

Effective low volume production at Brunvoll

Knut Ola Tverdal - COO



AGENDA

- Brunvoll – facts and products
- Production facility
- Production strategy
- Planning characteristics and challenges
- Planning strategy
- Long-, medium- and short term planning
- Production monitoring
- Future focus areas

Brunvoll facts

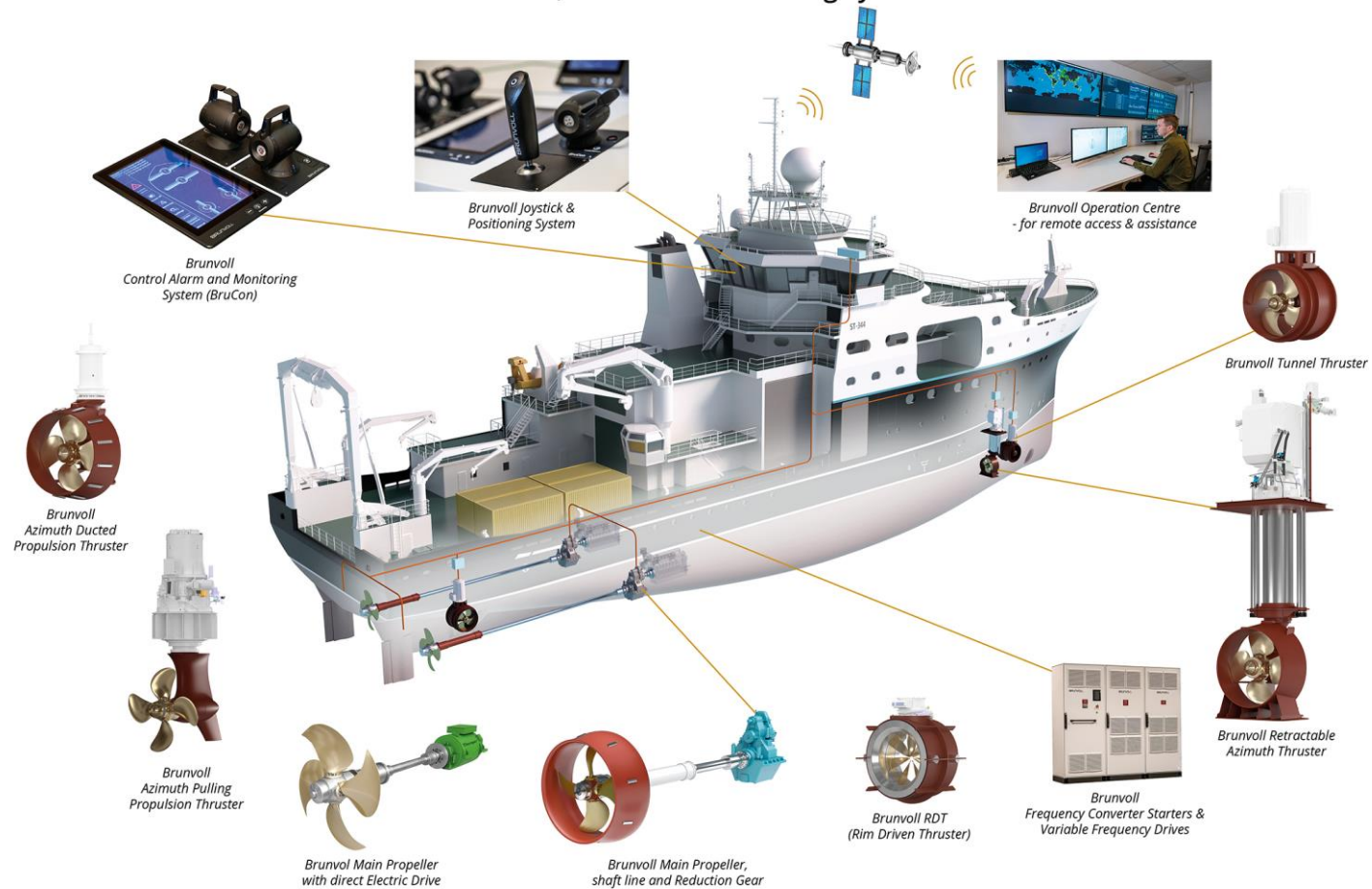
- Established in 1912
- Approx 510 employees
- Three production sites: Molde, Volda and Dalen
- 100 % owned by Brunvoll family
- Supplier of thruster and propulsion systems including control systems for ships
- More than 10.000 delivered products
- Turnover in 2021: approx. 1,1 BNOK (140 MUSD)
- Export rate approx. 80%



