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Recovery model for cyclical industrial work

(ISO TR 23076)

Dunajcsik Zoltán
MTM Hungária Egyesület
Chairman

The method

Methods
Time
Measurement

The **method** determines the **time** (and ergonomic load)

MTM – process language
A worldwide standard for the design of human work.

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Two aspects of MTM (Methods-Time Measurement)

Method

MTM process language

- Integral description, quantification and design of human work (labor) to set work standards
- Fundament to calculate ressources
- Globally accepted and approved performance and education standard

MTM norm (standard) performance is accepted globally and appreciated by social partners!

Organization

Assignment of non-profit industrial association

- Dissemination and R&D for MTM
- Globally uniform trainings and certificates

MTM ASSOCIATION e. V. / One-MTM

Training, software, consulting, research from a single source!

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Work measurement status quo vs ergonomic standards

In a competitive economic system productivity is a key driver.

The ISO 11228-1/2/3, ISO 11226 and ISO TR 12295 establish ergonomic recommendations for different manual handling tasks, repetitive movements and working postures. Work-related musculoskeletal disorders arise from a complex interaction of events that may accumulate over time.

Is Work Analysis sufficient to (re-)design efficient work systems (e.g. assembly line) in full compliance with recognized ergonomic standards?

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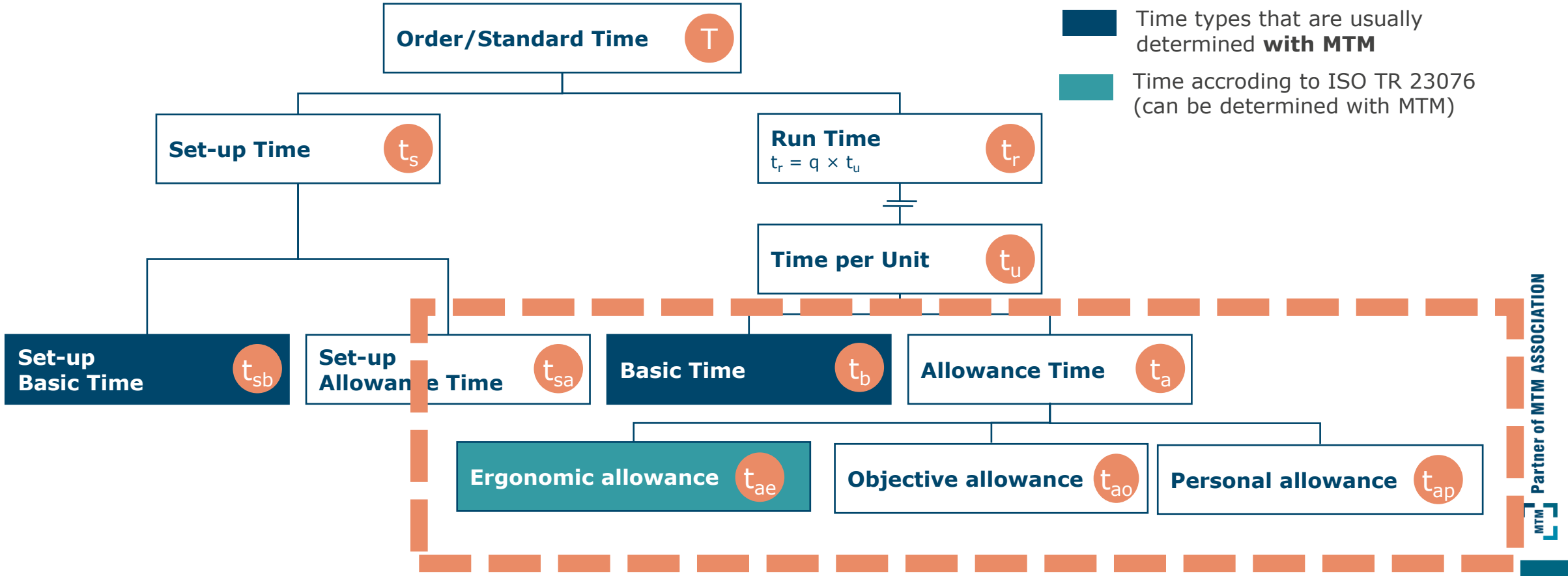
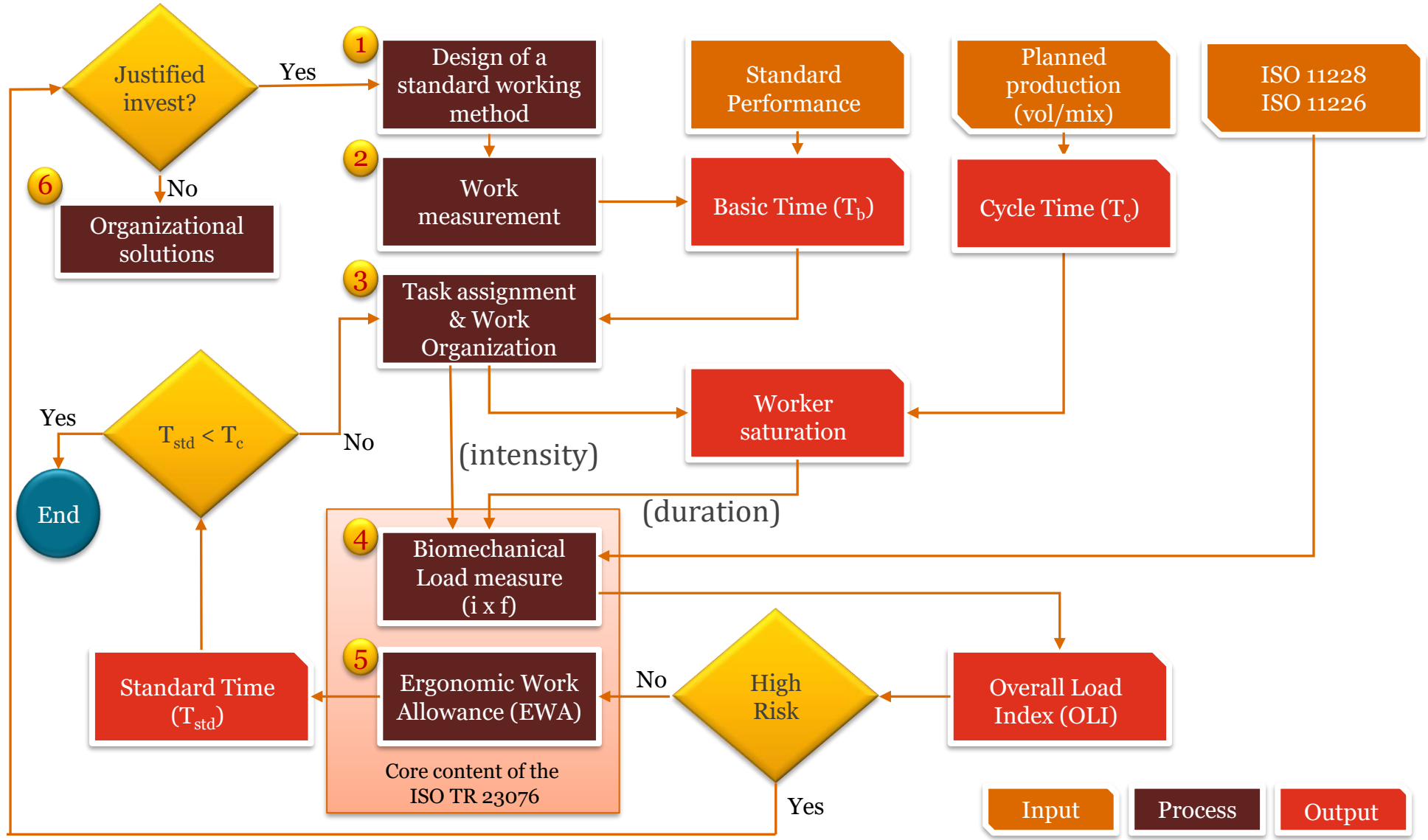
Order Time structure (Time Structure Scheme)



