DIGITALIZATION CHALLENGES FOR LEAN VISUAL PLANNING IN DISTRIBUTED PRODUCT DEVELOPMENT TEAMS

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1. Introduction

As products become more complex and the competition increases, the development of new products has become more important to companies [Clark and Fujimoto 1991], [Chen et al. 2010]. It has been stated that a high-quality product development process is the most important driver for success in product development (PD) [Cooper and Kleinschmidt 1995]. During this process the companies needs to have a method for developing sharing correct information at the right time, otherwise projects can be delayed due to re-work and modifications [Zirger and Hartley 1994].

The process of developing new products has changed a lot over the past 40 years. During the 80's the Japanese outrun its competitors concerning number of product models in combination with time to market [Womack et al. 1990]. The Japanese companies relied on a concept later termed as Lean Product Development (LPD) [Womack et al. 1990]. From LPD emerged a method for planning and synchronizing projects named Visual Planning (VP), which have shown strong benefits for its simple design and ability to plan project with little effort and a low threshold to the methodology [Lindlöf 2014]. VP helps the team to focus on the execution of the project involving resource allocation, assuring deliverables and keeping focused on the common goal [Lindlöf 2014]. Traditionally the only resources demanded are sticky notes, some pens and a wall to place the notes on. However, limitations of a physical solution becomes apparent when more and more projects are conducted in distributed teams, where information on wall-based boards becomes difficult to share and interact with.

One method that has similarities to Lean VP is Scrum and the most obvious difference between the Lean VP board and Kanban/Scrum board is the horizontal axis which in VP is presented by a timeline while on the Kanban/Scrum board is presented as different phases/statuses (Figure 1) [Sutherland et al. 2009], [Söderberg and Alfredson 2011], [Mundra et al. 2013]. Kanban/Scrum boards are common to use within Agile development and especially within software development. Lean Thinking and Agile development are two different but complementary concepts [Oehmen et al. 2012]. The research concerning VP is very limited [Lindlöf and Soderberg 2011] and therefore the name, definitions and description of the methods on the matter varies [Lindlöf 2014]. For example, what Lindlöf [2014] describes as VP can be included in Mascitelli's [2011] term Visual Workflow Management. A definition of VP that is used in the context of this research paper, emphasize the support for the team concerning task coordination and is independent of physical boards and notes*: "One method for development teams to handle this task coordination is to visualize tasks and deliverables to enhance their communication and coordination within the team"* [Lindlöf 2014].
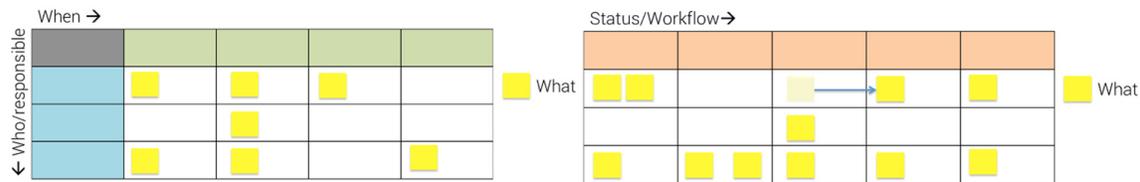
Figure 1. Example of common structural difference between Lean VP (left) and Kanban/Scrum board (right)

Visualizations concerning project and product management are commonly used in industry today, both in production environments and within PD, and the research is expanding [Leon and Farris 2011]. Many highlights the importance of visualizations within PD, but the terminology varies: Visual Control [Liker 2004], [Parry and Turner 2006], Visual Workflow Management [Mascitelli 2011] and Visual Management [Lindlöf 2014]. Liker [2004], Parry and Turner [2006], and Mascitelli [2011] connect visualization to Lean, and Liker [2004] describes visual control as "any communication device used in the work environment that tells us at a glance how work should be done and whether it is deviating from the standard".

Visualizations in production and PD is often used to get an overview of the situation. Parry and Turner [2006] believe that visual control can help companies to high performance and Mascitelli [2011] argue that a company should start their Lean implementation by adopting Visual Workflow Management. Visual Workflow Management will ensure fast and visible improvements, which is crucial to create long-term and successful changes within an organization. According to Söderberg and Alfredson [2011], several companies start their Lean journey by implementing VP. Lindlöf [2014] highlights task communication within product visualization and says it is rather unexplored area and relates it to "the planning and execution of tasks".

