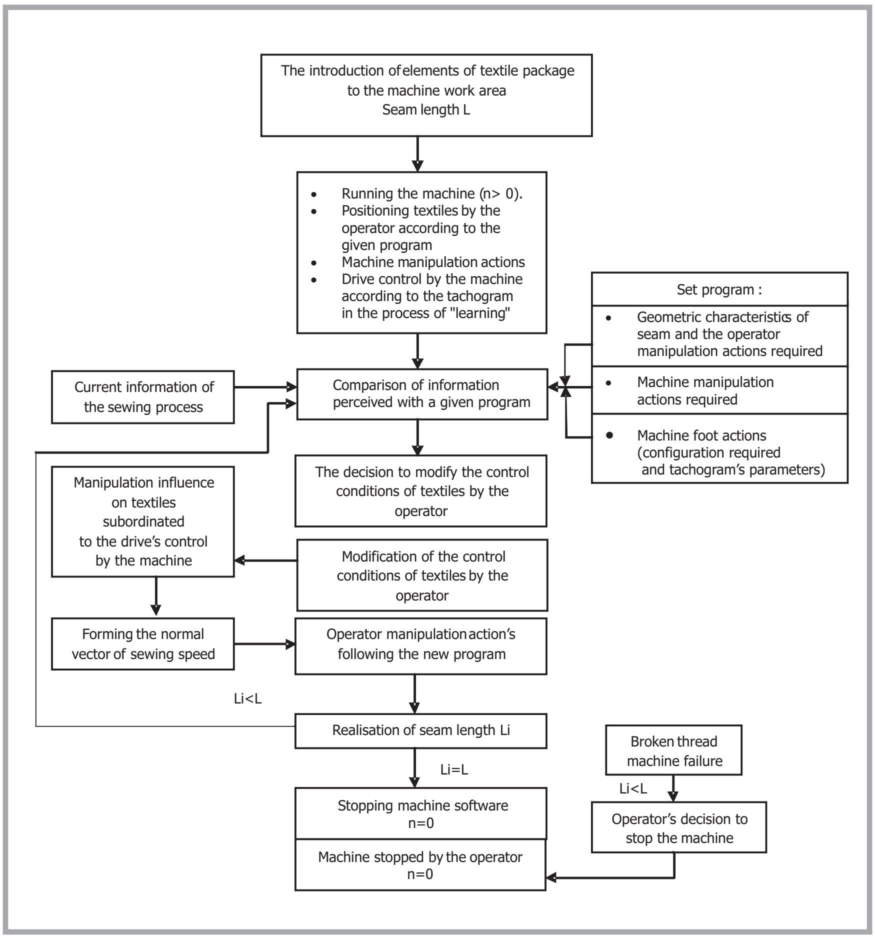


__Figure 9.__ Process of sewing in the machine-operator system - a machine with aided manipulative actions and the sewing speed control software.

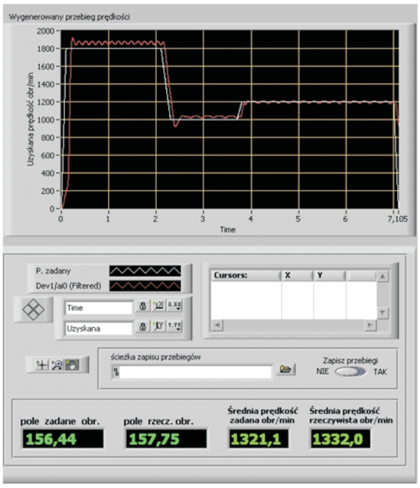


Figure 11. Tachogram configuration and its parameters in the trial of programming the machine drive and operator's learning (step 2).

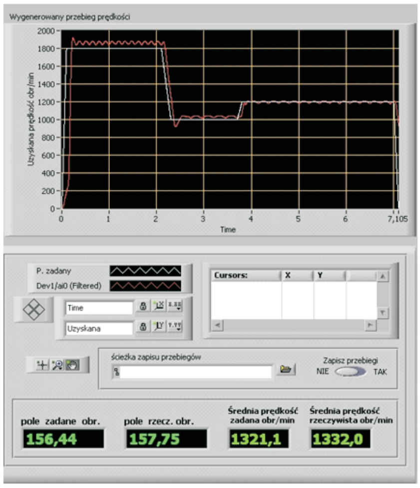


Figure 12. Tachogram configuration and its parameters in the final phase of the machine drive programming and operator's learning (step 4).

and, as a result, correct reflected features of the seam proposed that are sensitive to changes in speed.

3. The programmable drive control system of a sewing machine with a tachometer adjuster creates conditions for the effective use of the machine speed, and thus may lead to an increase in productivity at the workplace.
4. The control panel of the tachometer adjuster allows to program the tachogram as a broken curve as well as to record the actual speed of the machine. Comparison of the tachogram based on the number of cycles of the machine designated by the program and the average adjuster speed is used as a basis to correct the specified tachogram.
5. Differences between the given tachogram and the real one, which occur in the process of sewing, are dependent on many factors. The following should be distinguished:
   - non-linear characteristics of the programmable drive control system of the sewing machine,
   - inertia of drive of the system, induced by the mass moment of inertia of the machine and drive mechanisms, reduced to the motor shaft,
   - stiffness and backlash in the drive mechanism,
   - friction moment of machine and motor mechanisms
   - technological moment in the process of sewing.

