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Sebastian Peltonen

PROTOTYPE PRODUCTION MATERIAL FLOW IMPROVEMENT AND IMPLEMENTATION OF IMPROVEMENTS

TURUN AMMATTIKORKEAKOULU
TURKU UNIVERSITY OF APPLIED SCIENCES

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Tuomo Rautava, Ilkka T Ikonen

Sebastian Peltonen

PROTOTYPE PRODUCTION MATERIAL FLOW IMPROVEMENT AND IMPLEMENTATION OF IMPROVEMENTS

The purpose of this thesis was to recognize and solve problems related to material flow to and from prototype production and research laboratories. Issues pointed out before starting this thesis were materials being stored in pathways, or other areas where storage was not allowed, for an undefined duration. Materials were also hard to recognize as markings were insufficient.

The first task was to list reasons for why this practice had taken place. When a basic understanding of reasons was achieved, an Action Workout, a derivate of GE Work-Out and Kaizen Event, was planned and conducted. This was the first event of this type conducted at ABB Oy, Drives in Helsinki and required studies in Kaizen Event methods as well as in group psychology and idea generation.

The event generated two bundles of solutions that were accepted for execution by the sponsor of the event and during the subsequent 30 days most of the improvements were implemented, and within 90 days all agreed improvements were completed. The improvements included erecting a pallet shelf, improving usability of two existing pallet shelves, a visual management system for common drop zones and new guidelines for all involved. The goals set for the improvement project were reached resulting in suggestions for further improvement in related functions.

The primary purpose of this thesis was to solve problems with the material flow and pilot Action Workout as a method at ABB Oy, Drives was also a significant part of this thesis. The pilot was successful and welcomed by the participants and a second Action Workout was already planned.

KEYWORDS:

R&D, logistics, material flow, Lean, track and trace, Kaizen, Kaizen event, development programs, development.

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Sebastian Peltonen

PROTOTYYPPITUOTANNON MATERIAALIVIRRAN PARANTAMINEN JA PARANNUSTEN IMPLEMENTAATIO

Tämän lopputyön tarkoitus oli tunnistaa ja ratkaista ongelmia liittyen prototyyppituotannon ja tuotekehityslaboratorioiden materiaalivirtaan. Lähtökohtainen ongelma oli materiaalien säilytys käytävillä ja muilla kielletyillä alueilla pidempiäkin aikoja. Materiaalien tunnistaminen oli hankalaa johtuen puutteellisista merkinnöistä.

Ensimmäinen tehtävä oli tunnistaa syyt miksi tällainen käytäntö oli kehittynyt. Kun tästä oli saatu ymmärrys, suunniteltiin ja pidettiin Action Workout tapahtuma, malli joka juontaa juurensa GE Work-Out:sta ja Kaizen Event:stä. Tämä Action Workout oli ensimmäinen ABB Oy, Drives:llä ja vaati Kaizen Event:in, ryhmän psykologian sekä idea kehityksen opiskelua.

Action Workout tuotti kaksi ideapakettia jotka tapahtuman sponsori hyväksyi toteutettavaksi. Suurin osa parannuksista implementoitiin tapahtumaa seuraavan 30 päivän sisällä ja loput 90 päivän sisällä. Parannukset olivat uuden raskashyllyn rakentaminen, kahden olemassa olevan raskashyllyn käyttöasteen parantaminen, visuaalinen hallinta yhteisille laskualueille sekä uusien toimintaohjeiden laatiminen kaikille jotka ovat tekemisissä uuden prosessin kanssa. Tapahtuman tavoitteisiin päästiin ja uusi prosessi loi lisää kehitysehdotuksia koskien sidostoimintoja.

Lopputyön päätavoite oli ratkaista materiaalivirran haasteet, mutta myös Action Workout:in pilottikokeilu on huomattava osa tästä työstä. Pilotti oli menestyksekäs ja osallistuneet ottivat sen metodina hyvin vastaan. Pilotille oli jo suunniteltu jatkoa.

.

ASIASANAT:

Tuotekehitys, logistiikka, materiaalivirrat, Lean, seuranta, Kaizen, Kaizen Event, kehitysohjelmat, kehitys

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LIST OF ABBREVIATIONS (OR) SYMBOLS

R&D	Research and development
GE	General Electrics

1 INTRODUCTION

This thesis was done at ABB Oy, Drives production and development facilities in Helsinki, Finland. The intended outcome of this thesis was to pilot Kaizen event as a method with the theme recognizing and solving inefficiencies in prototype production and research laboratory material flow.

The thesis process is divided into four parts. The first task was to recognize the issues of the material flow with the existing processes. The second task is to propose solutions, arrange and conduct a modified Kaizen event, called Action Workout, in the roles of consultant and facilitator.

The third part is to implement the solutions, evaluate and ensure the sustainability of the achieved improvements. During the implementation phase the new processes are tested and adjustments are made to meet the specific requirements spawn from the large turnover of personnel.

The last part is to use the attained knowledge and experience to recognize and propose further improvements both regarding the material flow and directly tangible issues, but also regarding Kaizen event as a method of working.

The text of this thesis is divided into three parts. A theoretical background section describing Kaizen and Kaizen event as well as some theories supporting Kaizen events. Secondly a section describing the conducted Kaizen event from planning to conducting the event to implementing the improvements. Thirdly results are examined.

ABB is world number one in power and automation technologies. It employs around 145000 people worldwide and has functions in around 100 countries. In Finland, ABB is one of the largest industrial employers, employing circa 6600 professionals. In the capitol area ABB is the largest employer.

Turnover of ABB Finland is approximately 2.3 billion Euros and 184 million Euros is spent on research and development annually.

2 THEORETICAL BACKGROUND

2.1 Kaizen

Kaizen is a Japanese pair of words, originating from Kai and Zen. Kai stands for "modify" or "change" and Zen for "make good" or "make better". Therefore Kaizen can be translated to "change for the good" or "Good change". However, continuous improvement may be more applicable when considering the philosophy.

Kaizen is a continuous improvement philosophy that relies on involving all levels of an organization, from shop floor to the board. The philosophy states that everyday life should be focused on improvements. In many large organizations this philosophy is so natural and deeply incorporated in the culture that it might be forgotten (Ortiz 2006, 7).