Product portfolio

Brunvoll trusted solutions for Propulsion and Manoeuvring

– complete with Propellers & Reduction Gears, Thrusters, Drives, Control, Alarm and Monitoring Systems



Brunvoll Complete System Solution 11-2020.indd

Made in Norway & Trusted World Wide



CP-Propellers

- Hub size: 520 – 2050 mm
- Propeller diameter: up to abt. 9000 mm
- Meet any class society notification and up to the strongest arctic ice class



Reduction gear boxes

- Vertical, Horizontal, Co-axial offsets
- Twin-in Single-out versions
- Two-Speed Gears
- Power range up to abt. 25000 kW
- Extensive program of PTO/PTI's



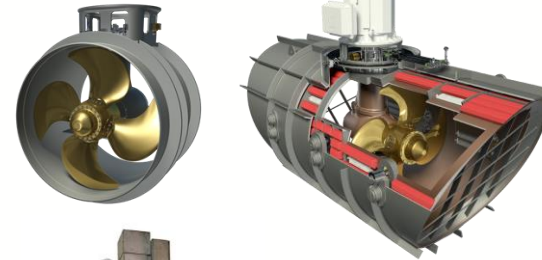
Azimuth Push Ducted & Azimuth Pull Open propulsion thruster

- Power range: 500 – 3500 kW
- L- or Z-drive
- Top gear with PTI/PTO



Retractable Azimuth Thrusters

- Propeller diameter: 1650 – 2900 mm
- Power range: 500 – 3800 kW



Tunnel Thrusters

- Propeller diameter: 850 – 3500 mm
- Power range: 75 – 3800 kW
- Low noise tunnel thrusters with noise reduction of 11-15 dB.



RDT- Rim Driven Thrusters

- Propeller diameter: 800 – 2100 mm
- Power range: 150 – 1400 kW

For more information: www.brunvoll.no

Production facility - Molde



Production facility

- Steel department
 - Processing of steel from plates to final products
 - Welding robots
 - Specialized semi-automated machines for mounting and welding
 - Part of the process is tact based
- Machinery department
 - Large specter of machining centers with pallet supply, focus on unmanned operation
 - Manually operated CNC machines
 - Robotization ongoing
- Surface treatment
 - Blasting and painting in three different shops
 - Large variance in painting system and production time
- Assembly department
 - Assembly done in different steps dependent on product
 - FAT (Factory acceptance testing) of complete product

Research projects at Brunvoll (ongoing and recently completed)

- EFFEKT – Efficient flow and reduced lead time in production
- RESPONS – methods to optimize handling of planning changes
- Auto QC – cooperation with suppliers about common online QC information
- MANUNET – cooperation in supplier network and increase of competence
- SEAOPS (Safe Energy efficient Autonomous Operations of Ships).
- GELY (Greener maritime activities: implementing the use of water based Environmentally acceptable Lubricants in the ship industry)
- CRP (Contra Rotating Propellers)
- Propeller forum Phase 3 (Computational Fluid Dynamics for the Design of Energy Efficient and Environment Friendly Marine Propulsors)
- FAST (Use of advanced sensor technology)
- eSeal (Expanding the use of Environmentally Acceptable Lubricants in the maritime industry)

Production strategy at Brunvoll

- Control of value chain
 - In house production
 - Production in Norway
- Automatization and robotization
 - Invest in advanced production equipment
 - Optimize interface personnel-machine
- Utilize the equipment
 - Off-line programming
 - Unmanned production
- Special focus on manufacturing of parts
 - Key to get production efficiency and control
 - Planning optimizing based on our characteristics



Planning characteristics

- New sales planning characteristics
 - ETO/CTO final products
 - Relatively «long» horizon (>4-5 months)
 - Complex product structure with a multiple level BOM
 - Both manufactured and purchased parts in each product
 - Manufacture parts with many production steps
 - Some purchased components have longer lead time from supplier than delivery time of finished product to Brunvoll's customer
 - Mix of ETO/MTO (project specific) and MTS (generic) parts are fabricated
- Service planning characteristics
 - Manufacturing of MTS (generic) parts
 - Short delivery time (< 2-4 weeks)