Distributed teams

The term "virtual team" is used to describe members of a group or a team that works closely together without being in the same physical location [Townsend et al. 1998], [Hertel et al. 2005], [Duarte and Snyder 2006], [West 2012]. A virtual team could also be spread out in time, i.e. different time zones [West 2012]. This paper will use the following definition of virtual team, focusing on distributed team members, connected by IT:

"Virtual teams are groups of geographically and/or organizationally dispersed coworkers that are assembled using a combination of telecommunications and information technologies to accomplish an organizational task" [Townsend et al. 1998].

A team that are spread out within a building have some similarities with a virtual team [West 2012]. According to Hertel et al. [2005] it is unusual that the whole virtual team is spread out at different location, in most virtual teams some of the members have the opportunity to have face-to-face communication with each other. Also, communication media is used by team that are located together, and is not exclusively for virtual teams [Hertel et al. 2005]. Therefore, some researchers instead talk about the "virtuality" of a team [Hertel et al. 2005].

Some characteristics are highlighted for virtual teams: they collaborate and coordinate their job with the help of electronic means and communication electronics [Townsend et al. 1998], [Hertel et al. 2005]. According to West [2012] the way of working using virtual teams is quite new which also is the case for the technology used to facilitate virtual teams. However, Hertel et al. [2005] argue that work distributed over different locations is not a new thing but it has become much easier, faster and efficient with the development of electronic information and communication media.

Hertel et al. [2005] and Duarte and Snyder [2006] discuss some aspect that they believe are important for the success of a virtual team (aspects that have not already been covered above):

- Clarified goals and team roles, to avoid causing conflicts with work tasks
- Careful implementation of efficient communication and collaboration processes to prevent misunderstandings and conflict escalation due to virtual communication

- Continuous support of team awareness and performance feedback of the individual team members working situation
- Create experiences of interdependence to compensate for the feeling of disconnectedness within the team
- Organizational culture
- Leadership support of virtual teams
- There is no ideal set of technologies for all teams
- A virtual team needs to have a clear strategy for matching technology to the task
- A great deal of social presence and information richness is not always desirable
- Bandwidth, cost, and compatibility issues can affect a team's performance

Distributed teams using VP

Most of the research done concerning VP have the scope of PD at one site. There are less knowledge documented about how to use VP in distributed teams. Lindlöf [2014] identify this as an area in need of more future research, and that many believe VP need a single-site team to work. According to Lindlöf [2014] rich communication is needed to gain the benefits of VP, and a single-site team can be seen as a prerequisite. However, Lindlöf [2014] also assumes that VP can support a distributed team, if further effort is taken to adapt it to its context. He presumes that the standards of VP could be beneficial for communication between sites to limit misunderstandings within communication due to culture and language differences. Mascitelli [2011], Söderberg and Alfredson [2011] and Lindlöf [2014] highlights the importance of face-to-face communication at frequent meetings.

Mascitelli [2007] discuss that different types of meetings should use appropriate communication technology, and argue that coordination meetings should use phone equipment when face-to-face communication is not possible. However, if the purpose of the meeting is collaboration video conference equipment should be used [Mascitelli 2007]. Hertel et al. [2005] also argue that the use of equipment should be based on the need of collaboration.

2. Research approach

The field of research concerning VP used in projects having distributed teams is, to a large extent, uncharted territory, while being an area of interest. The purpose of this study was to address how VP can help a distributed team within PD to succeed and what challenges might interfere. A combined literature review and qualitative case studies will support the study with data. Together the results aim to give input to how VP can be used to support distributed teams both concerning the methodology and practical tools.

The research questions for this study are:
- RQ1: What are the existing challenges for distributed teams to work effectively with Visual Planning?
- RQ2: How does these challenges apply to physical and digital Visual Planning respectively?

There are some delimitations in the study such as the companies are medium to large enterprises operating around the world but the interviews are performed in Sweden or Norway, which might effect the possibility for the interviewees to be aware of all tools and methods used in the company. The differences in the cultural aspects are not considered during the study.

Case company selection and criteria

Companies that primarily develop a product or deals with high complexity products has been chosen for this study. Working with distributed production or development, i.e. having a multi site problem worked as a second critera. Third aspect deals with availability, i.e. proximity to the researchers and availability to host the researchers for meetings and granting the researchers access to planning meetings and information. The case companies are shown in Table 1 and in Table 2.

