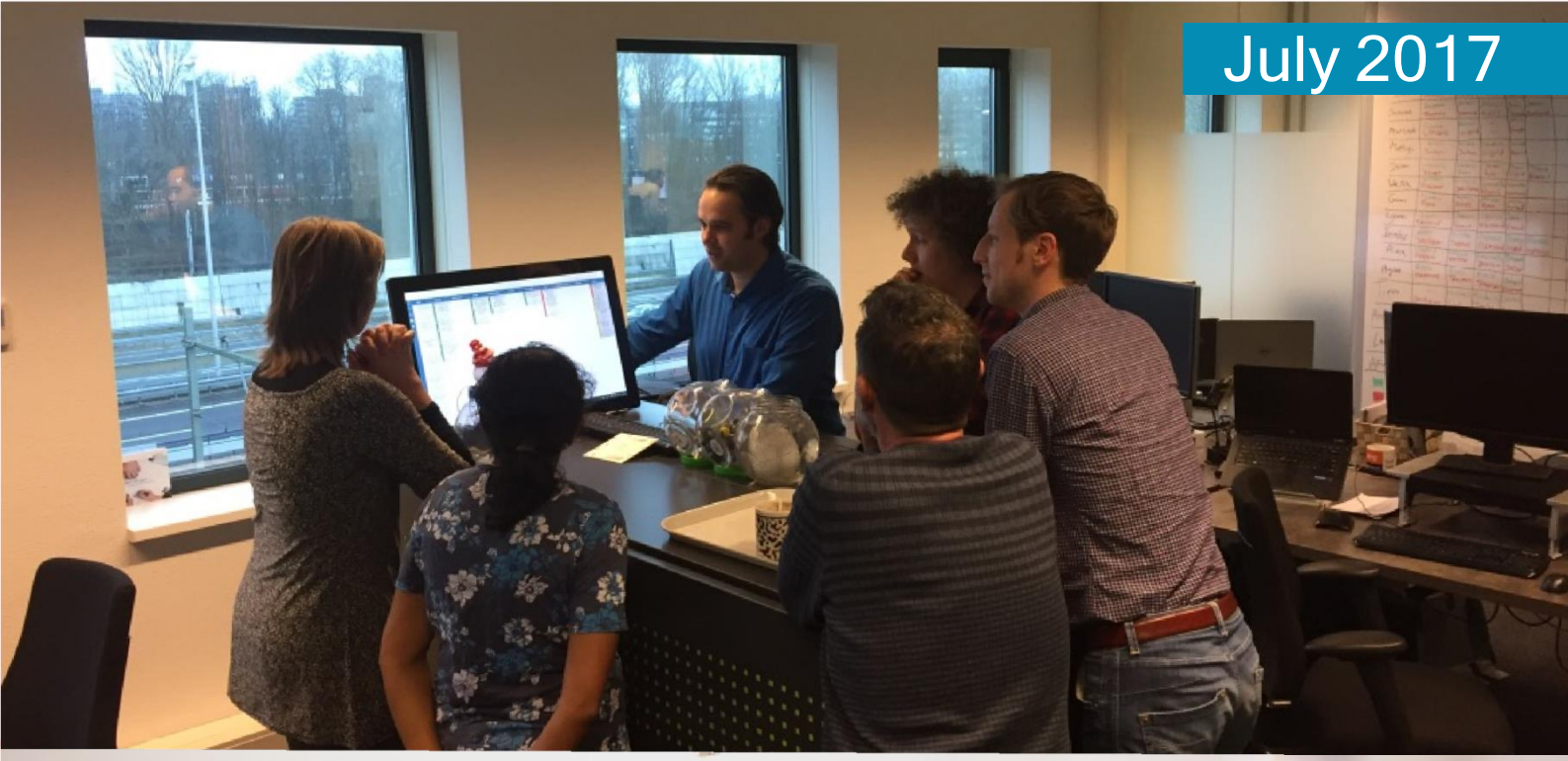


July 2017

Software Engineering consistently within Time, Scope and Budget…. Is that possible?