Planning challenges and goals

- Challenges
 - Large variations in load distribution between final products → creates shifting bottlenecks
 - Large uncertainty in processing times for ETO value streams (require slack)
 - Shared resources between new-sales and service for parts manufacturing
 - ERP system used for all planning activities
 - Lack of flexibility for operational planning
 - Marked trend is larger product mix and more customization
- Goals
 - Increased machine utilization
 - Shorter delivery times
 - Reduced WIP and stock

→ Planning is key to obtain goals

Planning strategy – three levels

1. Long-term sales planning horizon: > 6 months horizon
 - Avoid/identify bottle necks and secure availability of long-lead items
 1. Forecasting of long-lead items for new sales
 2. Capacity planning
 3. Forecasting of service sales
2. Medium-term planning horizon: 3-4 months before production start
 - Focus on getting all prerequisites for production ready
 1. Engineering and class approval
 2. Detailed capacity planning
 3. Availability of purchased materials – identify and solve potential delays
3. Short- term planning horizon: 2-4 weeks look out
 1. Testing and final assembly schedule
 2. Detailed manufacturing schedule for each resource
 3. Focus on specific items not ready for each assembly
 4. Detailed production monitoring
 5. Fixed dates for final testing (including external customers visiting for FAT)

Long-term planning: Bottleneck identification

- Scenario planning
 - Will it be possible to add another Thruster of a certain type in a specific week?

General\External

RESPONS: Rough-Cut Capacity Planning (RCCP) version 3 with Templates

Skjul ikke planlagte resurser

Planning Horizon Uker

52

› Kjør beregning

Template Name

TEM200610-COMP AR115LNC 2900 13/43 W19A

Type

AZ

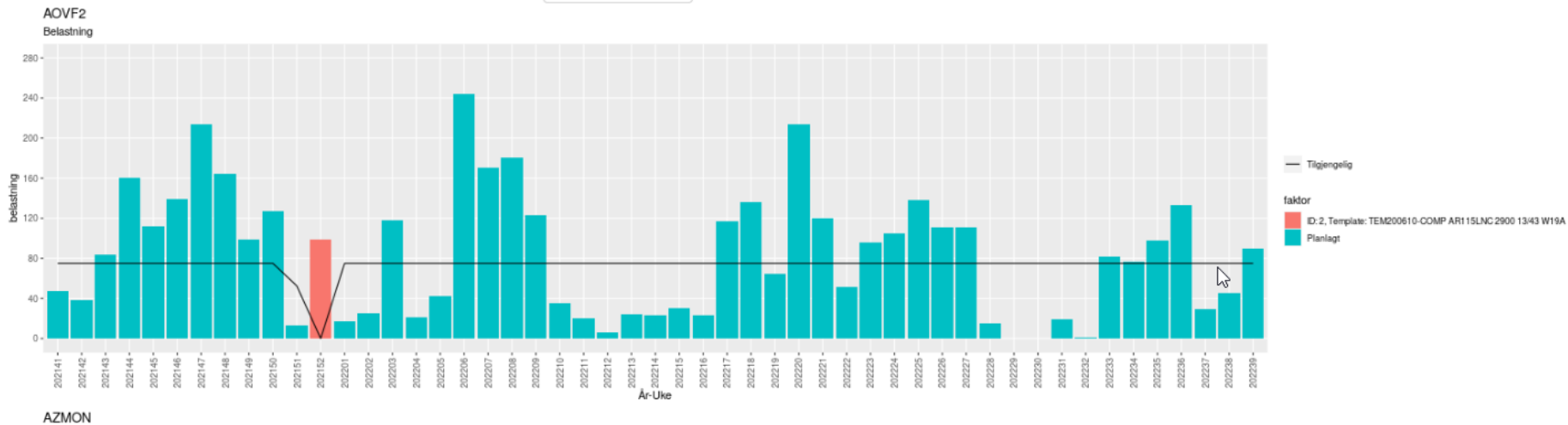
Finish week

202152

+ Legg til Template

Template Planlagt, selekter for fjerning

id: 2, Template name: TEM200610-COMP AR115LNC 2900 13/43 W19A, Template type: AZ, Ferdig: 202152, Time distribution: 1,1,2,2,2,1