Standard Time setting process

(abstract from ISO TR 23076)



Step 2: Work Measurement

The definition of the Basic Time is built on the concept of standard work performance, strictly related to the much-discussed **fair day's work**. The standard work performance represents an effort level that could be easily maintained year in and year out by the worker with average physical capabilities **without in any way requiring him/her to draw upon his/her reserves of energy**. Working at standard performance brings the worker to **get to the end of the fair day's work without an excess of physical stress**.

The choice of a well-known level of standard performance is crucial for the process of designing safe and ergonomic work systems, especially as far as the upper limbs risk evaluation is concerned.

Comparison among different work performance scales

REFA	MTM	BASIC WF	BSI	BEDAUX
100,0	95,2	90,1	79,0	63,2
105,0	100,0	94,6	83,0	66,4
111,0	105,7	100,0	87,7	70,2
126,5	120,5	114,0	100,0	80,0
158,1	150,6	142,5	125,0	100,0

Source: IMD technical report

MTM Standard Performance

The MTM Norm Performance (MTM Standard Performance) of 100% is described by the MTM developers as the

> performance level which an average trained person can render in the long term without work fatigue.

The **MTM Standard Performance** is also called „**prototype meter** for **human labor**".

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Step 2: Work Measurement
Most adopted Work Analysis techniques

Stop-Watch

Stop-watch makes use of performance rating to ensure that times calculated are times for 'an **average qualified worker**' to carry out the work being measured. Since this average qualified worker is not actually observed, performance rating is used to modify what is observed and thus convert it to 'basic time'.

Stop-watch procedure

Stop watched time T_{sw}

Rated Performance P

Standard performance $\overline{P}$

Basic time $T_b = T_{sw} \times \frac{P}{\overline{P}}$

Example

Stop watched time $T_{sw} = 100$

Rated Performance $P = 90\%$

Standard performance $\overline{P} = 100\%$

Basic time $T_b = 100 \times \frac{90}{100} = 90$

Methods-Time Measurement (MTM)

MTM directly provides the basic times, without the need to rate the operator's working performance and, even more important, without the need to observe. This is the reason why MTM is strongly recommended for designing and planning a new work system, making possible a preventive approach to ergonomics.

Example (MTM-UAS technique)

MTM-UAS datacard:

Get and place			DT	1	2	3
			Code	TMU		
<= 1 daN	Easy	aprox.	AA	20	35	50
		loose	AB	30	45	60
		tight	AC	40	55	70
	Difficult	aprox.	AD	20	45	60
		loose	AE	30	55	70
		tight	AF	40	65	80
	Handful	aprox.	AG	40	65	80
> 1 to <= 8 daN		aprox.	AH	25	45	55
		loose	AJ	40	65	75
		tight	AK	50	75	85
> 8 to <= 22 daN		aprox.	AL	80	105	115
		loose	AM	95	120	130
		tight	AN	120	145	160
Place			Code	1	2	3
approximate			PA	10	20	25
loose			PB	20	30	35
tight			PC	30	40	45

	Code	TMU
Get & Place a screw to target and engage thread	AF 2	65
First motion to fasten the screw	ZA1	5
Further motions to fasten the screw	ZB1	10 x 2
	TOT	90

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Step 2: Work Measurement

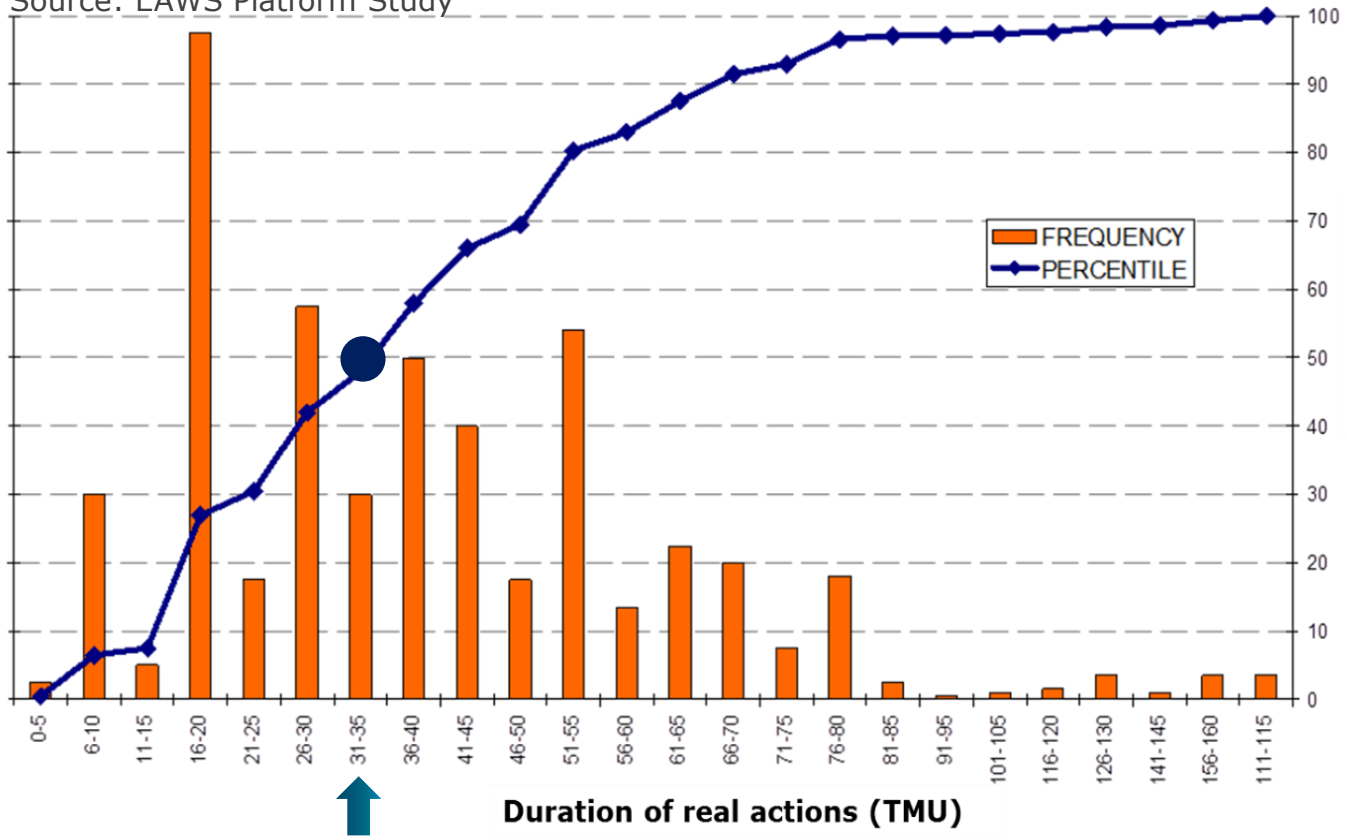
The Iso standard 11228-3 sets the maximum **number of actions** at 70 Technical Actions per minute.

