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ECONOMICAL USE OF CUTTING TOOLS IN SERIAL PRODUCTION

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ABSTRACT:

* The economical use of cutting tools at drilling and face milling on the machining center in serial production was investigated.
* Selection and introduction of the three new cutting tools.
* The output effects of the cutting process in production conditions are observed.
* Result:
  - the productivity and quality are increased,
  - the machining costs are decreased.
  - the profitability (Break Even Point) in a relatively short time was realized.

CUTTING TOOL - THE MOST IMPORTANT ELEMENT OF THE MACHINING SYSTEM

- Cutting tool has a decisive influence on the machining process.
- Cutting tool is the smallest but the most important element of the machining system.
- It is known that the cutting tool costs are

  3 to 8 % of the machining costs, but their influence on machining costs is very important and amounts 60 to 70 %.

CUTTING TOOL - THE MOST IMPORTANT ELEMENT OF THE MACHINING SYSTEM

There is a well known proverb:

"Neither machine tool or machining system can not give more than cutting tool allows. Machine is the mother of all machines and most technical products, but it is not the king of technology. The King of technology is a tool" [1].

STRICT CUSTOMER REQUIREMENTS IN THE MARKET

- Strict customer requirements and competition in the market, enforce industry to increase efficiency, reliability and economy of production processes.
- At cutting tool selection a technologist needs to harmonize a cutting tool with machining operations features, and select cutting tool which will give the best effects.

CUTTING TOOL SELECTION

At this the important criteria are:

- **Machining quality**

  (accuracy, roughness and surface integrity).
- **Productivity**
- **Economy**
- **Machining process reliability.**

CUTTING TOOL SELECTION

- **Cutting tool selection is very important, because of its influence:**

  - on the cutting time

  - on the machining costs.

- **Technologist needs to harmonize a cutting tool with machining operations features, and select cutting tool which will give the best effects.**

WORKPIECE, MACHINE TOOL

Workpiece:

- The prismatic workpieces 36x24x150 mm (low alloy steel).

Machine tool:

- The machining centre Heller MCi16
  - 4 NC axis, 2-palette system with clamp devices for 4 workpieces in three workpiece clamping positions.
  - 59 cutting tools.

THE MACHINING CENTRE
Heller MCi16

COMPLEX OPERATION CUTS FOR TESTING WERE SELECTED

- Deep drilling of the hole Ø 2,15 x 35 mm

  ratio .... L/D = 16,4

- Deep drilling of the hole Ø 2,03 x 24 mm

  ratio .... L/D = 11,8

- Fine face milling of the workpiece sides

THE EXISTING TOOLS WERE TESTED IN PRODUCTION CONDITIONS

(1) HSS spiral drills Ø2,15 mm

(2) HSS spiral drills Ø2,03 mm

(3) Face milling cutter Ø 40 with 6 coated carbide inserts (every insert has 2 cutting edges with positive cutting geometry.

Radial placed cutting inserts

THE EXISTING TOOLS WERE OBSERVED & TESTED IN PRODUCTION CONDITIONS

EXISTING CUTTING TOOLS TEST RESULTS:

- **Spiral drills:**

  Large cutting time & large machining costs

  Lower tool life & lower machining quality

- **Face milling cutter:**

  Lower tool life

  Relative higher machining costs

  Good machining quality

THE INTRODUCTION OF THE NEW CUTTING TOOLS

After the insight and analysis were selected:

(1) Deep hole drill Ø 2,15 mm

(2) Deep hole drill Ø 2,03 mm
(all one-lipped gun drill with carbide cutting edges and holes for coolant in cutting zone)

(3) Face milling cutter **Ø 40** with 6 tangentially placed coated carbide inserts
(every has 8 edges).