Kaizen philosophy is to be integrated deep into the daily routines with emphasis on reducing waste, creating standards and creating a clean and well organized workplace. The improvements that spawn from Kaizen are usually small and subtle. The power of Kaizen lies in the cumulative effect; many small improvements make large and long lasting improvements (Ortiz 2006, 7).

According to Ortiz (2006) Kaizen is being threatened by corporate managers worshiping idea of buying innovation and technology instead of emphasizing people and their actions.

2.2 Kaizen event

Kaizen event is different from the Kaizen philosophy. Kaizen events are a type of rapid improvement events. Unlike the Kaizen philosophy, Kaizen events are based on bringing together small groups to address a certain issue. Complementing a functioning Kaizen culture with Kaizen events on a regular basis is highly encouraged. Kaizen events are usually around five days long,

but depending on the issue, complexity and scope, can be anything from one day up to four weeks in duration (Ortiz 2006, 7-26).

Kaizen events do not work well as a standalone improvement tool. If an organization is lacking the culture to support, through keeping employees involved and accountable, the Kaizen events, they are very likely to fail due to changes not being implemented or changes being overlooked over time. Kaizen events can become an unpleasant burden for employees if the management does not believe in the Kaizen event method. Management must provide clear targets, guidance and leadership for all Kaizen event activities (Ortiz 2006, 7-26).

Ortiz (2006) states that the only way to create a successful culture of Kaizen events is for the top managements to device a long-term plan for arranging Kaizen events and provide the tools necessary for the Kaizen teams. Ortiz (2006) further adds that "Kaizen events without vision and focus are like road trips not having a final destination".

Kaizen events are usually conducted in a way where the event includes solving the issue all the way until implementation and measuring of changes (Ortiz 2006, 7-26). However, the GE Work-Out model is different in the way that the events only produce an approved plan of actions complete with persons responsible for implementation. Implementation will be performed during the following 30-90 days after the event (Ulrich et al. 2002, 23-47)

The benefits derived from Kaizen events are more than just the improvements. Kaizen events have a tendency, when supported properly, to empower and involve employees in the organizations goals. Employees are allowed to identify solutions to problems and are, depending on execution, implementing them immediately or in a timely manner (Ortiz 2006,7-26. Ulrich et al. 2002, 23-47).

The second advantage of the Kaizen event method is that while normal flow of improvement suggestions or action requests may take months to travel up in the hierarchy to a level where a decision can be taken, given it ever reaches this level, Kaizen events provide a direct link between the idea owner and a

manager able to make the necessary decisions. Not only does this mean that changes can and are done faster, reducing waste for the time saved, changes can be made while relevant, as some changes might require immediate action to be effective to their full potential. Ulrich et al. (2002) call this feature of Kaizen events "Bureaucracy busting".

Kaizen event being the general term for a rapid improvement event and being a common term used between professionals, many organizations have adapted their own variations and given the variations a name to match. In this thesis the General Electrics Work-Out will be examined used as a base for the Kaizen event. Adaptations will be made to suit the organization and mentality of ABB Oy, Drives Helsinki. It will be named Action Workout.

2.3 Groups and Teams

Throughout their book "The GE Work-Out" Ulrich et al. write about teams and how it is important that the teams are in the center at any Kaizen Event. This section explains what a team is and what aspects affect it. The Oxford Dictionaries defines the word "Team" as a "a group of players forming one side in a competitive game or sport" or "two or more animals, especially horses, in harness together to pull a vehicle". The word "Team" has been adapted by managers and organizational behaviorists to describe a formal group that is highly task-oriented (Adair 1986). This coincides, in my opinion, well with the second definition by the Oxford Dictionaries describing all members pulling to reach a common goal.

2.3.1 Definition of a group

A group is defined by being two or more people that interact with each other, have psychological awareness of each other, perceive being in a group and purposefully interact to achieve a goal or goals. In practice the group has a

maximum size that is limited by the definition that they need to interact. Groups have different models of interacting due to different hierarchies, but a common feat is that communication happens face-to-face. When communication occurs in order to achieve a common goal, members of the group tend to get a feeling of shared identity. This common goal does not however necessarily coincide with an organization's goals (Rollinson & Broadfield 2002, 319-320).

2.3.2 Formal group

There are two or even three types of groups, if counting psychological groups which Deutsch (1949) defined. The two main categories are formal and informal groups. Formal groups are groups that are created by an external force, in example a manager in an organization. An informal group is a group that is created by its members, often by circumstance or by a common interest or goal. For example a person may be having coffee with a group different from her professional group, hence making this an informal group (Rollinson & Broadfield 2002, 320-321).

In the applications concerned by this thesis, formal group is the primary type of group. However, not excluding the benefits from using contacts from informal or external formal groups.

2.3.3 Justification for using groups

Schein (1965, 66-87) lists six primary, or formal, advantages for using groups in comparison to individuals:

- groups can work on complex tasks that cannot easily be undertaken by individuals
- groups have greater potential to generate new ideas and creating a stimulating atmosphere
- groups can combine and coordinate a mix of skills from different parts of an organization

- groups provide multiple viewpoints to every problem, making solving more thorough
- to implement decisions, giving multiple people a common goal
- groups can be socializing devices, communicating and reinforcing a common message, especially regarding an organizations culture.

The six formal functions described above are all relevant to why Kaizen events rely on groups, or preferably teams. Kaizen events are often tightly scheduled and require innovative thinking combined with having all involved departments and functions represented in the working phase. In a Kaizen event all implementable decisions are spawned from the groups, which will reinforce the will of the groups to implement and reach the set common goal.

2.3.4 Expected behavior of new team

Tuckman's (1965) integrative model is the best known model describing the stages of groups. It divides a group's life into five stages; forming, storming, norming, performing and adjourning. The last not being in the earlier stage models by Tuckman.

Forming is the stage where a number of people are put together and probably have been informed about a common goal. At this stage individuals tend to focus on getting to know each other and making suggestions for positions in the group. Group members are not yet experiencing being a member of a group. At this stage little progress is made towards the given common goal.

