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1. Initial situation & target

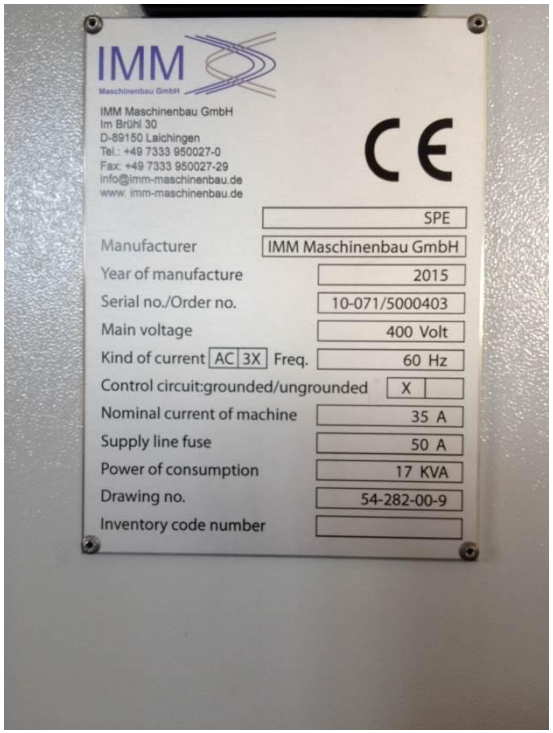
Initital situation:

GTTC operate several 5-axis milling machines for airfoil milling. Followed by this milling process is a tedious and time consuming manual belt polishing process

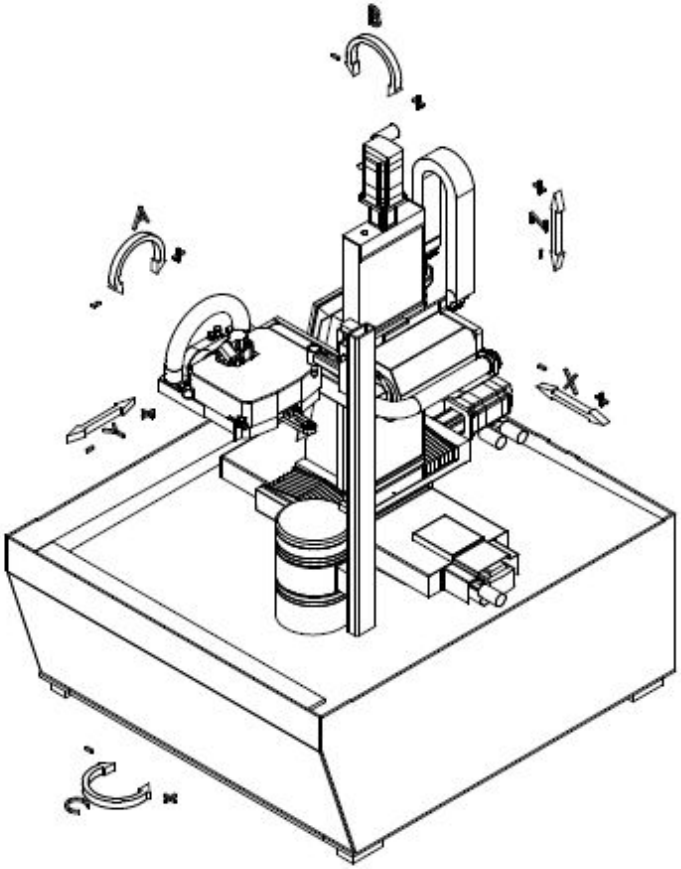
Target:

-Reduction of manual polishing operations
-Increase of milling capacity through balancing of the processes
-Increase of quality of blades
-Increase of accuracy of blades
-Zero scrap

2. Machine used for process presentation



3. Axis description of SPE machine



4. Recommended tools for GTTC

Based on the demonstration with the blade 146E1705 and your parts range we recommend the following standard contact wheel configuration for your SPE