THE INTRODUCTION OF THE NEW CUTTING TOOLS

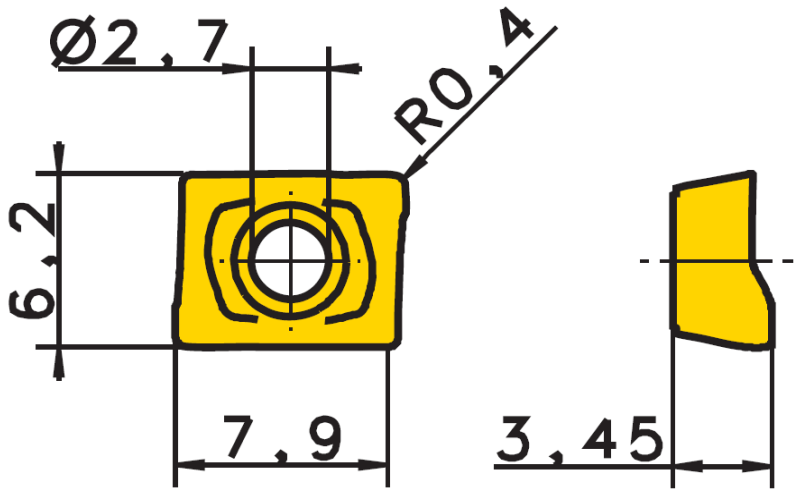
Deep hole drill Ø 2,15 mm

New milling cutter

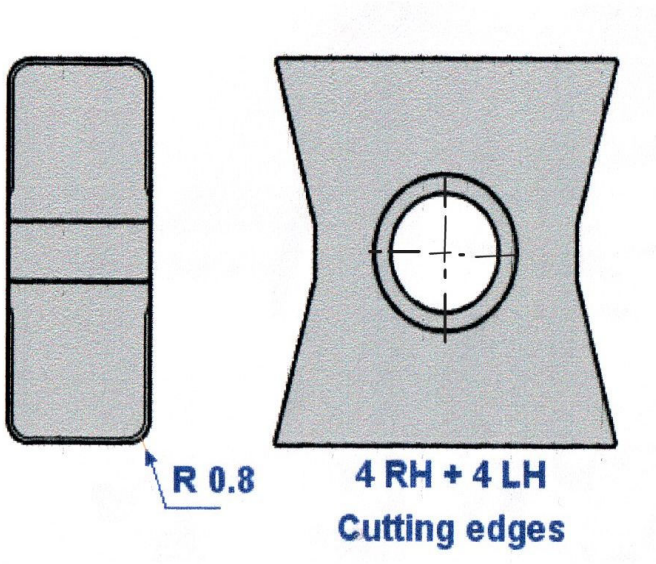
Tangential placed cutting inserts

CUTTING INSERTS

Existing milling insert



New milling insert



EXISTING CUTTING TOOLS TEST RESULTS

- Spiral drills:
  - Cutting time & Machining costs: Large
  - Tool life & Machining quality: Lower
- Face milling cutter:
  - Tool life: Lower
  - Machining costs: Relative higher
  - Machining quality: Good

TESTING
OF NEW CUTTING TOOLS

The testing under production conditions included:

- Visual observation of the machining process due to possible vibrations, regular chips removal etc.
- The number of the workpieces z_T machined in time of one tool life was noted
- After machining the accuracy and machined surface roughness were observed and measured.
- The machining costs and the productivity were computed