Considering the durations shown in the picture, the average duration of one action @MTM norm performance is in the range of 31-35 TMU, equivalent to 1,2s and generating a frequency of 50 Real Actions per minute (equivalent approx. to 87 Technical Actions/min).

MTM norm is a good starting point … but it's not enough!

Statistics of action duration @MTM norm performance, (1 sec = 27,8 TMU)

Source: EAWS Platform Study



Work measurement is not enough

In the previous example, the basic time to fasten manually a screw with 3 motions is 90 TMU. Let's calculate how many screws could be fastened in one shift in a typical manufacturing plant:

Gross shift time = 480 min

Net working time = 420 min

Cycle time per unit = 90 TMU = 3,24 sec

Targeted production = 420 * 60 / 3,24 = **7.778 screws**

MTM-UAS analysis

	Code	TMU
Get & Place a screw to target and engage thread	AF 2	65
First motion to fasten the screw	ZA1	5
Further motions to fasten the screw	ZB1	10 x 2
	TOT	90

Do you think this would be safe (physically and mentally) for a human being?

Even worst, if the operator had to get the screw from the work area and place it to a position above his head level (awkward posture)!

Traditional Work Analysis is NOT ENOUGH

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MTM is the best work analysis solution, but we must consider further factors

Strenghts

Analytical language to describe working method

Recognized as a global standard

Standard qualification procedure (One-MTM network)

No need to rate work performance (objective)

Supports Work design

Gaps to fill

Direction of movements is missing

Postures are neglected (body and upper limbs)

Motion frequency is not considered

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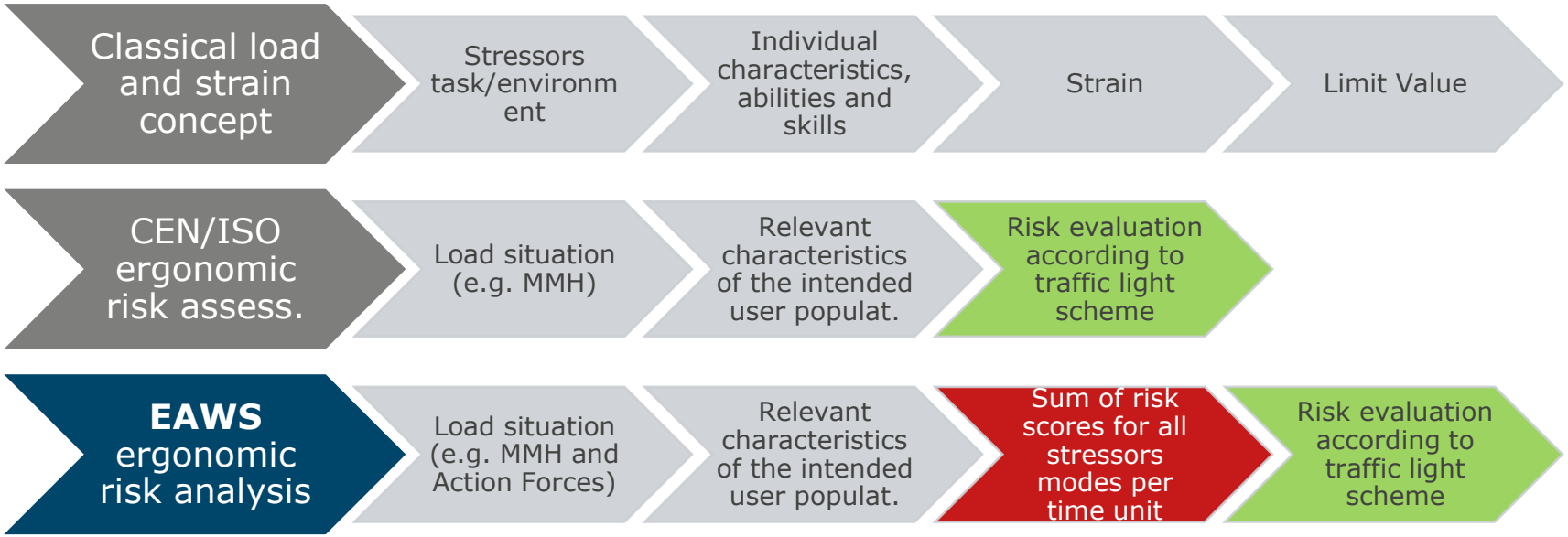
Step 4: Biomechanical Load

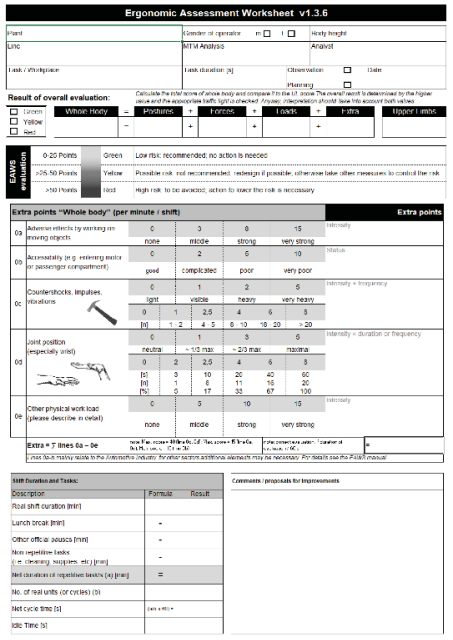
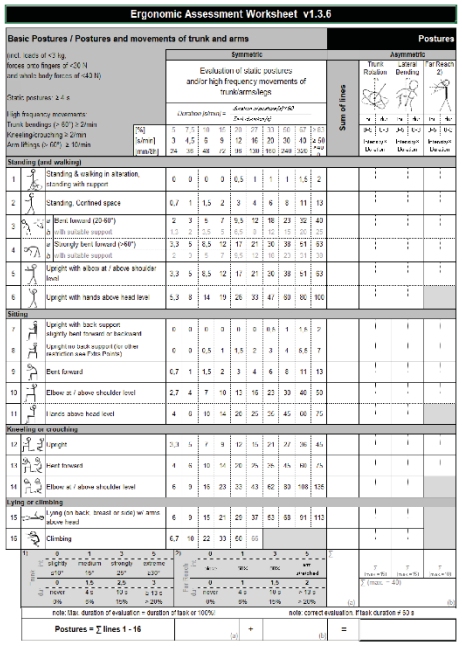
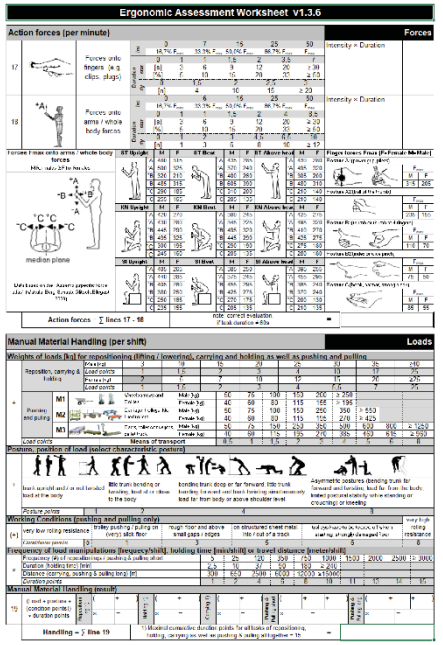
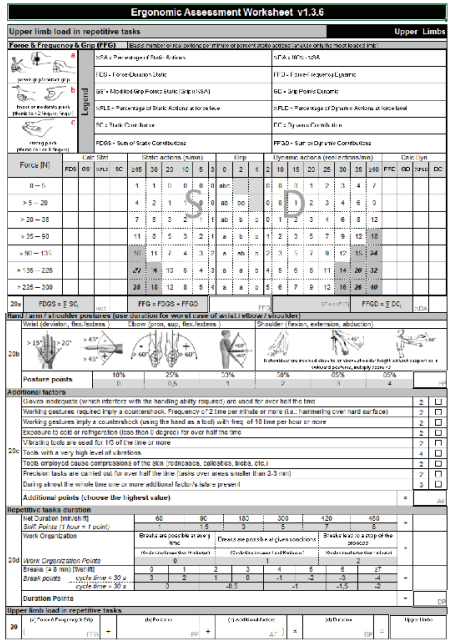
There are three factors that generate load: (1) physical factors like standing and use of force, (2) mental and cognitive factors like mental strain and eye strain, and (3) environmental and work factors like poor lighting, noise, and heat.