Diameter 25 mm

Diameter 35 mm

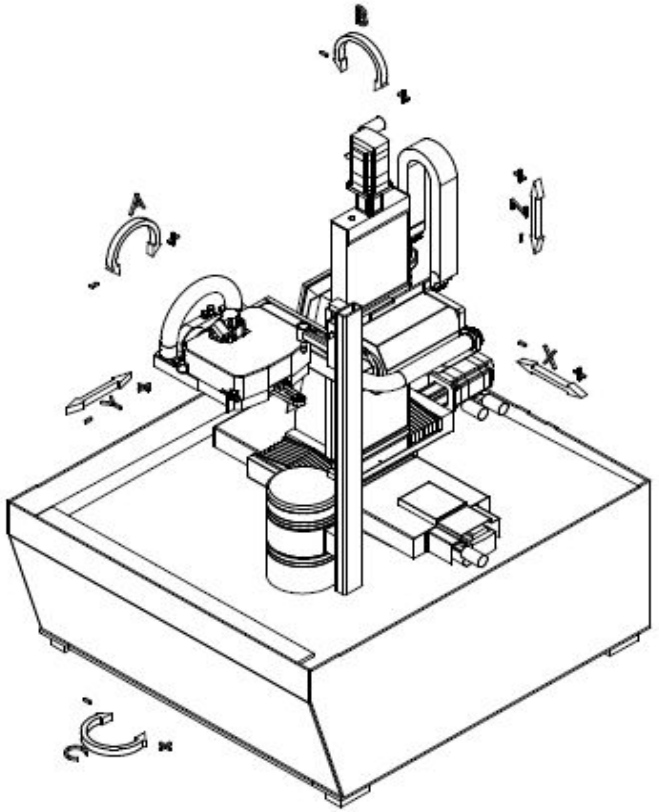
Diameter 50 mm

Recommended abrasive belt:
Maker: VSM
Type: KK772J
Grit: P800 or P600 depending on milling roughness

5. Process paramter description

The 3 CNC process paramters available for the SPE process are:

1. Feed rate (F)
2. Pressure (H1)
3. Cutting speed (S)
4. Tool path step over



6. Process report

Process report										
Customer:	GTTC, Monterrey, MX									
Date:	24.03.2015									
Machine:	SPE, machine # 10-071									
Blade:	Vane Compressor Stator Stage 16 146E1705									
IMM engineer:	Dominik Dietterich									
Programmer:	Markus Pingen									
Blade 1 - 3 were used for process setup and definition of process paramters Feed, Pressure, Cutting Speed and step over.										
Blade 4	Feed F	Pressure H	Speed S	Step over	Result Ra radially	Result Ra axially	Belt	Grit size	New or same belt from previous cycle	Process time
Concave	7000	3000	5000	0,8 mm	0,35	0,46	VSM KK772J	P800	New	01:31
Convex	7000	3000	5000	0,6 mm	0,3	0,57	"	"	Same	01:58
LE	5000	1500	800	0,25 mm	N/A	N/A	"	"	Same	00:45
TE	5000	1500	800	0,15 mm	N/A	N/A	"	"	Same	00:41
									Total process time, unoptimized:	04:55
Comment:	Overall result o.k. On the convex the surface of TE radius and convex overlapped. This lead to a increased material removal in this area and tapering.									
Recommendation: Surfaces of TE radius and convex should not overlap.										
Written by: Nikolas Lehrke / IMM										

7. Movies of process

Q:\Angebote_MAB\2014\GTTC Mexico\SPE process demonstration March 24th 2015\GTTC Mexico SPE process Concave 146E1705.MTS

Q:\Angebote_MAB\2014\GTTC Mexico\SPE process demonstration March 24th 2015\GTTC Mexico SPE process Convex 146E1705.MTS

Q:\Angebote_MAB\2014\GTTC Mexico\SPE process demonstration March 24th 2015\GTTC Mexico SPE process LE 146E1705.MTS

Q:\Angebote_MAB\2014\GTTC Mexico\SPE process demonstration March 24th 2015\GTTC Mexico SPE process TE 146E1705.MTS

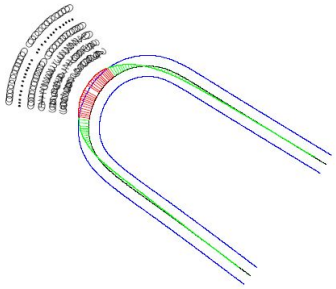
8. Example of process set-up

STEP 1

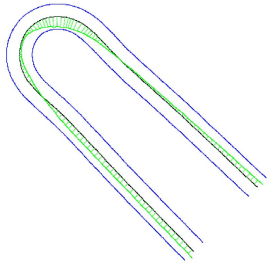
Define the ideal contact wheel, abrasive belt and process paramters (Feed, Pressure, Speed) to remove the milling scallops and reach the desired surface roughness in Ra/Rz

STEP 2

Measuring by CMM to verify dimensional accuracy



If required, correct process paramters to reach dimensional accuracy



STEP 3

Blade CNC programm is released for serial production.