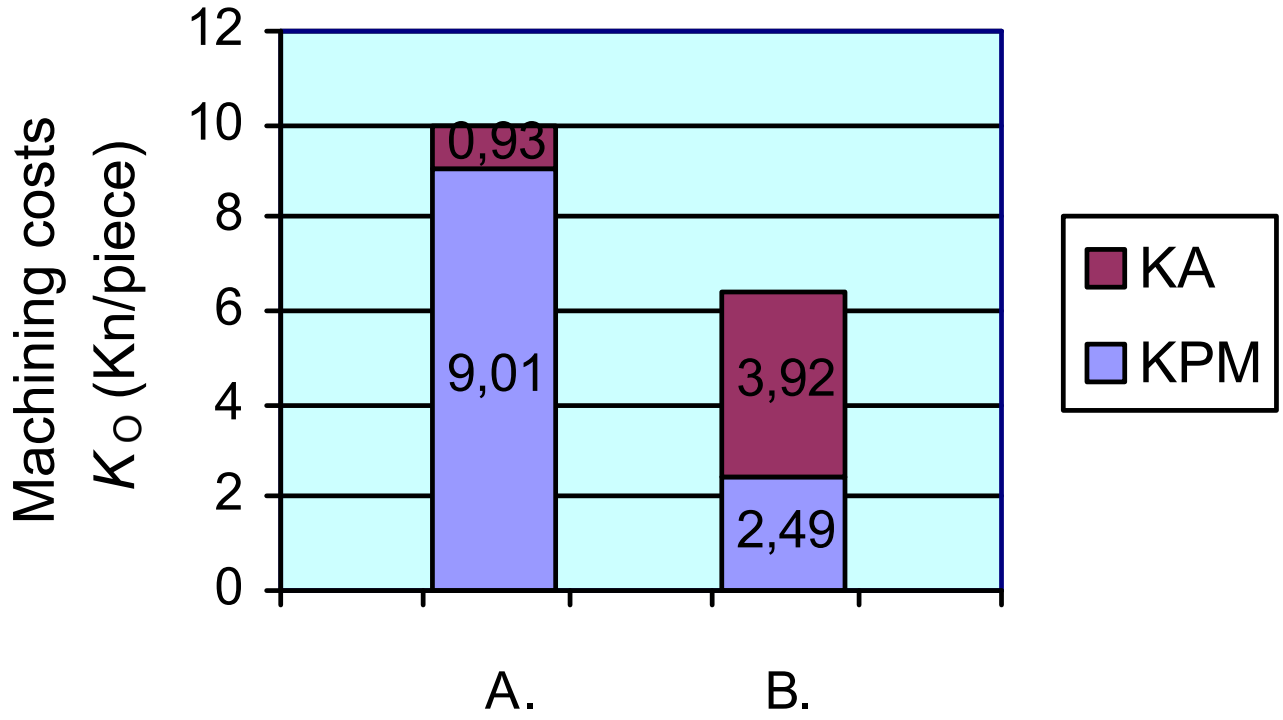
TEST RESULTS AT DRILLING

The effects given by using of the new cutting tools at drilling:

- Machining costs lower by 3,53 Kn/piece or 35,51 %
- Effective productivity greater by 53 piece/h or 265 %
- Workpiece quality - better

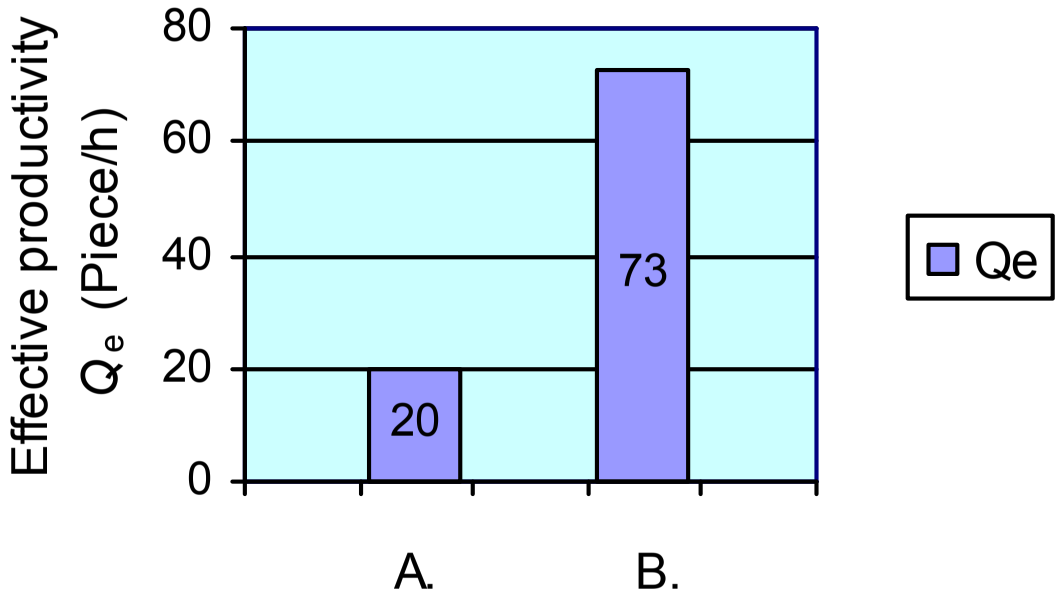
HISTOGRAM OF MACHINING COSTS AT DRILLING