Storming is the stage where individuals start to bring their own ideas and agendas up into the open. The gentle bids for positions or territory made in the forming stage are now brought up more forcefully, creating hostility between rivals and often making the situation uncomfortable for all involved. This stage is, however, necessary to create a functioning group. If this stage is neglected, groups will tend to break up into smaller subgroups which will continue battling in the background while lowering the efficiency of the group. Different

personalities will act differently in this stage, but although unpleasant for some the presence of different personalities is necessary.

Norming is the third stage. In this stage focus changes to the given goal, how to achieve it and with what methods. Interpersonal relations improve and cooperation begins. Rules for social interaction are created. These rules are seldom written or in any way formal, but still they are the base of the group and its internal culture.

Performing is the stage that the creator of any group has in mind. This is the stage where time and money spent start to pay off. At this stage the group members have completed the three previous stages and both personal and methodical issues are ironed out. Members have found their place and provide the group with expertise from their own departments or functions.

Adjourning is the last stage of a group. it was added later to complement the four previous stages. Adjourning represents stage where a group is seizing to exist, either because the task is complete or as a result of members moving on.

All stages are normally not reached during a single meeting, given that the group needs to exist for an extended time, in example for the duration of a product development project. However, in my experience when formal groups are created and a deadline is set in the near future, for example the same day or the next day, group members tend to conform with an internal hierarchy more easily. I believe factors contributing to this are that members are aware of the need to conserve the scarce time for performing, as well as members seeing that for a shorter period of time even a slightly uncomfortable hierarchy can be tolerated as a trade-off. In practice this time is saved in the storming phase, and according to Tuckman's (1965) model would lead to the group not functioning to its full potential. In Kaizen event applications Ulrich et al. (2002, 115) suggest to name team leaders in the team creation phase to save time spent in the storming stage during the event.

2.4 Brainstorming and Idea selection

2.4.1 Generating Ideas

Brainstorming is the most known method for generating ideas in groups or teams. Brainstorming is not a solution itself, but will generate ideas for solutions. Although it can be used also as an individual, with some limitations, commonly brainstorming is done in groups of 5-10 participants. A brainstorming group must always have a leader who is, while participating, also moderating the session and ensuring a productive atmosphere. The main aspect of maintaining a good atmosphere is to eliminate critique at the brainstorming session, as even small critique may torpedo an idea leaving it unelaborated (Välimaa et al. 1994, 85-101).

For a brainstorming session to work there are ground rules (Välimaa et al. 1994, 85-98):

- No critique during the brainstorming
- Wild ideas are welcome
- Ideas are wanted in great quantity
- It is desirable to elaborate and improve on others ideas
- All ideas must be documented

At the beginning of a brainstorming session the subject or problem must be clearly defined, and if needed necessary supporting information is to be provided. To ensure that the task is understood it is advisable to encourage participants to ask questions (Välimaa et al. 1994, 85-98).

There are many different methods for how ideas are presented and documented. Ideas can be presented freely during the meeting, paced only by the person writing them down. Question lists can be used, a paper is circulating and all participants may write down one answer per round. However using lists might be frustrating if a person is unable to generate an idea for a couple of consecutive rounds. In which case the team leader should move on to the next list or method (Välimaa et al. 1994, 85-98).

The 635-method is a silent brainstorming method where ideas are immediately documented. The "6" is for six people participating, the "3" is for the three ideas they are each expected to generate during five, the "5", minutes. When the first five minutes have passed and all papers have three ideas the papers are passed on to the next person, clockwise or anti-clockwise. During the next five minutes participants should use the ideas already on the papers and elaborate them or use them to come up with new ideas. Repeating the same ideas on multiple papers is forbidden. Papers are passed until they make a complete round (Välimaa et al. 1994, 85-98).

Mind maps can be used for brainstorming following the basic principle described above. Mind maps can be collaborated on using software or spreadsheets, the ideology is the same. To start the main topic is written in a shape in the middle. At first all ideas are connected directly to the main shape, but as the mind map matures new ideas can be elaborations of existing ideas and are hence linked to one of these.

2.4.2 Selecting the Best Idea

When brainstorming is completed, usually takes around two hours, the team should have a lot of ideas how to solve or improve an issue. As per the rules of brainstorming, no critique was allowed and to boost creativity participants might have been encouraged to disregard laws of physics and finance too, leading to some portion of the ideas to be unrealistic or impossible to implement. These ideas must be eliminated in order to skim the best ideas, also known as reducing noise. For idea selection there are a few methods. In this phase discussion is allowed and depending on the method necessary.

When unrealistic ideas have been eliminated the remaining ideas need to be evaluated and the best ideas recognized. Time consuming and analytical evaluation and selection methods are not applicable for Kaizen event purposes, leaving voting as a primary option. Voting can be done by assigning every

participant with a certain amount of points that he or she may dispense among the ideas. This can be done on paper or by a moderator collecting points. If the starting amount of ideas is great, a second round can be held between ideas that attained a score of one or above. Voting is based on participants subjective opinions, which can be viewed as a weakness of the method.

2.4.3 VDI 2222

When solving a problem consisting of interlinked sub-problems I have found it functioning to utilize the systematic development model VDI 2222 (VDI 1997). It is a model created by the VDI (Verein Deutscher Ingenieure) for product development purposes. It allows ideas to be combined in a novel way while also raising questions about compatibility of solutions to interlinked sub-problems. The main problem is broken down to sub-problems which are listed in the first column of a table. Every sub-problem now has an own row where solutions can be described, either in writing or drawing. For example in the table below (Table 1.) the problem is broken down in to three phases, inbound movement, performing a task and outbound movement. For each task there are multiple solutions, marked A1-D3. Any combination can be made so that one solution is picked from each row. The first step is to evaluate the sub-solutions individually to assess the best and then sub-solutions are combined into a solution for the problem. In many cases the best sub-solutions combined do not result in the best solution due to compatibility issues. In this case the sub-solutions A1,B4 and C2 might be the best individual solutions but they do not fit together as well as A4, B1 and C1. Therefore the best solution is A4, B1 and C1.