Load results from the intensity and duration of the work and the working conditions in which it is carried out. **The load describes the objective demand of work**, which is to be fulfilled in a period. It is independent from the individual who performs the activity.



EAWS – Ergonomic Assessment Work-Sheet

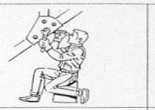
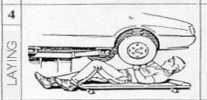
(ISO 11226) (ISO 11228-1/2) (ISO 11228-3)

Page 1 (Header)	Page 2 (Section 1)	Page 3 (Sections 2 and 3)	Page 4 (Section 4)
			
Overall Index and Extra Points	Body Postures	Action Forces and MMH	Upper Limbs repetitive movements

Step 5: Ergonomic Work Allowance

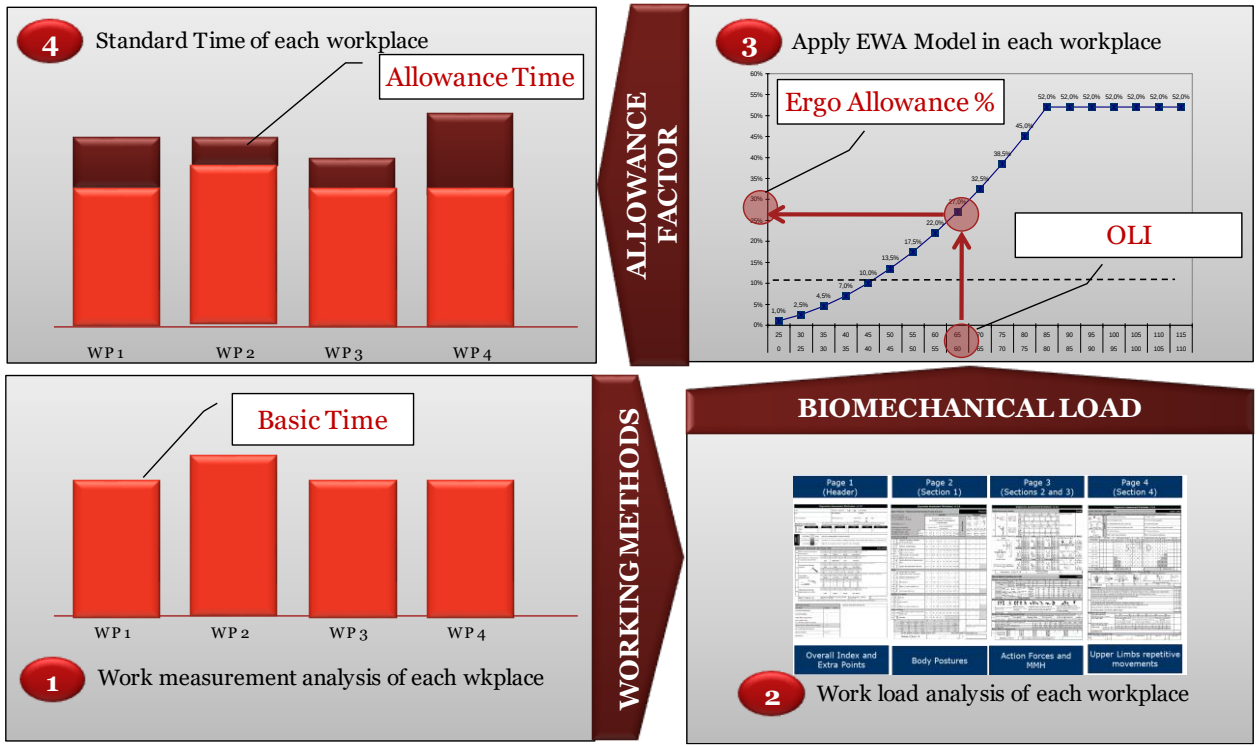
An allowance is the adjustment of the basic time to obtain the standard time for the purpose of covering the time spent for personal needs, recover from fatigue, and unavoidable delays. By providing a small increase of the basic time in each cycle, the "non-productive" time becomes planned and a worker can still be able to complete the assigned work. **The fatigue allowance is intended to cover the time that the worker should be given to overcome fatigue due to work related stress and conditions.**