*On-time delivery at 90 % - the implementation of the **TameFlow approach** at ORTEC, Zoetermeer, The Netherlands*

Scrum, Kanban and Agile are now widely introduced in the technology & engineering world. They aim to increase the efficiency and productivity of technology or engineering departments in order to deliver more value and benefits to customers or users. Although many good results have been achieved, there are still several challenges to be tackled. Still, projects run into delays, requiring lead times that are too long causing customer or user dissatisfaction. Moreover, the balancing act between quality and on-time delivery is ever present, causing employees or team members to be exposed to varying priorities and need for multitasking. And above it all: the workload of engineering teams is already high or actually too high in many cases.

Software developer ORTEC based in Zoetermeer (www.ortec.com) also encountered these problems. Despite the introduction of new methods and insights like Agile and Scrum, their “backlog” remained high; the lead times were often too long causing customer dissatisfaction. Also, quality levels needed to be improved and team-members were exposed to high workloads.

It became evident that their problems had a logical cohesion and that solving these problems individually only meant fighting the symptoms.

It was acknowledged that applying the principles from the Theory of Constraints together with the TameFlow approach would provide a solution for eliminating these problems.

Variation and Interdependencies

In every production process and every system there is a natural variance: each step in a production process differs in processing & lead time, plus, it is virtually impossible that the same steps always require an equal amount of time.

This makes the production process outcome (read: the delivery date of the product) uncertain. Moreover, if there is interdependence between steps and people, the frequent consequence is that projects and tasks slow down whilst employees have to work on more than one task or project at the same time.

This means that more “work in progress” remains in the “system”, resulting in even longer lead times and an added distribution of focus and attention (multitasking). Task variation and task interdependency inevitably lead to longer lead & processing time, resulting in (significant) capacity loss.

Within the Theory of Constraints it is recognized that the output of each production process or system is determined by only one factor, namely the constraint or bottleneck. For this reason, it does not make sense to flood the system with work. One should only allow as much as the constraint is able to handle; while ensuring that the constraint will not run idle. The first is addressed through Work-in-Process (WIP) control, the second through buffer management. Together this is called Drum Buffer Rope.

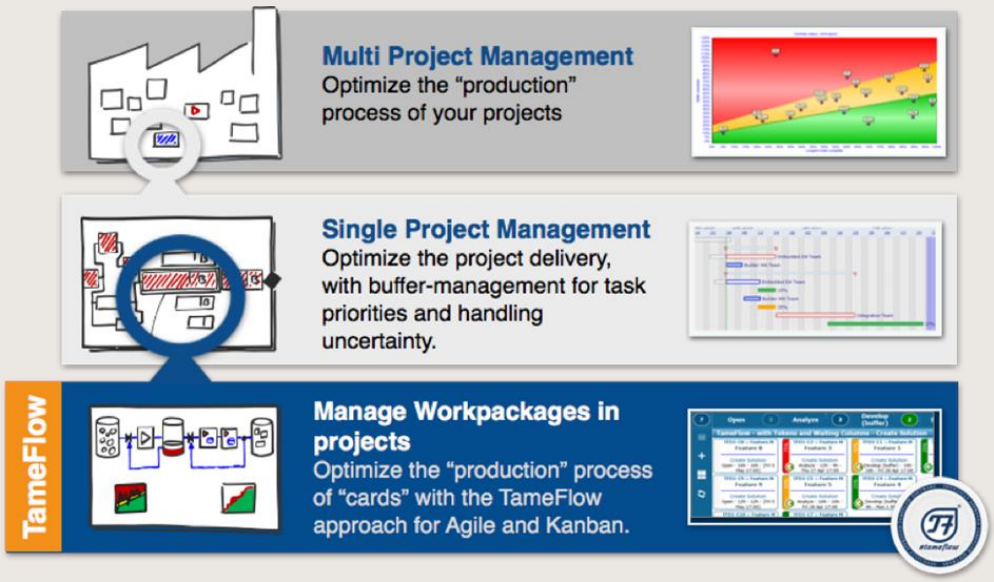
The three layers in the Production Process