	Solution	Solution	Solution	Solution
Inbound movement	A1	B1	C1	D1
Performing task	A2	B2	C2	D2
Outbound movement	A3	B3	C3	D3

Table 1. Example of a VDI 2222 table.

3 THE WORK-OUT EVENT

Ulrich et al. (2002, 106-108) divide Work-outs in three categories:

1. You want to implement a specific solution to a problem
2. You want to develop a solution to a problem
3. You want to define a problem

None of the above mentioned types can directly be used to characterize the type of Work-out that is to be conducted. At best it could be described as a mix of #1 and #2.

3.1 What business issue to work on?

3.1.1 The Issue

The material flow to the research laboratories and prototype production was not well coordinated. No clear practice existed causing the personnel to do manual work in order to assure that the materials they needed were available when needed. There was a set of guidelines, however these were not followed as they were deemed unpractical or unclear.

A repeating issue was orphan materials, i.e. materials that nobody had claimed. Materials were ordered and delivered, but the subscriber was not acting. This resulted in pallets being left in the drop zones or in laboratories/production areas and occupying valuable space. There was a clear need for a predefined process dealing with these issues.

Pallets were only marked by the subcontractor’s pallet place tag, if at all. This tag is not sufficient for determining action for an unidentified pallet, as there is no marking of contents or delivery date. It can be thought of as a license plate.

Tracing of materials was furthermore complicated by the fact that many materials were not ordered to be delivered to a certain location at the factory, but only by the name of the subscriber. This also complicated maintaining the statistics for the process. At worst this could be an issue when discussing lead-time for the service provided.

Some laboratories receive materials, i.e. customer returns, without a material order. This creates a need for a designated drop-zone where this kind of materials can be sorted and assigned to the corresponding laboratory or unit.

3.1.2 The Pre-event Suggested Solution

This section describes the suggested solution that was recognized prior to the event, for the approved solutions generated by the event please refer to sections 3.6.2.1 and 3.6.2.2. Incoming and outgoing materials have designated areas (see Table 2.). These areas are located as close to the workstations as possible. The outgoing materials should no longer be hauled to the dispatch department by the R&D personnel, but are instead picked up by the internal logistics partner.

Subscriber	**Location of temporary storage**	**Type of materials**	**Type of storage**
Downstairs laboratories	Corridor outside laboratories	Boxed and pallets	Pallet shelves
Prototype production	Opposite the elevator	Pallets	Pallet shelves
Cabinet testing	Between the elevator and test area	Cabinets	Floor space

Table 2. Temporary storage locations

All materials arriving on a pallet are marked with a A4 size re-usable green tag where the logistics partner will mark the date of arrival and the date of return to the external warehouse. The tag may also have a field where the subscriber may fill in a suggestion for the return date. For this there needs to be rules of what the default time for automatic return is and the criteria for delaying the return. The outgoing materials could have a red tag to make it immediately clear for the internal logistics partner that this pallet is ready to be shipped to the external warehouse. The tag may be green on one side and red on the other (See Picture 1.). This does, however, still mean that the internal logistics partner would need to check the green tags as well as there is no guarantee that the subscriber has taken any action and turned the tag by the return date.

Picture 1.Pallet tag, front and back

A rule regarding unattended pallets will be put in place to ensure that pallets cannot be left in the drop zones or production areas for an undefined amount of time (see Chart 1.). For special materials and unexpected deliveries, which are materials exempt from pallet tags, temporary storage areas or places will be specified and rules for maintaining material flow will be put in place.

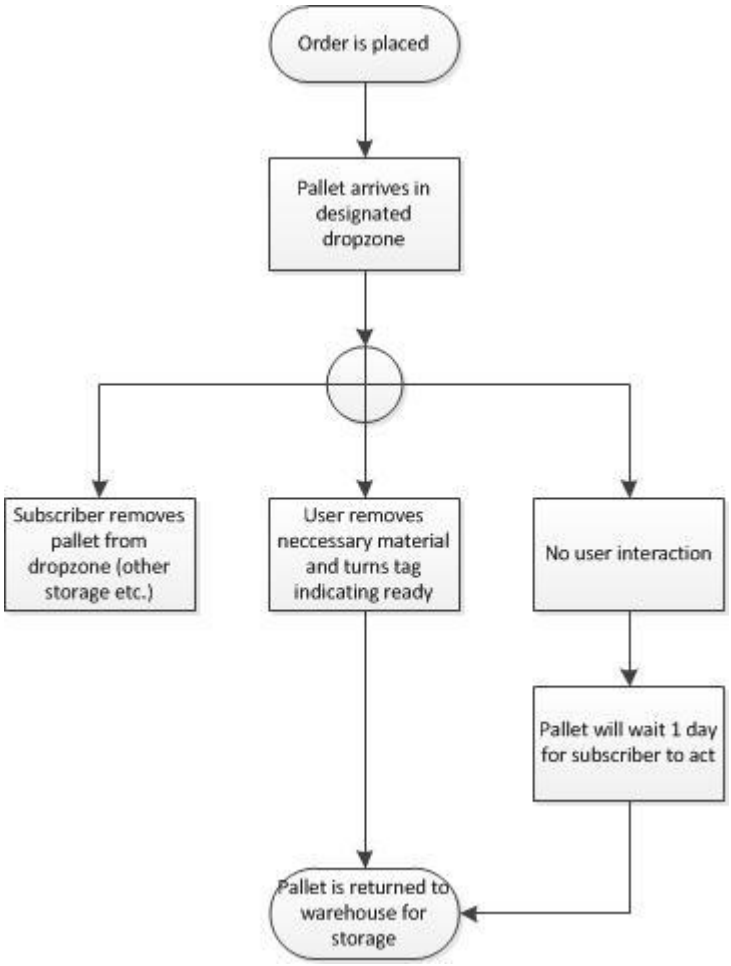


Figure 1.Proposed order process return rules.

3.2 Who is going to participate

3.2.1 List of Participants

A list of participants needed to be created. All roles, except for the last three in Table 3, are required in the planning phase (Ulrich et al. 2002 112-118).