   These differences do not have great significance for the quality of their actions, because the operator makes an assessment of the correctness of the technological task and decides to end the programming process of the clutchless control system.
6. The test adjuster of the tachometer of the clutchless control system provides opportunities to use the tachogram database. Because of the need to adjust the configuration and tachogram parameters to the task technological content and adaptability of the operator, the tachogram base serves as an auxiliary and includes the so-called tachogram limit, i.e., designed to limit the speed (the average in the technological cycle). Matching the tachogram and its effectiveness varies according to the algorithm proceeds developed.
7. The programmable drive control system developed is an important step in the development of sewing machine drives in open-cycle technology. A further development of this drive seems to be advisable to consider the possibility of using neural networks and fuzzy logic. The use of a neuro-fuzzy controller could relieve the operator in the tachogram fitting activities, which requires the development of additional equipment for the image analysis system of evaluating the correctness of tasks realised.

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INSTITUTE OF BIOPOLYMERS AND CHEMICAL FIBRES
INSTYTUT BIOPOLIMERÓW I WŁÓKIEN CHEMICZNYCH

IBWCh

Polska

Director of the Institute: *Danuta Ciechańska Ph.D., Eng.*

The Institute of Biopolymers and Chemical Fibres *was consolidated with the Pulp and Paper Research Institute in 2007.*

The research subject *of IBWCH is conducting scientific and development research, as well as implementing their results into praxis in the following fields:*
- *processing, modifying, and application of biopolymers,*
- *techniques and technologies of manufacturing, processing, and application of chemical fibres and other polymer materials and related products,*
- *techniques and technologies connected with manufacturing, processing and application of products of the pulp and paper industry and related branches*

R&D activity *includes the following positions, among others:*
- *biopolymers – modifying and processing,*
- *functional, thermoplastic polymers,*
- *biodegradable polymers and products from recovered wastes,*
- *industrial biotechnology, e.g. bioprocesses for modifying and processing polymers and fibres, and biosyntheses of nanobiomaterial polymers,*
- *biomaterials for medicine, agriculture, and technique,*
- *nano-technologies, e.g. nano-fibres, polymer nano-coatings, nano-additives for fibres.*
- *processing of polymer materials into fibres, films, micro-, and nano- fibrous forms, and nonwovens,*
- *paper techniques, new raw material sources for manufacturing paper pulps,*
- *environmental protection,*

The Institute is active *in implementing its works in the textile industry, medicine, agriculture, plastic processing, filter and packing materials manufacturing, as well as in the cellulose and paper industries.*

The Institute has *the following five laboratories, which have accreditation certificates PCA:*
- *Laboratory of Microbiology*
- *Laboratory of Biodegradation*
- *Laboratory of Environment Protection*
- *Laboratory of Metrology*
- *Laboratory of Paper Quality*

The Institute's offer of specific services *is wide and differentiated, and includes:*
- *physical, chemical and biochemical investigations of biopolymers and synthetic polymers,*
- *physical, including mechanical investigation of fibres, threads, textiles, and medical products,*
- *tests of antibacterial and antifungal activity of fibres and textiles,*
- *investigation in biodegradation,*
- *investigation of morphological structures by SEM and ESEM*
- *investigation and quality estimation of fibrous pulps, card boards, and paper products, including paper dedicated to contact with food, UE 94/62/EC tests, among others.*
- *Certification of paper products.*

The Institute is member *of domestic and international scientific organisations, the following, among others: EPNOE Association-European Polysaccharide Network of Excellence, Polish Chitin Society, Centre of Advanced Technology of Human-Friendly Textiles 'PROHUMANOTEX', Polish Platform of Textile Technology, Polish Platform of the Forest-Wood Technology Sector, International Scientific Network 'Environment versus Technology' ENVITECH-NET.*

The Institute participates *in the following strategic research projects: KEY PROJECT: 'Biodegradable fibrous goods', BIOGRATEX – PO IG 01.03.01-00-007/08; FORESIGHT PROJECT: 'Modern technologies for textile industry. A Chance for Poland' – UDA – PO IG 01.01.01-00-005/09-00 (as a leader); STRATEGIC PROJECT: 'Technology for the preparing of biodegradable polyesters using renewable raw materials', BIOPOL – PO IG 01.01.02-10-025/09; STRATEGIC PROJECT: 'Application of biomass for production of environmentally friendly polymeric materials', BIOMASS – PO IG 01.01.02-10-123/09.*

The Institute organises *educational courses and workshops in fields related to its activity.*

The Institute is active *in international cooperation with a number of corporation, associations, universities, research & development institutes, and companies from Austria, Germany, Finland, France, Sweden and the United States among others.*

The Institute is publisher *of the scientific journal 'Fibres and Textiles in Eastern Europe'; the journal is since 1999 on the 'Philadelphia List' of the Institute for Scientific Information.*

60 Years of the Institute of Biopolymers and Chemical Fibres

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