Table 1. Case companies within the study

Company	Industry	Revenue (mEuro)	Employees
A	Manufacturing and services	57 000	44 300
B	Automotive safety	4 400	39 000
C	Instrumentation and automation systems	120	401
D	Automotive	1 000	10 000
E	Dealership	90	200
F	Automotive	9 700	42 100
G	Industrial equipment	260	1 100
H	Car manufacturer	10 400	15 768
I	Industrial equipment	1 800	9 000

3. VP within the case companies

The study show that VP supports an organization's capability to process information and help PD teams in their daily work to handle increasingly more complex products by supporting communication and coordination. VP gives the ability to enable improved internal communication, both participative and reflective, by giving the objectives of the projects and activities clarity among the team members. The whole team gain increased communication efficiency by short and frequent meetings and access to real time information; the managers and the leaders mostly see the benefits of coordination. However, for VP to be useful it is important that there is a need for coordination by having relations about work packages between the team members.

The study does not fully agree to Lindlöf and Söderberg [2011] which stress the importance of seeing VP as a complement to previous working methods, not a replacement. There are examples of projects where VP has fully taking over the support function for planning in the case companies.

Table 2. Properties within the studied groups at the case companies

Company	Data Collection (I=interviews, O=observations during meeting)	Function involved in the study	Where VP is used?	Tool /Realization	Distributed teams
A	2 I & 1 O	PD	Project	Post-it/ Excel	Yes
B	14 I & 9 O	PD	Line organization and project	Yolean	Yes
C	15 I & 10 O	PD	Project, and sometimes in the line organization	Post-it and Yolean	Yes
D	2 I & 2 O	PD	Project	Post-it and Yolean	Yes/No in studied case
E	5 I & 5 O	Management team	Management team and in projects	Yolean	Sometimes meetings over distance
F	3 I & 1 O	PD	Line organization	Post-it	Collaboration, but not teams
G	1 I & 1 O	PD, mechanical	Line organization	Post-it	No
H	2 I & 1 O	Operational Development	Line organization	Post-it and Yolean	Collaboration, but not teams
I	3 I & 2 O	PD	Line organization , function & in projects	Post-it, Excel and Yolean	No

Mascitelli [2011] highlights the importance of the team instead of the team leader to lead the meetings and to decide what to do and from the interviews this is seen as one of the strengths of the VP in the

case companies. By having the team performing the planning, a feeling of ownership of the task and activities is achieved compared to traditional planning where the project leader creates the plan and "applies" it to the team.

Experiences that has been expressed during the study, and which are in line with Holmdahl [2010], is for example; Improved resource utilization, Fewer delays, Better control through: increased participation, Increased understanding and simplified problem solving, Resource balancing, Increased flexibility, Improved knowledge dissemination, Reduced work due to preventive double work, and Better control/managing of the project.

In all, VP consists of two components: the board and the meeting, and are both considered equally important and should therefore be implemented and used together [Mascitelli 2011], [Söderberg and Alfredson 2011]. Within this paper it will be referred to as a VP-board and VP-meetings respectively. VP in some of the case companies are referred to as Knowledge Innovation/Visible Planning (KI/VP) developed by the consultancy firm JMAC [Hines et al. 2006].

The creation of VP

If the team creates the plan there is a greater feeling of ownership from them and it is more likely that the project will finish on time [Mascitelli 2011]. "Visualize the complexity, within a project, involve all project members in the planning" – project manager at C. It is important that teams understand the basics of project management, and to remember that it is impossible to create the perfect plan instead one should focus on getting a good starting point which can be dynamic to upcoming changes. It is recommended to start with final deliverables and to work the way backward. In the beginning the detail level can be very low. The VP are recommended to be based on milestones that are set by people outside the project team for example a general PD process for the company.