No further CMM inspections required as the SPE process reamins highly consistent and offers a high R&R

9. Benefits of SPE process

Benefits
1. Reduction in milling time through increased pitch
2. Elimination of manual polishing
3. Rapid return of investment
4. Constant quality of blades
5. Impeccable surface quality of blades
6. Highly repeatable and reproducible process
7. Easy to programm
8. Easy to operate SPE machine tool
9. Proven technology within GE group of companies GE Oil & Gas and TGTC since 2008
10. Low running costs of SPE machines

10. Case study / Business case SPE invest for GTTC. 90000 blades type 146E1705 per year

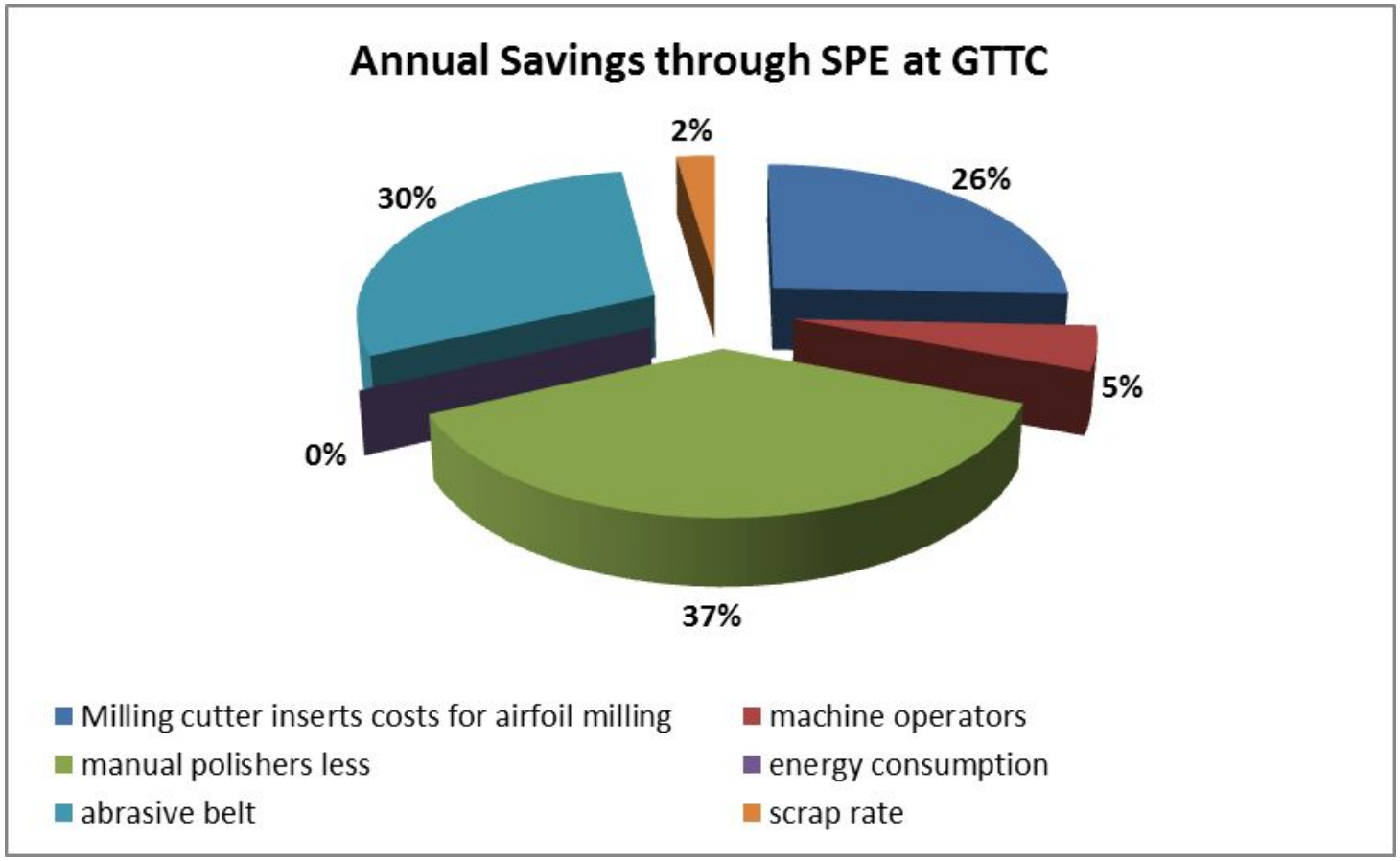
IMM Maschinenbau GmbH

Current situation without SPE:
11x Milling machines, 5-axis required for 90000 blades/annually. Milling pitch 3 mm
6x manual polishing machines,
Annual labor costs 15 milling machine operators, ca. 0,252 Mio. €
Annual labour costs, 18 hand polishers, ca. 0,302 Mio. € (three shift)
Annual abrasive belts costs (based on belt type 3M Trizact 953FA), ca. 0,234 Mio. €
Annual airfoil milling cutter insert costs (based on average SECO and Kennametal values) ca. 0,473 Mio. €
Annual energy costs for 11 milling machines, each 50-60 kVA consumption, ca.: ??? Mio. €