Traditional single motion allowance

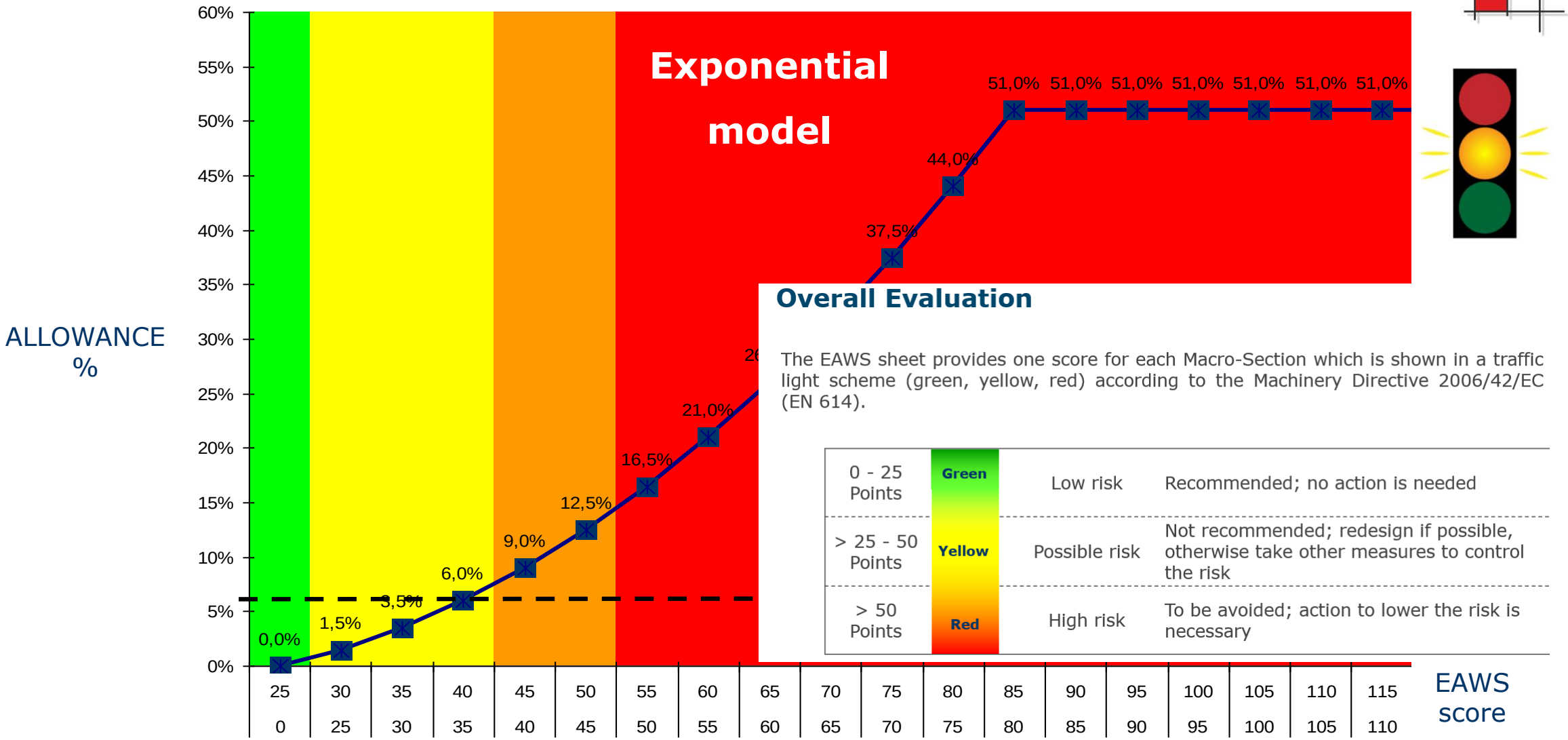
	Basic Body Posture		TRUNK AND UPPER LIMBS POSTURE	FORCE EXERTION OR WEIGHT L 0-2 Kg.	M 2-10 Kg.	P 10-20 Kg.	PP 20-25 Kg.
				ALLOWANCE IN %			
1	SITTING		A TRUNK AND UPPER LIMBS IN NORMAL POSTURE STATIONARY TRUNK	5	6 -7	-	-
			B TRUNK AND UPPER LIMBS IN AWKWARD POSTURE; STATIONARY TRUNK	7	8 - 10	-	-
2	STANDING		A TRUNK AND UPPER LIMBS IN NORMAL POSTURE; STATIONARY TRUNK	7	8 - 9	10 -12	13 - 17
			B TRUNK AND UPPER LIMBS IN NORMAL POSTURE; MOVING TRUNK	9	10 -12	13 - 15	16 - 20
			C TRUNK AND UPPER LIMBS IN AWKWARD POSTURE; STATIONARY TRUNK	11	12 - 14	15 - 18	19 - 23
			D TRUNK AND UPPER LIMBS IN AWKWARD POSTURE; MOVING TRUNK	13	14 - 16	17 - 20	21 - 25
3	KNEELING		A TRUNK AND UPPER LIMBS IN NORMAL POSTURE STATIONARY TRUNK	8	9 - 10	11 - 13	-
			B TRUNK AND UPPER LIMBS IN AWKWARD POSTURE; STATIONARY TRUNK	12	13 - 15	16 - 19	-
4	LAYING		A TRUNK AND UPPER LIMBS IN NORMAL POSTURE STATIONARY TRUNK	10	11 - 13	-	-
			B TRUNK AND UPPER LIMBS IN AWKWARD POSTURE; STATIONARY TRUNK	14	15 - 18	-	-
5	WALKING		A FLAT SURFACE, WITH OR WITHOUT LOAD	10	11 - 14	15 - 19	20 - 24
			B SLOPED SURFACE, WITH OR WITHOUT LOAD	13	14 - 17	18 - 22	23 - 27
			C PUSHING/PULLING TROLLEYS OR CARTS ON A FLAT SURFACE	11	12 - 15	16 - 20	21 - 25

NOTE: PERCENTAGES IN THIS TABLE DO NOT INCLUDE ANY ALLOWANCE FOR PHYSIOLOGICAL NEEDS (4%)

Ergonomic Work Allowance (EWA) model (ISO TR 23076)



Ergonomic Work Allowance model



Overall Evaluation

The EAWS sheet provides one score for each Macro-Section which is shown in a traffic light scheme (green, yellow, red) according to the Machinery Directive 2006/42/EC (EN 614).

0 - 25 Points	Green	Low risk	Recommended; no action is needed
> 25 - 50 Points	Yellow	Possible risk	Not recommended; redesign if possible, otherwise take other measures to control the risk
> 50 Points	Red	High risk	To be avoided; action to lower the risk is necessary