A – Existing cutting tools **B – New cutting tools**



HISTOGRAM OF EFFECTIVE PRODUCTIVITY AT DRILLING

A – Existing cutting tool **B – New cutting tool**



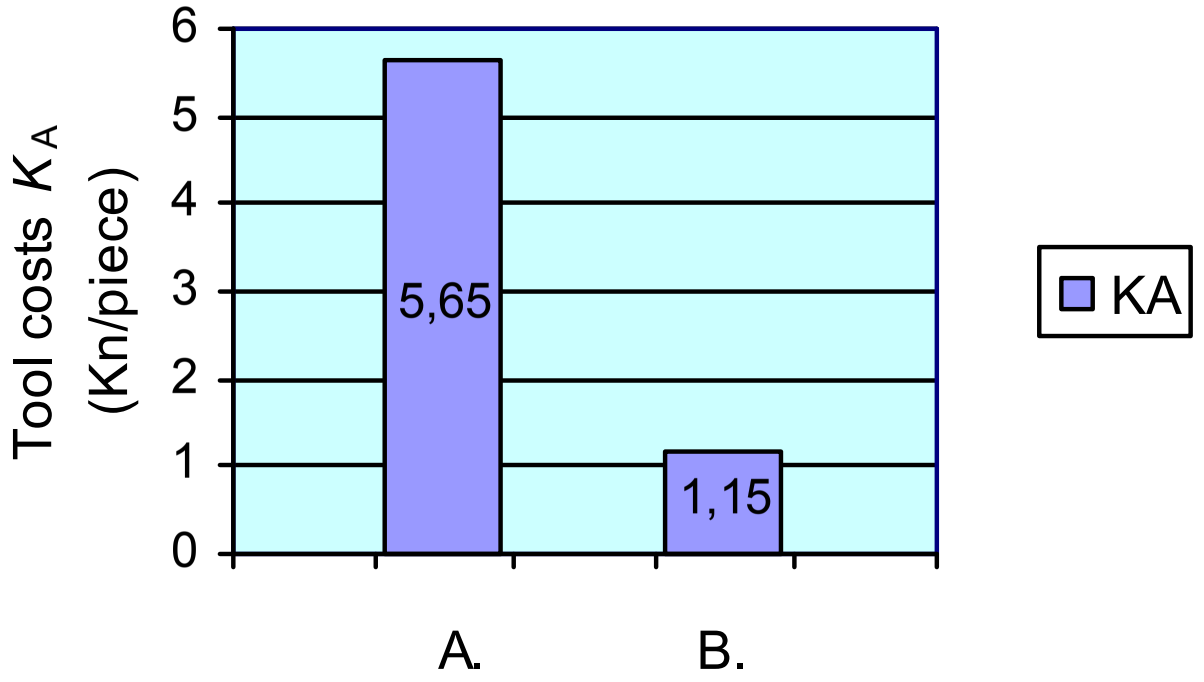
TEST RESULTS AT FACE MILLING

The effects given by using of the new tools at milling:

- Machining costs: Lower by 4,50 Kn/piece or 79,6 %
- Tool life: Longer by 133 %
- Workpiece quality: Better (measure stability)
- Productivity: Approximately the same (because the cutting data are the same).

HISTOGRAM OF TOOL COSTS AT FACE MILLING

A – Existing cutting tool **B – New cutting tool**



INVESTMENT PROFITABILITY (Break Even Point)

At drilling:

Cost function & Savings function (straight lines)

$F_T = A_1 \cdot X + B_1 = f(X)$ ..... Cost function

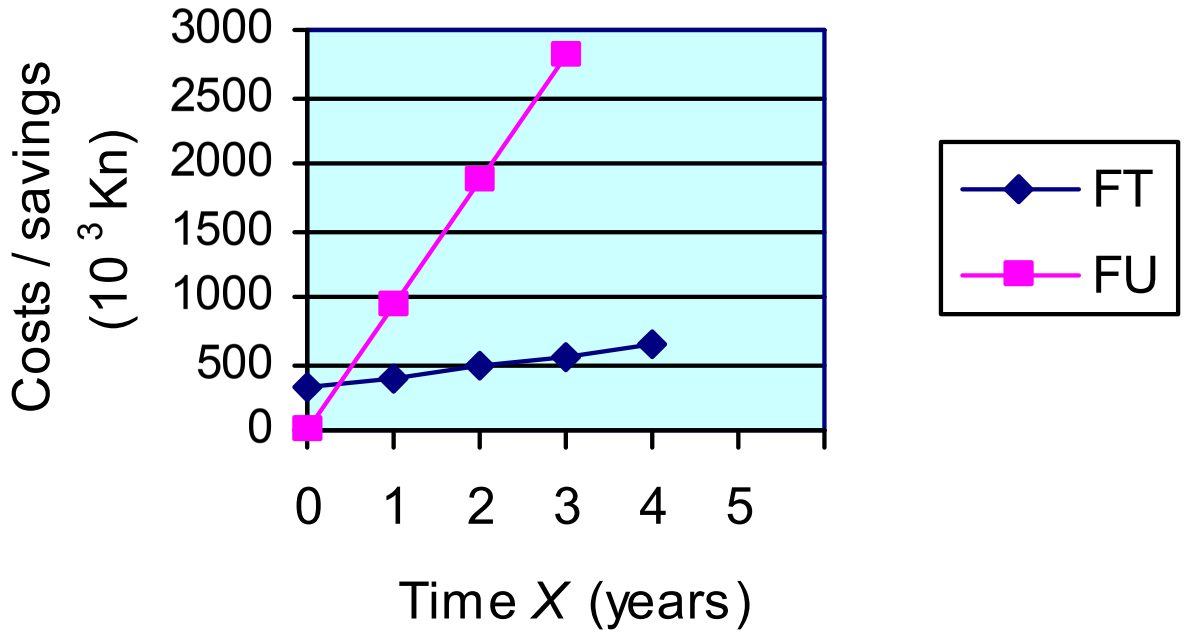
$F_T = 79272{,}5 \cdot X + 317090$

$F_U = \Delta K_1 \cdot X = f(X)$ ..... Savings function

$F_U = 931920 \cdot X$

INVESTMENT PROFITABILITY (Break Even Point)