For the implementation of WIP control and Buffer Management (Drum Buffer Rope), it is required to model the engineering production process in three layers:

1. Portfolio management,
2. Project management and delivery
3. Task and subtask management (cards)

The application of the TOC and TameFlow to this model in essence means: any decision taken at each of the levels aims to achieve a common operational goal. From portfolio level to subtask level and vice versa. This implies that each person always needs to have insight into the status, priority and due-dates of tasks, allowing him or her to - at any time - make the right decisions required to achieve the common goal. This creates focus at any moment in time on what needs to be done now in order to achieve the goal maximally.

Regular analysis (e.g. once a month) of actual performance, with respect to pre-set KPI's denote deviations and the need to take action to structurally improve system performance.



The three layers in the production process

Necessary Conditions

This way of working sets several demands on the behaviour and collaboration of employees and management. The following conditions have to be met:

- Community of Trust: Employees and management fully trust each other and assume that everyone always has good intentions. If things do go wrong; it is either the result of an incident (special cause variation) or a system error (normal cause variation). In the first situation issues are to be solved during execution. For the

second situation, the subject of analysis are the potential measures to improve the system.

- Employees and management pursue the same (SMART) goal: Unity or Purpose. This goal must be both operationally defined as well as tactically agreed. At a software development company such as ORTEC, this was done by making the following agreements:
  - An annually agreed budget (and therefore capacity) is available for producing "development points"
  - A x number of development points per person, team and department is expected to be delivered annually. From this follows an average production per week
  - Each software product to be developed is assigned to one categories; Small, Medium or Large. This establishes a processing time (number of development points to be spent) and a (short) target lead time.
  - Each team is expected to complete 90% of the development products within the defined target lead-time.
  - Self-managing teams of professionals: the professionals in the team decide for themselves - how, when what - they will will complete tasks. They also decide if they would need help to complete the task: in this case a manager or team lead will provide support as is required to reach the goal and helps when this is at risk
  - There is agreement on the prioritization of tasks and projects and their respective delivery dates, which makes Buffer Management possible
  - There is agreement on limits for the level of Work-in-Progress in the system as a whole through: WIP limits

Required Tools

In addition to these organizational agreements, software that correctly supports the specific TOC principles is required. At ORTEC this was found in A-dato's LYNX TameFlow application. This application implements the so-called TameFlow approach for Kanban (see The TameFlow approach and its application to Scrum and Kanban by Steve Tendon and Wolfram Müller).

Kanban is a method for managing knowledge work or immaterial processes, it focuses on the continuous delivery of output in which demand for work is balanced with the available capacity for new work. Work items are visualized on a “Kanban board” to give participants a overview of progress and process; from task definition to customer delivery. This method aids decision-making about what, when and how much to produce. Team members "pull" work as capacity permits, rather than work being "pushed" into the process when requested.

Although the first application of the method (inspired by the Toyota Production System) occurred in software development and IT; Kanban is nowadays successfully applied to any professional service firm whose work outcome is intangible rather than physical. Examples are:

- **Systems Engineering**
- **New Product Development**
- **Marketing**
- **Services Management**

The TameFlow approach entails the application of several innovations for optimizing the flow and output of a Kanban process. In TameFlow, the "pull" process and the amount of work in progress are regulated on the basis of capacity that has become available across the entire process rather than per process step (status column). In addition, a "Drum Buffer Rope" mechanism is available, this mechanism ensures that the most critical process step is assured of continuous supply. This is controlled with the help of tokens.

Furthermore, "buffer management" is incorporated, this makes it possible to identify bottlenecks at an early stage in the progress, given the limited time available.