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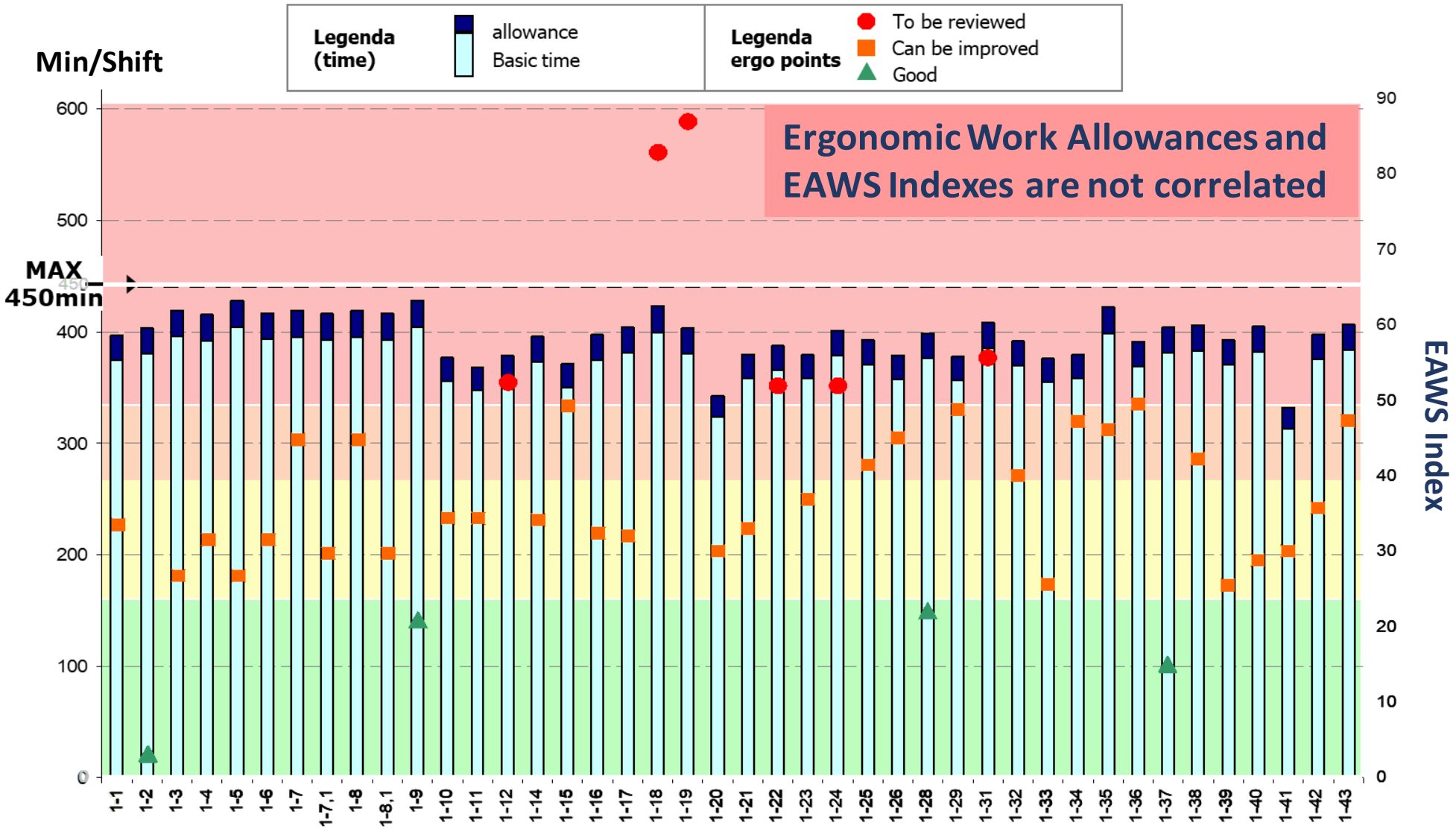
Case Study – Single motion allowance



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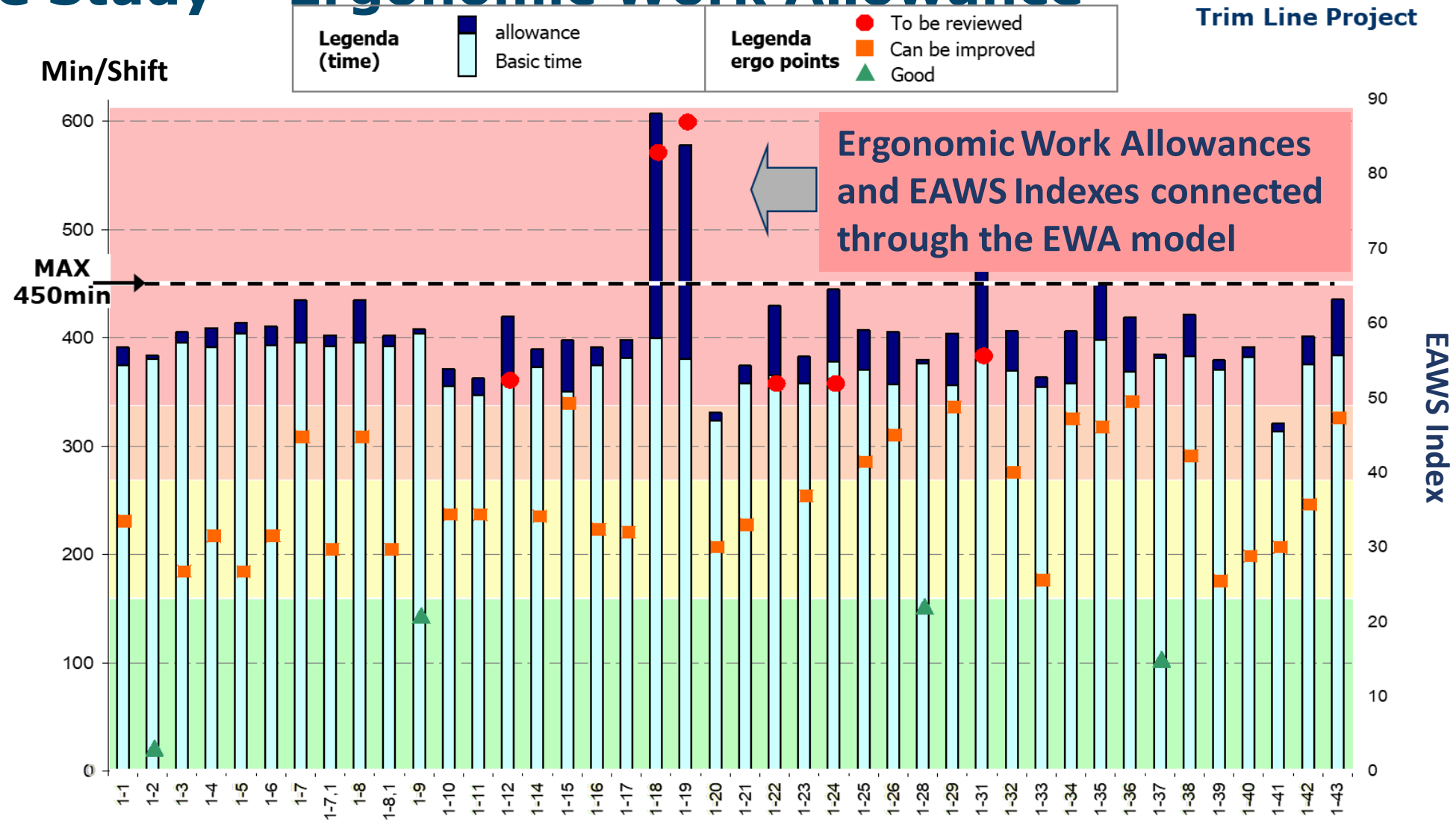
Case Study – Ergonomic Work Allowance