New drilling tools: X_{KB} = 0,372 years = 4,5 months



INVESTMENT PROFITABILITY (Break Even Point)

At face milling:

Cost function & Savings function (straight lines)

$F_T = A_2 \cdot X + B_2 = f(X)$ ..... Cost function

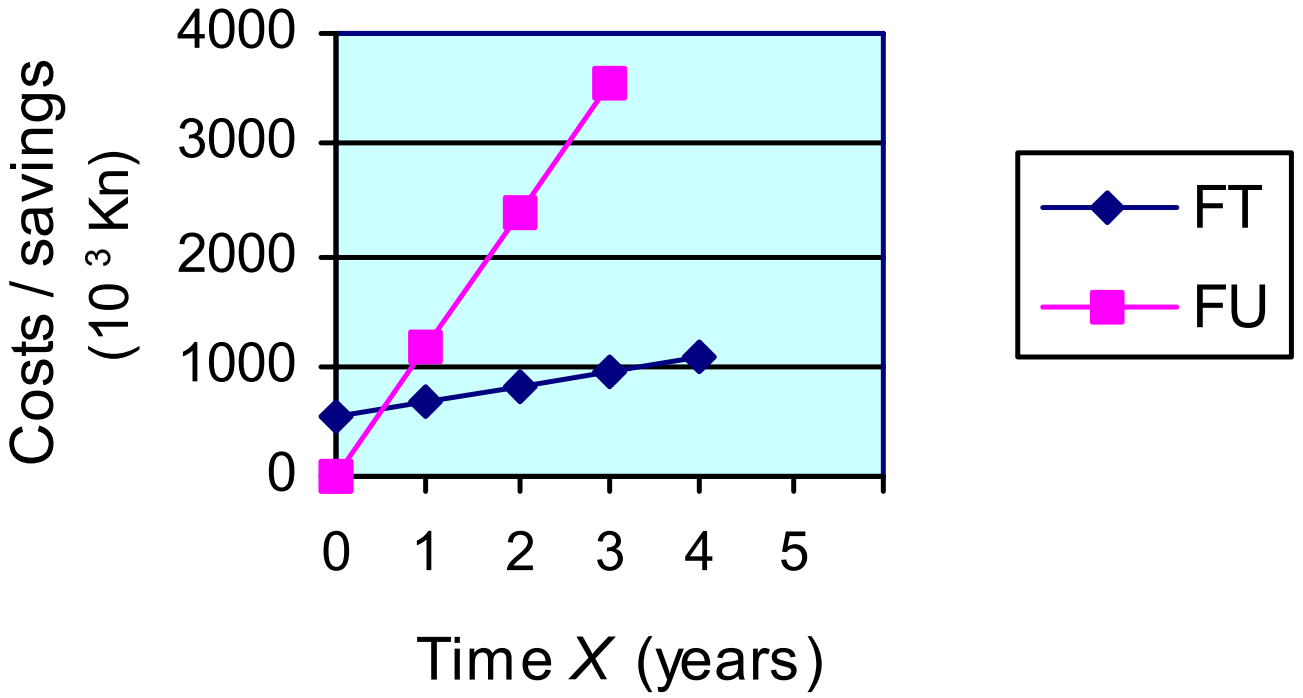
$F_T = 137012 \cdot X + 548049$

$F_U = \Delta K_2 \cdot X = f(X)$ ..... Savings function

$F_U = 1188000 \cdot X$

INVESTMENT PROFITABILITY (Break Even Point)

New drilling tools: X_{KB} = 0,521 years = 6,3 months



CONCLUSION

By selecting & using of the modern new cutting tools the manifold effects were obtained:

- **At drilling: Effective productivity increased by 72 %, machining costs by 35 % lower and machining quality and reliability were significantly increased.**
- **At milling: Productivity remained the same, machining costs lower by 79,6 %, tool life longer by 133 % and the machining quality better.**
- **Total savings per one year: 2,119.920,00 Kn (286.475 €)**
- **Overall investment / year: 865.139,00 Kn (118.512 €)**
- **Investment profitability in new cutting tools was achieved:**
  - **at drilling in 4,5 months**
  - **at milling in 6,3 months**