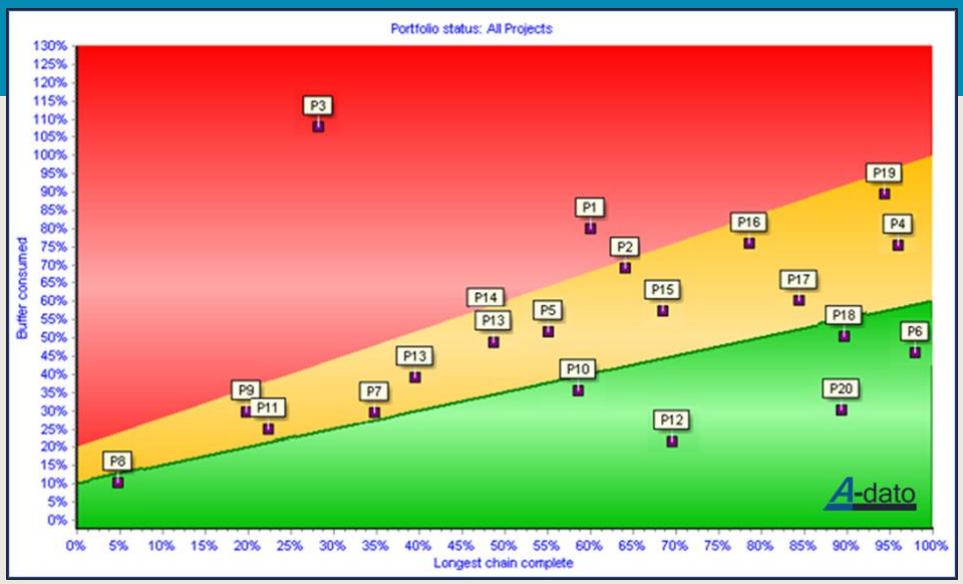
Note: LYNX TameFlow is integrated with LYNX for multi-project management (Portfolio Management) and LYNX for (Critical Chain) Project Management.

Portfoliomanagement

The available capacity of development teams is limited by definition: it is as large as the number of team members that fulfill this function within an organization or department. This capacity can be expressed in development days or points, which makes it possible to consider the production process as a factory that produces an average number of days or points per week or per month.

Projects then get an estimate of both the required number of days of processing time and the required number days of lead time. The application of the TOC mechanism Drum Buffer Rope ensures that the Work in Progress (WIP) remains low enough to guarantee an optimal flow (ensuring reliance); and remains high enough to prevent idle capacity

Whether or not new projects can be started is decided between the client and the development teams. This decision is mainly based on the "Target" value of each project. The "Target" value drives the priority and sequence of tasks (see also the publication "The Project Factory"). In case dilemmas occur in the decision making process, TOC Thinking Processes are used to determine the best and most acceptable solution. The expected lead time that can be committed is based on the historical performance of the team (number of points per week).



The Feverchart

During a software engineering process, the so-called Feverchart provides insight into the actual status of each project. The Buffer

management principle of Critical Chain Project Management (CCPM, see below) gives focus on what goes well (green) and where adjustments are necessary (red). An example from Lynx is provided above, the software that supports this process.