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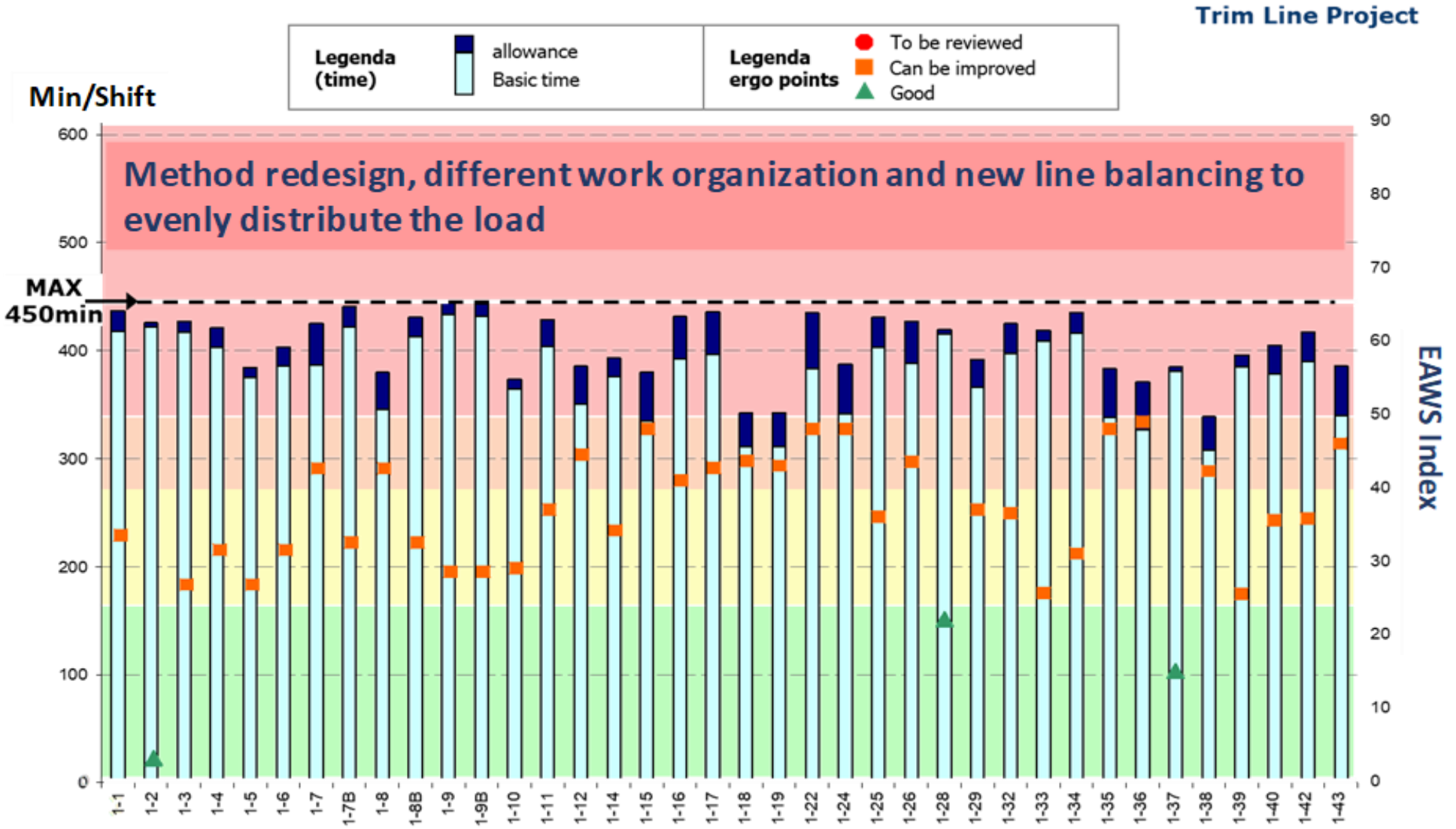
Case Study – Ergonomic Work Allowance and rebalancing



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Posture, Lighting, Working height

Source: 36th Summer University on Ergonomics

5 key messages

1. **Adopt EAWS, it is a comprehensive system to improve ergonomics**
2. **Use MTM to design the most efficient working method and set basic times on a fair and safe norm performance level**
3. **Adopt the Ergonomic Work Allowance model to balance the biomechanical load (see ISO TR 23076)**
4. **Run a Proof of Concept in your factory to validate and share the social and economical benefit**
5. **One-MTM network is ready to globally support the transformation**

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MTM HUNGÁRIA EGYESÜLET

2024.09.20.

BUGYI

Partner of MTM ASSOCIATION

Gyakorlati megoldások MTM használatával

08:40 **Regisztráció**

09:00 **Köszöntő, bevezetés**

Strauss Pierre
OBO BETTERMANN Hungary Kft., cégvezető - MTM Hungária Egyesület, elnökségi tag

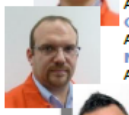
09:15 **MTM bevezetés az egri Boschnál**

- Standardizált munka variánsok megalkotása kormányoszlop gyártósoron
- Kormánytengely előszerelés optimalizálása
- MTM alkalmazása új projekt tervezésekor

Olajos István
Automotive Steering Column Kft., Folyamatmérnökségi csapatvezető
Szöllősi Ákos
Automotive Steering Column Kft., Folyamatmérnök

- István a Miskolci Egyetemen szerzett mérnöki diplomáját követően folyamatmérnökként szerzett nemzetközi és hazai tapasztalatot. Fejlesztési projektjei során csapatával az MTM-et is használja.
- Ákos 2018-óta dolgozik a vállalatnál, 2 éve folyammérnökként. MTM-Alkalmazóként az eljárást standardizálási és folyamatfejlesztési munkái során előszeretettel alkalmazza.

09:45 **A gyártási folyamat változáskövetése az Audinál**
MTM eljárás alkalmazása a villamos hajtások termékbefolyásolása során



- A változáskövetés oka és alkalmazásának módszerei az AUDI Hungáriánál
- A változáskövetést támogató rendszer részletes bemutatása gyakorlati példán keresztül
- Járműhajtás komplexitásvizsgálata és követése a „PEP" folyamán; termék és folyamatbefolyásolás

Höbe Norbert
Audi Hungária Zrt., az ipari mérnökség járműgyártási szakreferense, ergonómus
Gergely Bálint
Audi Hungária Zrt., Ipari mérnök
Makai Zoltán
Audi Hungária Zrt., Analízismérnök

- Norbert már 27 éve szervezi a járműgyártás folyamatát, 5 éve az ipari mérnökség szakmai koordinátoraként. Termékintegrációs IE projektkoordinátor.
- Bálint 2011 óta az Audi Hungária járműgyárnak ipari mérnökségén a hatékonyabb gyártási folyamatok megvalósítását segíti, többek között a Lean és az MTM használatával.
- Zoltán a SZIE-n Mérnöktanár-Gépészmérnök szakon diplomázott. A fejlesztés alatt álló villamos hajtások műszaki komplexitásának elemzésén dolgozik az Audi Kísérleti Motorgyártó Központban.

10:40 **Kávészünet**

11:10 **Csomagolási folyamatok fejlesztése a munkabetanítás módszeréve**

- Atlas Copco csomagolási folyamata a kezdetekkor (kihívások, megoldandó feladatok).
- A projekt főbb lépései, állomások közti munkamegosztás, új/beugró dolgozók, nehézségek a folyamat elsajátítása során.
- Eredmények a munkabetanítás módszertanával.

Holdampf Gábor
Atlas Copco Hungary Kft, Operations manager
Takács József
Atlas Copco Hungary Kft, Folyamatfejlesztő mérnök

- Gábor a SZIE-n gépészmérnöki, a BME-n MBA végzettséget szerzett. Termelés és mérnökség vezetőként a Lean és six sigma mellett az EIE képzésen szerzett tudásának is nagy hasznát veszi.
- József Győrben és a BME-n járműmérnöki diplomát szerzett. Az elmúlt 10 évben termelési vállalatoknál lean menedzsmenttel, és folyamatok fejlesztésével foglalkozatott.