Role	**Name**
Sponsor	Senior Vice President
Champion	Project Manager - R&D Processes
Consultant	Sebastian Peltonen
Analyst	N/A
Facilitators	Sebastian Peltonen
Expert Resources	OPEX Manager
Administrator	N/A
Team Leaders*	Test Engineer, Laboratory Engineer
Team Members*	Test Engineer, Test Engineer, Test Engineer, Test Engineer, Laboratory Engineer, Laboratory Engineer, Laboratory Engineer, Verification Engineer
Town Meeting Participants**	OPEX Manager

Table 3. List of participants. *not included in planning phase. **optional, other senior managers, may give the Sponsor opinions and counsel.

3.2.2 The Roles

3.2.2.1. Sponsor

The sponsor is a senior manager responsible for the parts of the organization that are to be influenced by the Work-out. The sponsor will open the event and present the goal and will return to make yes or no decisions at the town meeting. The sponsor is ultimately responsible for the decisions which the Work-out generates. The sponsor is often viewed as a barrier buster as he/she will give the approved ideas' owners a mandate to execute the changes. (Ulrich et al. 2002, 112)

3.2.2.2. Champion

A champion is the business manager for the area or unit where changes are to be done. Or simply problem owner, although in my opinion it is better to avoid the term problem. The sponsor may take the role of champion.

The Champion is the person who plans the agenda, designs the event, collects background data and assists in selection of teams.

After the Work-out the champion oversees the progression of changes. At GE the standard intervals are 30, 60 and 90 days. (Ulrich et al. 2002, 112-113)

3.2.2.3. Consultant

The consultant is a person with experience of Work-Out and the process of creating a Work-Out. The consultant helps the champion in designing the Work-Out and organizing the logistics of the event. Before and during the event the consultant is working with team leaders, facilitators and other support staff to ensure that the event goes smoothly. (Ulrich et al. 2002, 113)

3.2.2.4. Analyst

The analyst is an optional role. In some Work-Outs where the measuring of the progress requires special skills or is otherwise time consuming, an analyst is put in place to support the teams work. The analyst will also prepare relevant data in advance to support the Work-Out event. (Ulrich et al. 2002, 114) This post was deemed unnecessary in the pilot Action Workout.

3.2.2.5. Facilitator

Facilitators are the consultant's helpers, the consultant being the lead facilitator. The facilitators do the physical preparations for the event and are on site during the event to take care of any issues that may appear. Facilitators should have good skills in facilitating group processes. Amount of facilitators may vary from one upwards, depending on the amount of teams and size of the event. (Ulrich et al. 2002, 114)

3.2.2.6. Expert Resources

Expert resources are people who are not members in the teams but are providing the teams with background support in specific areas (for example marketing). Expert resources are available during preparation of the event, during the creation of the action plan after the event and during the event. Expert resources are not required to be physically present during the event but are to be reached if needed by for example phone, e-mail is often too slow. (Ulrich et al. 2002, 114-115)

3.2.2.7. Administrator

This is an optional role. The administrator is person who is responsible, if appointed, for the logistics of the event. The administrator sends out invitations, books venues, ensures that all documentation is recorded and shared and various smaller tasks to ensure that the event goes smoothly. The administrator

works closely with the lead Facilitator, which is the consultant. (Ulrich et al. 2002, 115)

3.2.2.8. Team leaders

The team leaders are responsible for preparing their teams for the Work-Out, leading the teams from the process of brainstorming and generating ideas all the way to presenting their ideas at the town meeting and generating an action plan.

Ideally the team leaders should be notified about their roles prior to the Work-Out event. This gives team leaders the opportunity to prepare and acquaint themselves and their teams with the agenda. If teams are not selected, the team leader's first task is to assemble a team.

Team leaders may arrange a preliminary meeting with their teams to discuss the goals and gather background data for the event. For complex processes this meeting can be valuable if used to map the current processes. This meeting may not evolve into the brainstorming phase as this may cause the Work-Out to be not as productive.

The team leaders can ask the team members to gather data for the event and alert colleagues, who are not part of the Work-Out, to keep their phones on in case any questions arise during the Work-Out. (Ulrich et al. 2002, 115-116)

At this implementation a preliminary meeting was not deemed necessary as all participants were well acquainted with the issue. A preliminary meeting would probably have led to brainstorming before the event.

3.2.2.9. Team members

Team members are the core of the Work-Out. If a preliminary meeting is held or some sort of preliminary info is distributed to the team members, they may gather some data and do some individual thinking on the subject prior to the Work-Out event. However, the main efforts are done during the Work-Out. At the Work-Out their job is to solve a business issue as a part of a team. The

team members start by brainstorming and selecting ideas. Here different methods can be utilized, see section 2.4 about Brainstorming and Idea selection. The brainstorming phase is succeeded by presenting an executable idea at the town meeting and, if approved by the sponsor, creation of an action plan. All ideas that are presented must have one idea owner, a person from the group that is best suited to carry out the execution of the changes. One person may only be owner of one idea to ensure that one person is not overwhelmed if multiple ideas from a team are approved. In rare cases the idea owner may be a person from outside the team, but this has to be thoroughly discussed with the proposed idea owner and in my opinion should definitely be present at the town meeting and preferably present the idea as well.

The creation of teams is a rather challenging task. According to Ulrich et al. the optimal team size is 8-10 members, excluding the team leader. However, based on my experience any group size exceeding six persons, team leader included, will bring along freeloaders. Contradicting, the optimal team size for lean performance may be outweighed by the need to have all fields represented in order to perform well.

A good place to start is to evaluate the Work-Out goal and assess what fields should be represented, or what fields are affected. Teams may have different sub-goals that while supporting the main goal of the Work-Out may differ to a degree that requires different teams to have different representation. The main guideline is to have cross-organizational teams.

During the Work-Out there is to be no sacred cows that cannot be discussed or changed and no ranks exist. The latter being a state of mind that may be hard to overcome, it is better to not place a boss and his subordinate in the same team. (Ulrich et al. 2002, 116-118)

Following the guidelines above it was decided to form two teams (see Tables 4 and 5), to tackle the issues from their respective views. One team has a cross-functional team representing the different units in prototype production and the other will represent the research laboratories.