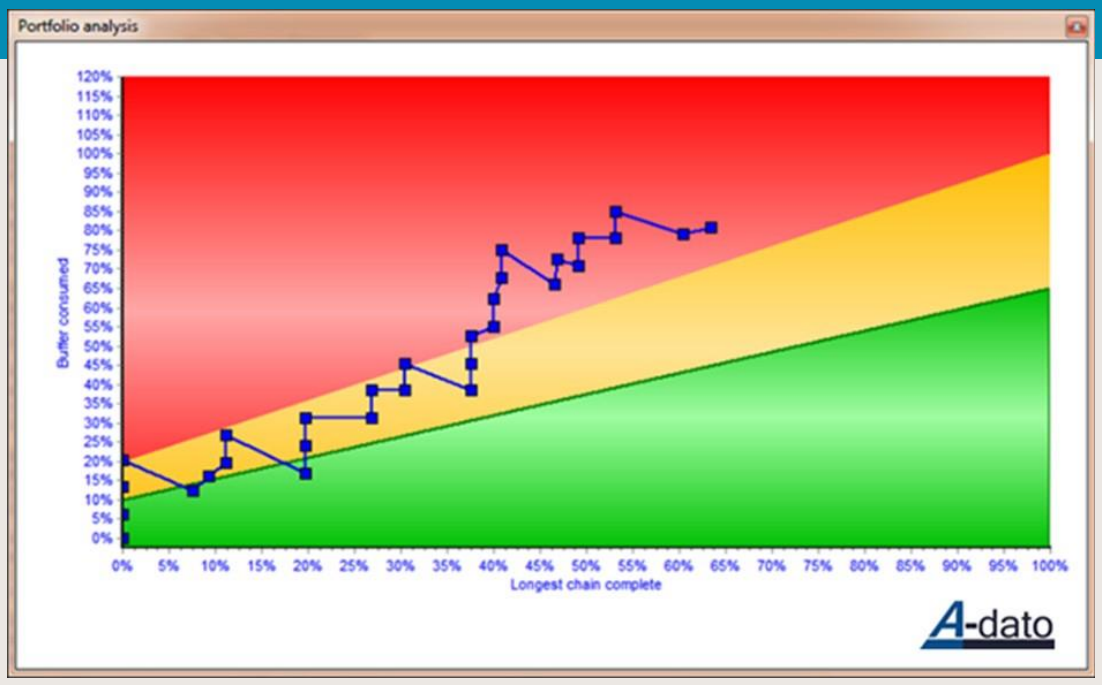
Projectmanagement

The way in which uncertainty is handled within Project Management is often a source of unnecessary delays or unnecessary high work pressures. This uncertainty is reflected by safety buffers that are (unconsciously) built into schedules and by additional room that is added with respect to scope deviations. In daily reality the latter is depicted by unclear and too broad definitions of the scope. TOC Thinking Processes help to keep the scope well under control.

By planning and prioritizing tasks in the right way, the committed scope receives attention at the right time. This is done with the help of TOC Prioritization: Buffer Management and CCPM (Critical Chain Project Management).

Within CCPM, each project receives a time buffer. I.e. safety in the project planning is made available at the project level and not at the task level. The project manager manages the project buffer and has the flexibility to allow more time to tasks that need more than planned. Because there are also tasks that require less time than planned, the chances are high that overall the project can be delivered within the agreed time.

At any time the consumption of the project buffer is visible: green means “On track”, red means adjustments are needed. See below an overview of the buffer status of a project.