11:40 **A termelési szervezet átalakítása a pótkocsik összeszerelésének példáján keresztül** (Transforming the production organization by using the example of the assembly of semitrailers)

- MTM bevezetése, bevezetés gyors sikere és termelékenység növekedés.
- Kapcsolódó szerevezési intézkedések, szervezeti változások

Sascha Kwiecinski
Brüggen GmbH (Member of Krone Group), gyárigazgató
Michael Leigers
Brüggen GmbH (Member of Krone Group), Műszaki folyamatirányítási vezető (Technical Processing director)

- Sascha vezetőként számos sikeres minőségi és műszaki folyamot irányított. Az elmúlt években a termelési folyamatok automatizálására fokuszál. Az MTM használatát sikerként értékeli.
- Michael ipari mérnökként diplomázott, majd folyamatszervezési és beruházási projekteket vezetett. Vezetőként a gyártmány- és gyártástervezésért, műszaki folyamatok irányításáért felel.

MTM HUNGÁRIA EG

2022.07.06.

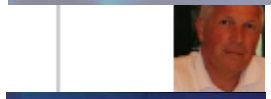
BUGYI

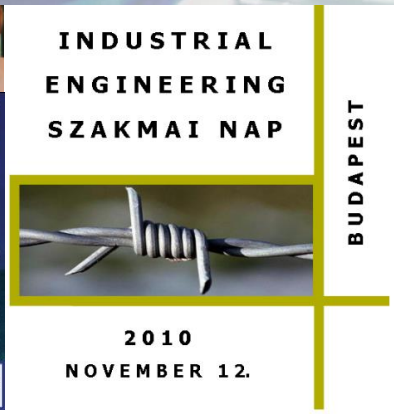
13:30 **Industrial Engineering at Audi Hungaria Vehicle Plant**

- Presentation of actual and planned IE system
- HWP cloud-based IE system details
- Planned usage of MTM-HWD (Human Work Design)

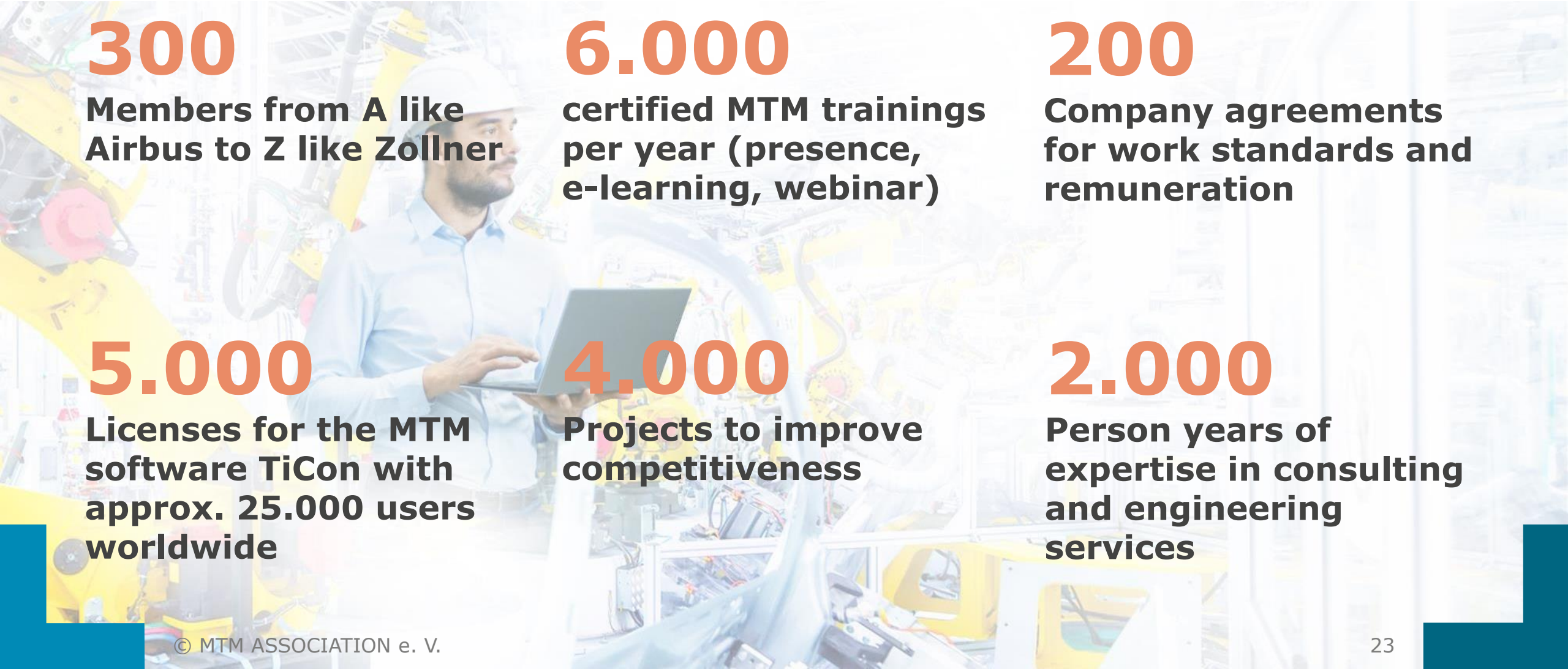
Gergely Bálint
Audi Hungária Zrt., Industrial engineer

- Graduated in Electrical Engineering at BMF (today Óbuda University), gain experience at Nokia Komárom and Philips at Győr.
- Since 2011, at the IE department of Audi Hungária automotive plant he is implementing more efficient manufacturing processes, by using Lean and





Figures – Data – Facts



300
Members from A like Airbus to Z like Zollner

6.000
certified MTM trainings per year (presence, e-learning, webinar)

200
Company agreements for work standards and remuneration

5.000
Licenses for the MTM software TiCon with approx. 25.000 users worldwide

4.000
Projects to improve competitiveness

2.000
Person years of expertise in consulting and engineering services

One-MTM References (extract)

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MTM
-
TIME TO WIN

Member companies

OBO BETTERMANN EZERSZÍN
Atlas Copco
beurer
Zollner
DUVENBECK THE CULTURE OF LOGISTICS
BOSCH

Further references

Audi Hungaria
STARTERS E-COMPONENTS GENERATORS AUTOMOTIVE
KNORR-BREMSE
flex LIVE SMARTER
FESTO
infineon
Rosenberger
VOLKSWAGEN GROUP SERVICES
Schneider Electric
HÜBNER
legrand
KnausTabbert
ÓBUDAI EGYETEM ÓBUDA UNIVERSITY
SICK Sensor Intelligence.
Veritas
SCHAEFFLER
Continental CONTITECH
FLAP COMPETENCE CENTER
felina
Mektec Group
Vincotech
KUEHNE+NAGEL
Rudolph Logistik Gruppe Alles erreichbar.
ADIENT
APTIV
ACPS AUTOMOTIVE
Mercedes-Benz
HBPO

Partner of MTM ASSOCIATION

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General manager
MTM Productivity Kft.

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