Team 1	Prototype production
Team task	1. Improve material flow – create rules 2. Define temporary storage area layout for all in- and outbound materials 3. Order and cleanliness – create rules
Leader	Test Engineer
Members	Test Engineer Test Engineer Test Engineer Verification Engineer

Table 4.Team 1 key factors.

Team2	Laboratories
Team task	1. Improve material flow – create rules 2. Define temporary storage area layout for all in- and outbound materials
Leader	Laboratory Engineer
Members	Laboratory Engineer Laboratory Engineer Laboratory Engineer Laboratory Engineer

Table 5.Team 2 key factors

3.3 How to load the process for success

3.3.1 The Goal

The goal needs to be important and urgent. A good goal is S.M.A.R.T.(see below). The subject needs to be broad enough to allow for brainstorming. (Ulrich et al. 2002, 109-110)

To reduce average material turnaround in temporary storage locations to 1 day (arrival date + 1 working day) within 90 days of Work-Out event.

3.3.2 SMART breakdown

SMART stands for stretch, measurable, achievable, realistic and time-related. The goal presented above is good on all counts.

3.3.2.1. Stretch

The stretch is the affected people and functions, here R&D personnel, R&D functions and any personnel using the areas that currently are used for temporary storage.

3.3.2.2. Measurable

The measurables are the turn-over time for a pallet or material, lead-time for material to arrive and the amount of floor space used by storing pallets.

3.3.2.3. Achievable

The goal has to be achievable. The question "how?" must be answered.

3.3.2.4. Realistic

The goal has to be significant enough to be profitable to execute, while not being too large to handle in the restricted time frame provided.

3.3.2.5. Time-related

The goal must be tied to a schedule to prevent the execution from being superseded by other tasks. In this case the given time frame for execution was 90 days from the event. However this was revised when the ideas were accepted as they could be implemented on a tighter schedule. New dead-line for physical changes was set to 21.6.2013.

3.4 When

The event was decided to be held on May 17th 2013.

3.5 Where

It was decided that the event is to be held on site to provide the teams with quick access to the targeted areas. Helsinki, Hiomotie 13, meeting rooms Virtuaali and Cabinetti

3.6 Conducting the Action Workout Event

3.6.1 The minutes of the day

The Action Workout started by a short introduction into the Kaizen Event method and the GE Work-Out alteration of it. After this the sponsor made his opening remarks and left to return to the town meeting in the afternoon.

Following this was the champion, in this case the problem owner, describing the issue to work on and the team briefing held by the facilitator.

The teams worked for 2.5 hours before lunch and although the scheduled time for working after lunch was only 1.5 hours both groups managed to extend this by effectively working through the lunch. In the afternoon both teams were given 30 minutes to present their solutions and suggestions to the sponsor. Both teams decided to go with one all-inclusive idea. The sponsor was pleased with the produce of the day and approved both ideas for execution.

3.6.2 Agreed upon changes

Two ideas were presented at the town meeting for the sponsor to approve. Both were approved for execution.

3.6.2.1 Team 1, material flow of prototype production

A pallet shelf for six pallets was to be constructed on the 3rd floor, opposite to the freight elevator. This will be used as a temporary storage for incoming and outgoing materials. An area for similar use for whole cabinets is to be marked on the floor on the 3rd floor. Some small supporting layout changes were also to be done, i.e. setting up the computed used for subscribing closer to the new pallet shelf.

New guidelines for the material flow were created and are put into place after the physical changes are completed. These include new orders for the logistics partner, as they will start delivering to and picking up from the prototype production area directly. New permissions were needed for the logistics subcontractor and its personnel.

A new visual pallet management system is put in place. All arriving pallets are marked by the logistics partner with a green pallet tag containing date of

delivery, date of pick up (next working day) and the name of the subscriber. To send materials the pallet tag is turned red side out.

3.6.2.2 Team 2, material flow of research laboratories

New guidelines for usage of the recently assembled pallet shelf are to be enforced. The pallet shelf is divided into segments and the segments allocated to the divisions represented in the laboratories. All segments have a responsible person, who is to maintain good order and ensure proper usage of the shelf. One segment is allocated to be the incoming and outgoing temporary storage. This segment has six pallet spaces. The logistics subcontractor will now deliver to this space and also pick up outgoing materials. The same pallet tag system described above is implemented with an addition of a yellow tag for unclear arrivals.

Physical changes include acquiring a stacker, founding an area for electronics waste and marking shelves and floor areas.

3.6.3 Where did we succeed and what could be changed

Team 1 was not able to create a set of guidelines regarding the cleanliness and order in the prototype production. This sub-objective turned out to not support the main goal and to be time consuming in a way that it would require a separate event.

3.6.4 Lessons learned

A survey (see Appendix 1.) was conducted after the actual event as a last task of the day. In general the Action Workout was praised as a method. The participants were positively surprised how quickly it was possible to get a significant change approved and that the execution started right away.

The feedback (see Appendix 7.) showed that some concern was still present relating to the execution; some participants were worried of the risk of the decisions being empty without any real intent to execute. This risk was countered by setting up a thorough plan for execution, complete with responsibilities and times (see Appendix 8.). This was further enforced by the event sponsor who announced that he will perform inspections on the progress from time to time during the implementation.