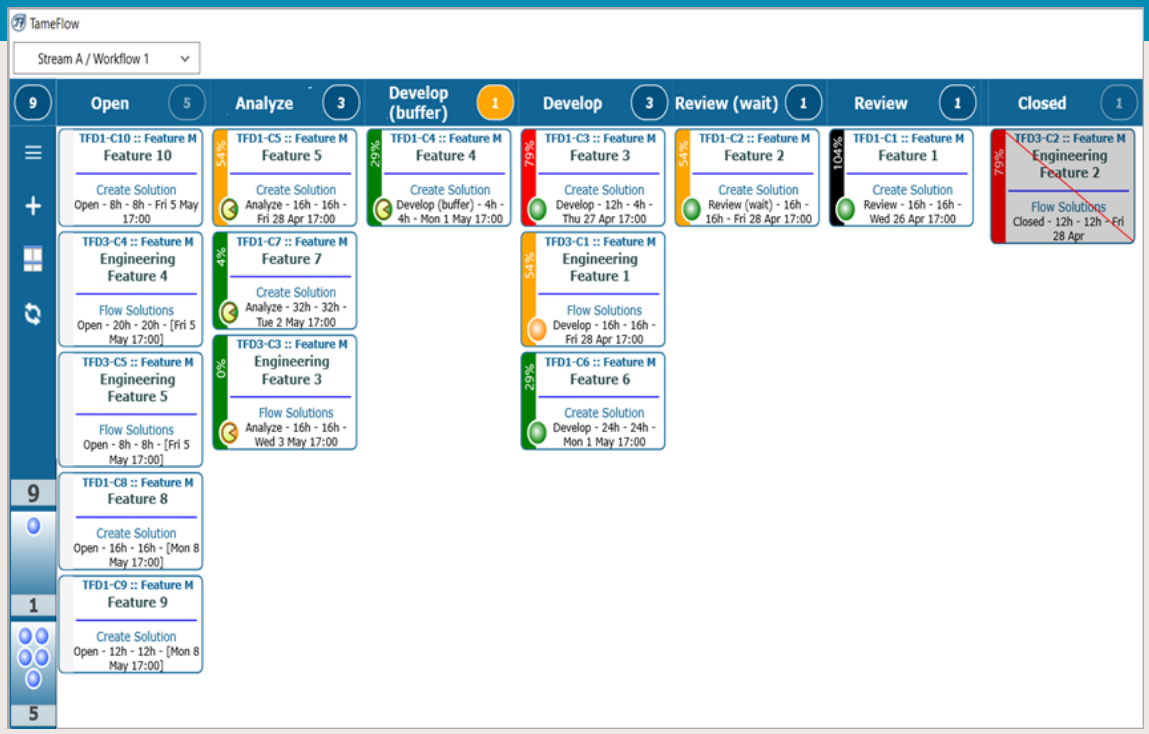


De bufferstatus van een project

Taskmanagement

Each team has its own kanban board, which gives optimal visibility and involvement. The WIP limits apply to the team as a whole (via so-called kanban tokens) and possibly to the designated constraint (via replenishment tokens). There are no WIP limits on individual columns, which results in a better flow compared to a normal implementation of kanban. A “card” on the kanban board covers a product, consisting of a number of tasks, for example: analysis, development, review and test. Each task has two columns: 'Waiting for execution' and 'Active'. This visualizes the workload at glance.

The cards representing the development tasks that need to be completed are classified according to standard product sizes (small, medium, large). This is done in order to gain insight into the estimated processing time and to determine the burn rate of the team. Subsequently, the team is also able to monitor the actual burn-rate. The burn rate shows how many developer-days or development points are / can be delivered per week. If the burn rate of a team is known, capacity planning is no longer necessary. The team itself is responsible for the completion of the right number of products (cards).



Buffermanagment in combination with kanban

Each card gets its own buffer that is intended to manage the lead time. The buffer goes from 0 to 100% of the (standard) lead time estimated per card. This clarifies at any time which card has which priority, offset against the planned delivery date.

As each card flows across the kanban board, it is always visible whether the flow is blocked or delayed. The team has daily standup meetings to discuss these disruptions in terms of 'what to do' rather than in terms of 'why did it happen'. Each card has a buffer status as indicated by a color and a percentage. The combination of the position on the board and the buffer status determines the priority. In practice, this means working from right to left and from top to bottom. Team members are jointly responsible for finishing the tickets, and where necessary they help each other. In principle a team works on one batch at a time; and when the backlog becomes empty, the cards of a new batch are released.

Maintenance issues (cards) are handled in the same way as the cards above, so one card represents one issue. The difference is that the buffer of the maintenance tasks are based on the delivery date determined in the SLA (Service Level Agreement).

Management Reporting

Behavior of employees is influenced to a large extent by the way their performance is measured. Therefore it is important to put the right metrics in place. Cohesion within the set of KPIs is essential for delivering the right performance. Not only a low Work-in-Progress is important, also the production, the lead times and the due-date performance are of essence. This requires attention during implementation and at management level.