Long-term planning: Forecast

- Long-lead items for new-sales
 - Kit for each product including all «standard» long lead items
 - Forecast added in ERP system to trigger purchase

- Aftermarket forecast

- Forecast method selected based on item value, lead time, sales volumes and sales frequency
- Tool for identifying forecast method and volumes per item developed by SINTEF in Respons project.
- Categories for forecast method
 - High- runners
 - Infrequent sales volume
 - Low-value items

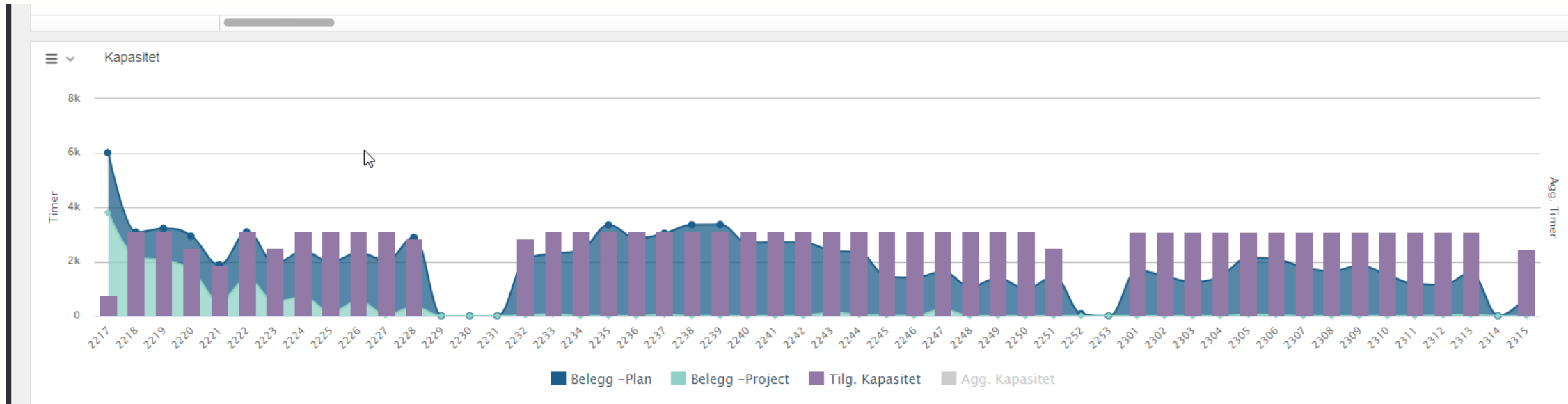
Virksomhetsenhet: 001
Produkt: TLK100001 / MPM AR115 Long Lead Items Kit
Dato/Utgave: 220428 / Prdstrukt Klasse

Brak

Snr /	Ope /	Fr dat /	Matnr/Plangr	Antall / Stykkid	Enh / Pitan	Aty / Operasjonsbenevning	Art arv /	Sts /	Rev /	Benevnelse /	element
0001			038202	1 ST	K		0	20		RULLELAGER SFERISK MLASESPOR	
0002			038013	1 ST	K		0	20		RULLELAGER KONISK	
0003			038015	1 ST	K		0	20		RULLELAGER KONISK	
0004			038200	1 ST	K		0	20		RULLELAGER SFERISK	
0005			038201	1 ST	K		0	20		RULLELAGER KONISK	
0006			038203	1 ST	K		0	20		RULLELAGER KONISK	
0007			109846	1 ST	K		0	20		RULLELAGER SFERISK	
0008			109847	1 ST	K		0	20		RULLELAGER KONISK DOBBELT	
0009			109422	1 ST	F		0	20		STAMMEHUS 115	
0010			109432	1 ST	F		0	20		STAMME STAMMEENHET 115	
0011			109945	3 ST	K		0	20		PLANETGIR M/BREMS 115	
0012			109349	1 ST	F		0	20		LØFTEÅK EMNE AZIMUTHENHET 115C	
0014			110604	1 ST	K		0	20		RULLELAGER SFERISK	
0015			038272	1 ST	K		0	20		FLENS PROPELL EMNE 115	
0016			038261	1 ST	F		0	20		PROPELLAKSEL EMNE 115	
0017			110055	1 ST	F		0	20		FLENS EMNE STAMMEENHET 115	