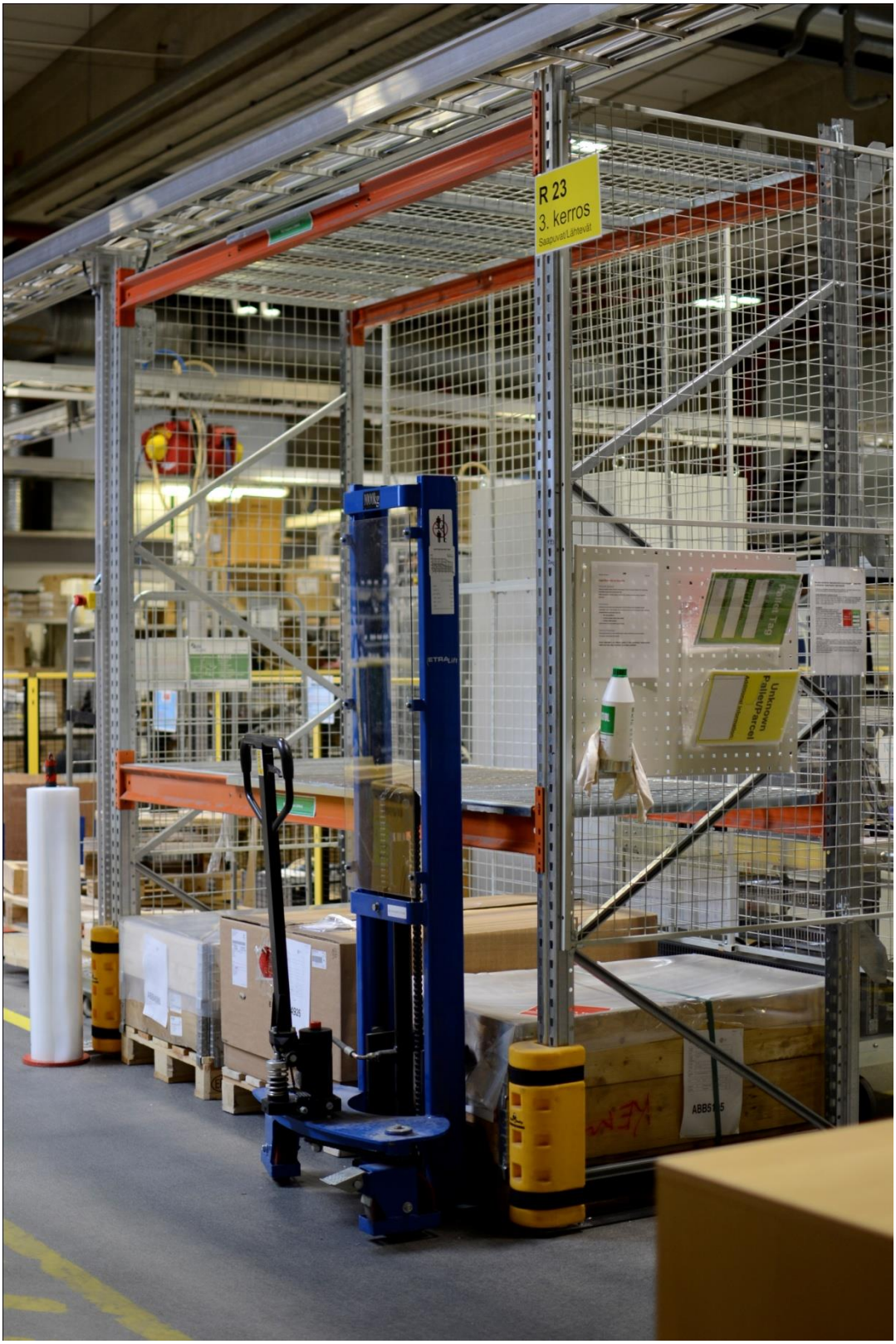
There was also one request for improvement among the feedback. There was some obscurity regarding the way the teams were assembled, a concern was raised that not all necessary personnel were present. Also the selection process was not explained.

3.7 Implementing the changes

It is important to take advantage of the energy generated at the Action Workout and use it as momentum to get the implementations going. Therefore action plans should be done as soon as possible following the event (Ulrich et al. 2002 171-173). The action plans complete with responsibilities were created by May 19th and a implementation schedule was drafted. The tasks along with the dead-lines were distributed to suitable persons, all from the teams of the event.

3.7.1 The layout change in prototype production

A pallet shelf for six euro-pallets was erected for temporary storage of incoming or outgoing materials. The lower shelf is directly on the floor to enable use of an electronic stacking machine. The shelf height is limited to 1000 mm allowing a Euro-pallet with up to four collars to be used. This is limited by the stacking machines lifting height. The upper shelf is suitable for higher units, such as modules (see Picture 2).



Picture 2. Prototype production pallet shelf and lifter.

Layout for the logistics computer station was also changed and it was moved as close as possible to the temporary storage shelf. The new step-by-step user instructions are easy to understand and mounted around the computer (see Appendix 6). The printer has been moved next to the computer eliminating unnecessary movement.

3.7.2 Assigning owners for the downstairs pallet shelves and floor spaces

The existing pallet shelves are divided among the surrounding laboratories, with an exception of one shelf space that is reserved for incoming and outgoing materials. All shelves are marked with labels containing information on coordinates of shelf, owner and often intended materials (see Picture 3). Some shelves are divided into personal spaces (see Picture 4).

Picture 3. Example of a shelf label

Picture 4. Some shelves are divided further into personal storage spaces.

Beyond the shelf issues agreed in the Action Workout it was realized that some non-standard dimensioned materials also need to be stored and for this some floor spaces were reserved and marked.

3.7.3 Subcontractor instructions

As the pallet shelf was completed at the 3rd floor prototype production area and the subcontractors were given authorization to enter the area, the deliveries are made to the 3rd floor. In addition, the subcontractor was assigned to use the pallet tag system (see Picture 1.) and move all red tags and expired green tags to the dispatch.

A supplementing directive was created and shared with the subcontractor (see Appendix 2). A guided tour was held for the supervisors of the subcontractor to show the new shelves, coordinates and to acquaint them with the new pallet tag system.

3.7.4 New material flow guidelines for prototype production personnel

New guidelines were created to support the new material flow process. A challenge was recognized concerning the spreading of the new guidelines. Most of the personnel uses the production area rarely and the turnover is large. Therefore it was decided to make a short and simple step-by-step manual for the tasks of ordering, receiving and sending materials. At first the new process guidelines were only available through visual instruction sheets and through the supervisors. On September 6th 2013 the new guidelines were presented in conjunction with a safety seminar. An entry into the internal instruction database is also made for storing all related materials.

For the manual see Appendix 3.

3.7.5 New material flow guidelines for research laboratories personnel

Following the new arrangements regarding use of shelf and floor space new guidelines were needed. The new manuals were posted at several places in the laboratories as well as by the pallet shelves. Training was arranged, information

was passed through laboratory supervisors and it was made available through the internal database for instructions and guidelines. Full manuals in Appendix 4.