The (management) reports are set up in accordance with the set of KPI’s identifying deviations and are the basis for defining corrective actions that need to be agreed and executed. In practice this will take place in bilaterals, standups, weekly meetings and monthly meetings.

The management reports show whether the organization is closing in on its goal. If this is not the case, additional analysis is required to identify what keeps the organization from achieving its goal. The analysis of the collected buffer management data will point to processes that can be improved.

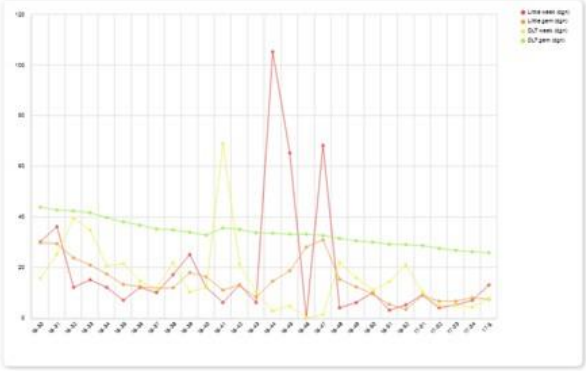
Management-Reporting

Maintenance Data from: 05-12-2016	**Binnengekomen:** week: 7 ptn totaal: 137,5 ptn	**OHW:** 30 ptn	**Gesloten:** Week: 10 ptn Norm: 18,5 ptn	**Gesloten:** Totaal: 173,5 ptn Norm: 167 ptn	**Leverbetrouwbaarheid in cards:** Week: 75% 6 weken: 91% Totaal: 76%

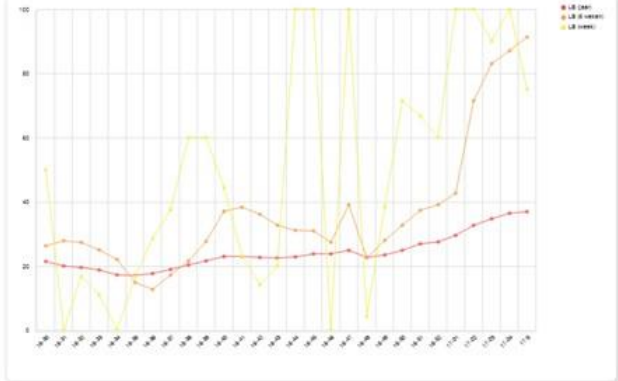
Product	Ingekomen		OHW	Afgerond				DLT			DLT Little		gem bewerkings tijd (dgn)		Leverbetrouwbaarheid norm: 90%						
	Week	Totaal		Week	Norm	Totaal	Norm	Week	Totaal	Norm	Week	Totaal	Week	Totaal	Op tijd (week)	%	Closed (6 weken)	Op tijd (6 weken)	%	Op tijd (totaal)	%
Mt-XS	0	3	0	0	1	3	8	0	1,22	1	0	0	0	0,03	0	0%	3	3	100 %	3	100 %
Mt-S	1	34	6	1	2	34	16	5,16	10,65	5	30	3	0,58	1,11	1	100 %	17	17	100 %	30	88 %
Mt-M	2	27	3	3	5	38	40	8,61	26,71	8	5	0,73	2,64	2,63	2	66 %	25	21	84 %	26	68 %
Mt-L	0	2	1	0	0	1	4	0	15,9	12	0	45	0	4,52	0	0%	1	1	100 %	1	100 %
Mt-XL	0	1	1	0	0	2	4	0	104,85	13	0	2,81	0	7,01	0	0%	0	0	0%	0	0%

Results

The graphs below show the results of the implementation of the TameFlow approach at ORTEC. Over a 6 month period, both the development teams and the maintenance teams have improved their due-date performance from 30% to 90% at a 6-week rolling average. In addition, the average lead time of all cards has decreased from more than 40 days to less than 25. Finally, the level of Work-in-Process in the teams has decreased from over 120 to about 20 days of development, which is about the amount of work that can be completed in 1 week.