Medium term-planning: Capacity

- Detailed capacity plans to identify bottlenecks



Medium term-planning: Identify material shortages

- Analysis across all BOMs in specific project to identify potential material shortages

Product Planner

Apps E-post – Kagnar.Ho... BBS SFA Filer – OneDrive Sharepoint Innkjøp BBS Jira Complete Control Brunvoll nyheter Nyheter - Metal Su... BI t

Division: 010 Brunvoll AS

Mankofilter: Innkjøpt, stat<=29,est bal<0

Projectfilter: 35244 - 2050

Productfilter:

Fra dato: 22.1.2021

>> Expand all

Level	M	Project	Eleme...	Order Number	Status	Material	Material Name	Est. Bal...	Plan Date	Week											
										1..	1..	1..	1..	1..	1..	2..	2..	2..	2..		
0	>> 🛒	35244	2050	0000098629	22 (22)				2022-07-05												
1	🛒	35244	2050	0000098629	22	122918	THRUSTERSEKSJON U...	0.0	2022-07-05												
2	🛒	35244	2050	9155564	20	122920	UNDERVANSENHET U...	0.0	2022-06-29												
3	🛒	35244	2050	9155573	20	017290	PROPELLAKSEL DELSA...	0.0	2022-06-22												
4	🛒	35244	2050	9155579	20	002250	RULLELAGER KON. INN...	-29.0	2022-06-22												

Short-term planning horizon: Status on material

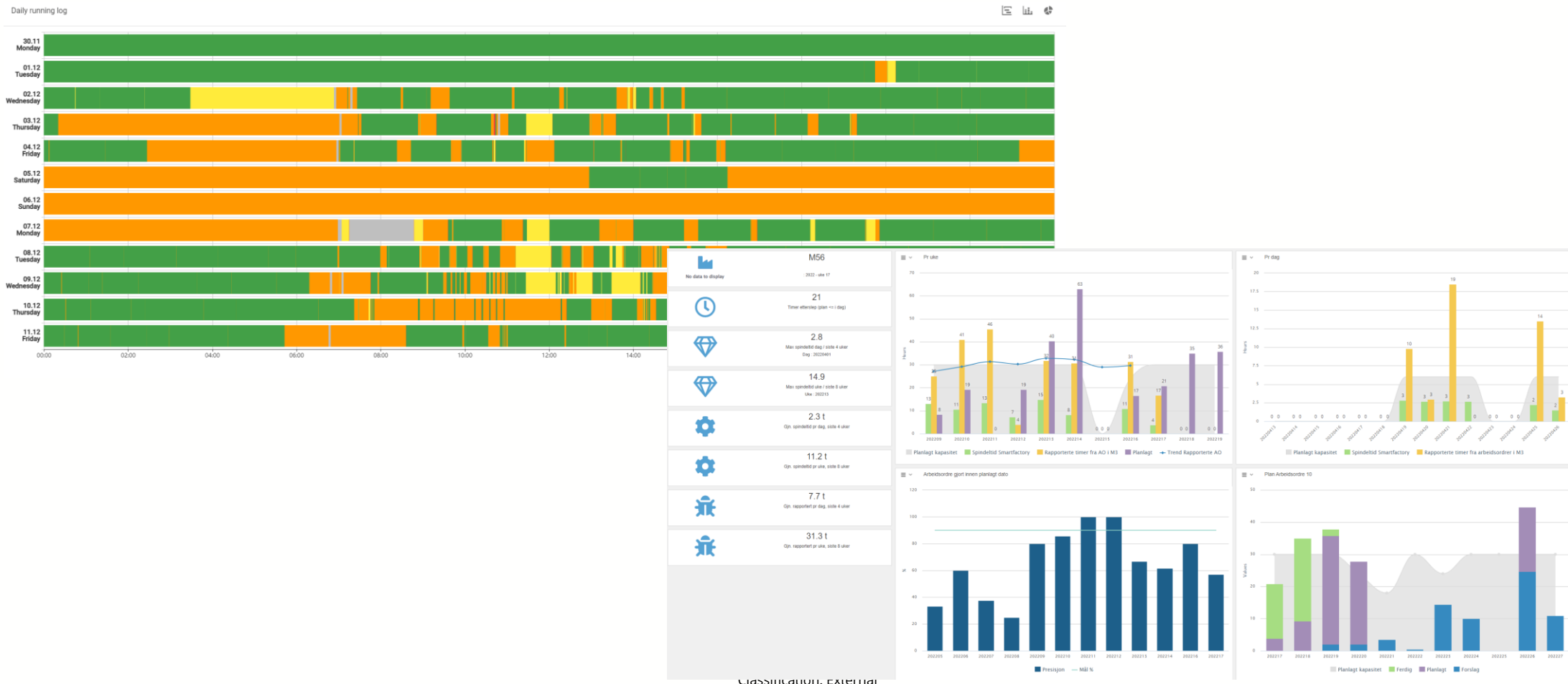
- Detailed status on material shortages for assembly