Situation with SPE:
7x Milling machines, 5-axis required for 90000 blades/annually. Milling pitch 6 mm
1x manual polishing machine for radius/transition area polishing,
Annual labor costs 10 milling machine operators, ca. 0,168 Mio. €
Annual labour costs, 3 hand polishers, ca. 0,05 Mio. € (three shift)
Annual abrasive belts costs (based on belt type VSM KK772J), ca. 0,036 Mio. €
Annual airfoil milling cutter insert costs (based on average SECO and Kennametal values) ca. 0,301 Mio. €
Annual energy costs for 7 milling machines 50 kVA and 3 SPE machines 16 kVA, ca.: ??? Mio. €

Savings:
Approx. Annual savings in labour costs, hand polishers: 0,251 Mio. €
Approx. Annual savings in labour costs, machine operators: 0,037 Mio. €
Approx. Annual savings in abrasive belts cost: 0,2 Mio. €
Approx. Annual savings in milling cutter inserts: 0,172 Mio. €
Approx. Annual savings through reduction of scrap rate: 0,016 Mio. €
Expected SPE invest (3 off): 1,28 Mio. €
Approx. ROI of SPE invest: 1,90 years, not including energy costs savings!

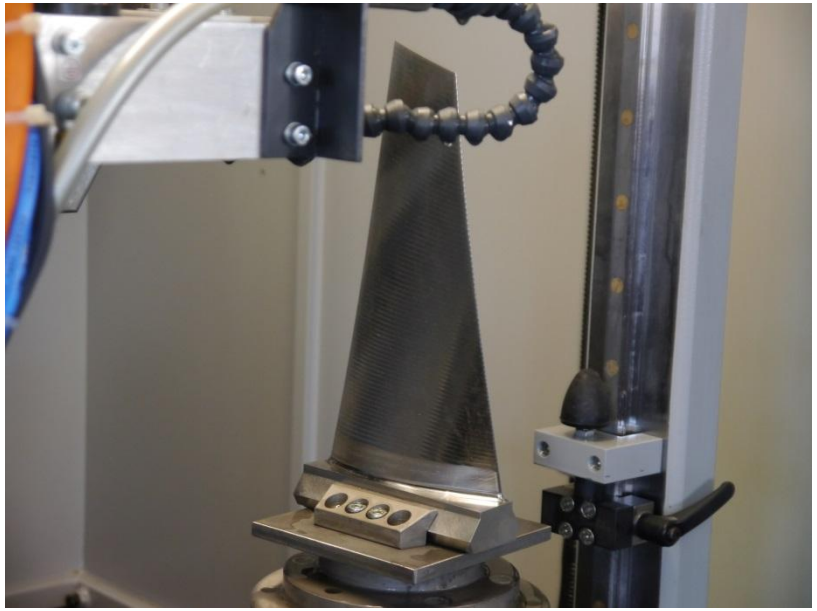
10. Case study / Business case SPE invest for GTTC. 90000 blades type 146E1705 per year

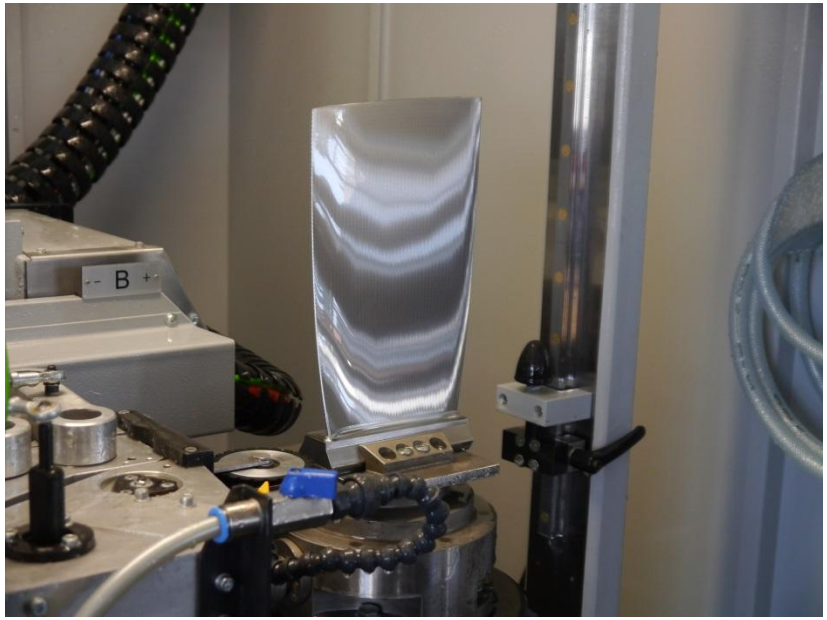


12. Further examples: GE Italy

12. Further examples: HITACHI

12. Further examples





Rotorblade Stage 2 Frame 7EA

Various other movies for presentation GTTC\SPE demo concave stage 2 frame 7EA.MTS

Various other movies for presentation GTTC\SPE demo convex and LE-TE stage 2 frame 7EA.MTS