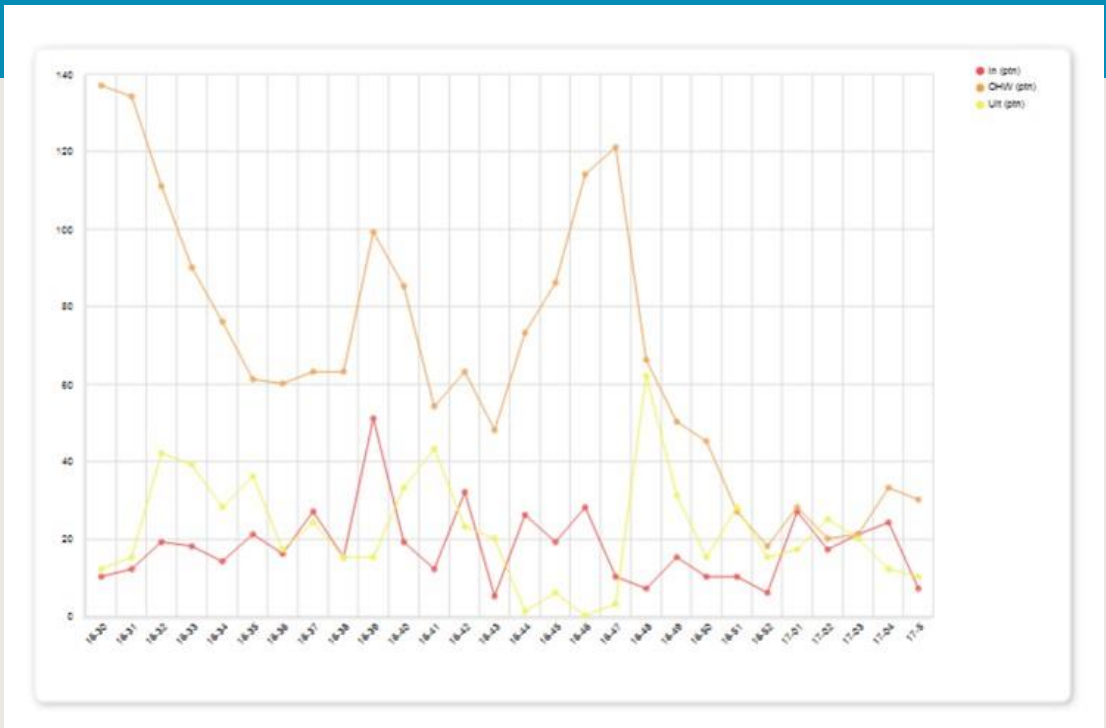
Development of lead time



Development of due-date performance

orta

In addition to these significant performance improvements, employees and team members experienced several intangible improvements. These include a better and smoother collaboration within the teams, much less work pressure and some pride as a result of better performance Yet, most satisfaction was the result of being able to deliver a level of quality that was previously thought of as unachievable.



Development of Work In Progress (WIP)

About ORTEC

ORTEC is one of the world's leaders in optimization software and analytics solutions that enable companies to make their businesses more efficient, more predictable and more effective. Turning complex challenges into easy-to-use solutions.

ORTEC delivers solutions on a global scale from 15 offices strategically located across 4 continents. ORTEC software is built on 30 years of experience, uses state-of-the-art technology and incorporates the latest optimization techniques.

ORTEC Products develops stand-alone, custom-made and SAP® embedded advanced planning and scheduling software. Optimizing amongst others fleet routing & dispatch, pallet & space loading, workforce scheduling, warehouse control, delivery forecasting and network planning.

The ORTEC Consulting Group provides advanced analytics and optimization solutions for companies to last, innovate and outperform. It offers tailor made and off-the-shelf analytics, optimization models and tools, analytics & consulting services for every level of maturity, as well as experts in the area of data science, business analytics, optimization modeling and software engineering.

www.ortec.com

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