Project/Serial Number	Parts not ready	
- Frigitt for plukk	Flere Ordre 29	↓
+ 35315 - 2050 - 12029	0	1→
+ 35315 - 2054 - 12033	11	0↓
+ 34870 - 2050 - 12003	0	1→
+ 35304 A - 2051 - 12060	7	0↓
+ 35304 A - 2052 - 12061	5	0↓
+ 35264 - 2050 - 12111	5	0↓
+ 35264 - 2051 - 12112	7	0↓
- Ikke frigitt	Flere Ordre 65	↓
+ 35304 B - 2051 - 12069	11	0↓
+ 35304 B - 2052 - 12070	13	0↓
+ 35014 - 2050 - 12049	16	0↓
+ 35014 - 2051 - 12050	18	0↓
+ 35304 C - 2051 - 12073	19	0↓
+ 35304 C - 2052 - 12074	20	0↓

Part Number	Material Status	Qty Ok	Qty All	Operation
+ 111902 - DEKSEL GIRHUS UNDER KOMPL 115	22	0	1	0001244559 LAGERINN: 900 Lagerlegging av artikler
+ 116815 - PLUGG M26 X 1.5	22	0	1	Neste IO - 393668 / 35:
+ 120897 - GIRHUS UND SENTERD PU-UA 115	22	0	1	0001244581 M62: 200 Maskinere. Kontrollere deler
+ 120898 - GIRHUS UND STAGDEL PU-UA 115	22	0	1	0001244582 GRA: 700 Grade
+ 120905 - KAPSEL GIRHUS UNDERVANN 115	22	0	1	Neste AO - 0001247426 / 20: M55: 100 Maskinere. Ko
+ 121128 - GIRHUS UND FINNEDEL PU-UA 115	22	0	1	0001244481 M53: 100 Maskinere. Kontrollere deler
+ 121213 - BOSS PROPELL PU-UA115	22	0	1	0001244578 M59: 20 Maskinere. Kontrollere deler
+ 121357 - KAPSEL PROPELL PU-UA115	22	0	1	0001244575 M59: 10 Maskinere. Kontrollere deler
+ 121367 - ÅK BOSS PROPELL PU-UA115	22	0	1	0001244510 M55: 20 Maskinere. Kontrollere deler
+ 122227 - TAPPSKIVE PU-UA115	22	0	1	0001244988 M61: 100 Maskinere. Kontrollere deler
+ 122477 - DEKSEL PROPELL PU-UA115	22	0	1	0001244642 M50: 10 Maskinere. Kontrollere deler

Short term planning: Production monitoring

- Detailed logging of each machine
- Dashboard for each machine



Future improvement areas

- Further improve utilization of our production capacity
- Improve handling of product varieties
 - Product range will increase in the future
 - Improve first time production of articles
 - Simulate production off-line
- Handle load changes and avoid bottle necks
 - Earlier identification of problems
 - Increase flexibility; alternative production routing
 - Increase degree of unmanned production
- Evaluate planning system/method
 - Improve operational planning (short term planning)
 - Use APS (Advanced Planning System) in addition to ERP system
 - Further digitalization



Questions?

www.brunvoll.no