4 RESULTS

4.1 Achieved improvements

The goal of the Action Workout was to reduce temporary storage time for arriving pallets or units to the day of arrival plus until the end of the next working day. This was reached after a short break-in period.

Simultaneously the amount of storage per square meter has improved. The area occupied by materials belonging to prototype production and research laboratories could not be calculated prior to this project due to the unstructured storage practices. However, after the improvements the storage area is restricted to 34,64m^2. The area could before be occupied by a maximum of 33 pallets instead of the 62 pallets + 5 racks it can accommodate now. The pallet amount can be adjusted between 56 and 83, depending on the pallet height needed.

		Pallet spaces	
Area	m^2	Before	After
Prototype production pallet storage	3,36	3	6
Research laboratories pallet storage	25,36	24	54
Research laboratories bulky pallet space	1,92	2	2
Research laboratories rack storage	4	4	0
	34,64	**33**	**62**

Table 6. Area allocated for storage and pallet accommodation before and after improvement.

The task of moving materials to and from workstations was occupying the R&D personnel for between 30 and 60 minutes per direction. This task was assigned

to the internal logistics partner. At the moment of writing, this arrangement does not require any additional resources. Annually around one thousand pallets are ordered to the plant, 984 pallets during the period May 3rd 2012 – May 2nd 2013. Giving a median for the time consumed by moving pallets of 45 minutes per direction the savings in man-hours are 1500 hours annually.

Additional improvements reached include better structure and fairer distribution of storage area for the laboratories. The factory floor (1st floor) is now empty of materials designed for the laboratories and prototype production. The overall visual impression is improved and looks organized.

A visual system was developed to recognize materials by status, i.e. the pallet tags. This system can easily be copied to other units within the plant.

Interviews with personnel working in the vicinity of the common areas that were affected have confirmed that the area in front of the cargo elevator, previously the most affected area, has been free most of the time. The areas owned by other departments have not been used for storage anymore. This generates savings through not having to investigate the unknown pallets and moving them before using the areas. There were remarks that the area in front of the cargo elevator still being used for short term, 1-2 hours, storage.

4.2 From un-measurable to measured performance

The pallet tag system has made it possible to follow the movements of pallets while at the plant. The color coding allows for a quick overlook, and the dates marked allow supervision of the logistics partner.

The pallet tag system is only deployed in the common landing areas. The shelves (Kellari K1, K3-K8) are the responsibility of the supervisors assigned. The second control measure is that all departments have limited pallet spaces at their disposal, limiting the total amount of pallets stored at the plant.

The pallets arriving to the common landing areas are subject to the turnaround goal of day of arrival + 1 day. This was measured during August 29th-30th 2013 and was proven compliant.

5 IMPLICATIONS OF RESULTS

5.1 Recognized needs for further improvement

This section addresses three suggestions for further improvement recognized during the implementation and observation of the new material flow process.

5.1.1 Enforcing the changes in the logistics process

The interviews and observations made at the end of the project indicate that while successful during the summer months, the return of the permanent employees have had an impact on the success. The process and the new guidelines (Appendix 2.) need to be emphasized. This is supported by the sustainability measures described in section 5.2.2.

5.1.2 Prototype production order and cleanliness

In the prototype production the order and cleanliness needs to be attended to. At the moment the common areas are kept empty by the new logistics arrangements, but there is a great risk of this being undermined by the materials being moved to the work cells and stored improperly there. A system already exists where all projects have a checklist that is to be kept visible on the top of the work cell allowing anyone to be informed of the status of the project. This is not used, making it difficult to get any understanding of work cells that are not manned at the moment.

Tools are lying on tables and lack designated storage. A solution would be to create a small set of basic tools for every work cell and create a tool wall for them, where every tool has its own distinct place. This would make the keeping the tools organized intuitive. Special tools and other irregularly used tools could

be stored in the same way as the work cell tools, but in a production area common tool cabinet.

5.1.3 Tornado storage system

The Tornado storage system has a capacity of 63 euro-pallets, most for pallets with 2 collars and a few for pallets with 3 collars. The use of the Tornado is not properly directed. No clear instructions are available. A guideline exists that the Tornado is inventoried every six months and forgotten and abandoned material scrapped or shipped to external storage. Currently the capacity utilization is 42/63 pallets. The stored materials are common parts and surplus components from finished projects. The surplus components are often forgotten when the developments projects reach the next step.

A solution would be to use the Tornado partly as currently, for storage of common materials that are widely used, allowing them to be readily available. The other storage space could be used to store work in progress for shorter periods, if the dimensions or some other factor is making it excessively troublesome to ship these to the external warehouse. Often it is needed to store semi-finished projects for 1-3 weeks while waiting for test results and for potential need for further development. The maximal storage time for this temporary storage could be set to 3 weeks.

The content of the Tornado is documented in an Excel file accessible on the logistics computer, as well as some others. The use of the Excel file needs to be reviewed and if needed additional information columns are to be added.

A secondary visual management method should also be put in place to speed up inventory. Every pallet should be marked with a A4 sized tag that contains information about what project the contents belongs to, the contact person and when it was stored in the Tornado.

5.2 Sustainability measures

In order for the improvements described earlier to be effective and generate long term benefits, the new process needs to be maintained and responsibilities must be clear.

5.2.1 Owner of process

The owner of the process will not be changed. The owner has the responsibility to supervise that no deviations are tolerated. To ensure this the owner will periodically do an inspection of the areas and see to it that any improper storing is rectified immediately.

In addition the owner is to be consulted regarding any changes to the logistics process.

5.2.2 Planned sustainability measures

During the first six months of using the new process regular inspections will be done once a week, preferably supplemented by a quick inspection every time passing the areas. A checklist has been created to support in the weekly inspection (see Appendix 5). When the new way of working has become routine, the frequency of the inspections may be lowered to once or twice a month, still being supplemented by the quick looks when passing the areas. As the new arrangements are visual and everything has a designated place it is possible to determine by just a quick look if everything is in order.

6 SOURCE MATERIAL

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