The goal and outputs from the first project breakdown meeting should be: High-level project master schedule, estimated product launch date, resource estimates and project budget, prioritized list of project risks and actions required to close the event. In this example the risks are prioritized by what probability they will occur and what the impact would be. The master schedule will work as the foundation for a three-month planning. The project breakdown meeting is in some of the case companies referred to as Barashi and aim to create a common understanding of what should be done in a project and to identify possible knowledge gaps. By doing a "Barashi", a visual target breakdown structure clarifies the project. The long-term plan is then based on the Barashi and represents the agreed commitments and the overall deliverables within the team [Oosterwal 2010]. The Barashi and long-term plan can be created at a common workshop for the whole team or some team representatives. The Barashi and the long-term and mid-term plans should help the individuals to see dependencies within the team and with other teams and to give an understanding of what should be done. The quality of the resulting plan is dependent on the knowledge and capability of the team members. The team cannot blame the tool if the plan is of low quality, since the tool is only a tool and it only reflects the ability of the users. However the tool will help in exposing such issues so that countermeasures can be taken directly, rather than hiding them for later.

The VP-board

The boards varies between the companies but are all built one some general design such as short-term board, a mid-term board and a long-term board, with the resolutions days, weeks, months or quarters, respectively on the horizontal axes. A common use of a visual project board in the studied companies include planned and unplanned work, a two-week action plan and a project timeline. A rule of thumb is that every delivery on the long-term plan should have at least one but probably more than one corresponding note on the mid-term board. Other suggested additions to the board are an inbox for possibility to add discovered crucial problems or actions that then can be assigned to someone at a later meeting. The rows represent the resources in form of functions or persons. In Figure 2, a version of a physical VP-board is presented showing the relationship between short-term, mid-term and long-term planning. The VP-boards can be used for other missions than projects and are sometimes referred to as initiatives rather than projects. Sticky-notes are used for the activities on the physical VP-board and the individual team members often write their own sticky notes on what they should do. Supporting software

often use the design of a sticky note and a whiteboard to increase the similarity. The sticky-notes can be color coded in different ways and even if the studied teams had the ability to affect their layout there seem to be a common standard description for the notes, following:

- Blue – Deliverables, Milestones
- Green – Proposed activities for someone else (Could also be used to indicate starting point)
- Red – Critical issues or Knowledge Gap
- Orange – Of site activities (including vacation)
- Yellow – Activities

In some cases deviations to tasks was highlighted with a red frame and milestones with a black frame. The green notes sometimes worked as an input-note, i.e. if another individual or team should perform one deliverable the requesting part can create a green note and stick on the receiver's row. A typical note includes text, estimated time, real time (actual amount of time) and a red dot down to the right if it is delayed.

The VP-board help teams to see current status of a project, and to work with a common truth instead of decisions based on different beliefs within the project. However, drawbacks that are observed with the physical VP-board are difficulties to track and link activities on the VP-board and it requires extra work to track the data related to the progress of the project Söderberg and Alfredson [2011] also highlights the lack of connection between the notes, and say that physical VP facilitates communication but not correlations between the notes when a note is moved.

Figure 2. Three different views within Visual Planning at case company C

The VP-meetings

The meetings at the case companies where short and where hold standing-up, which was seen, as essential. These meetings primary focus on the short-term VP-board. The meetings were commonly 15 minutes long and held regularly. But their frequency varied from daily to once a week depending on the

need of communication for each specific group. Most common were two meetings per week. The meetings usually started with the team manager highlighting some common deliverables and/or issues, and then every team member had a time slot each to go through the status of their respective row and to address possible problems. Due to the short time available at the meeting, there is no time for discussions. If necessary, a complementary another meeting should was booked with concerned members. It was also possible to use an hourglass to keep track of each individual's time. If the position of the VP-board was close to everyone's workspace it encouraged more interaction.

The idea for stand-up meetings in PD come from the shift-change meetings within production, where issues and likewise are addressed [Mascitelli 2007]. Stand-up meetings should be brief to create a sense of urgency [Mascitelli 2011]. Benefits with a stand-up meeting is that no one gets comfortable and starts doing other things such as checking phones and emails, the team focus on the VP-board [Mascitelli 2007]. Outcomes that has been observed on the case companies for frequent meetings are that they:

- Creates a shared language among team members
- Allows for real-time reallocation of resources
- Encourages focus on value-creating activities
- Establishes a clear, prioritized work for each day
- Provides a mechanism for cultural change
- Builds team identity and emotional commitment

The meetings are often hold in the morning and are due to the fact that people tend to forget tasks that are planned in the afternoon until the next day. Managers at the companies repeatedly highlights that whole teams should attend, preferable in person, but otherwise by phone or another member has responsibility re-cap the progress. The length of the meetings varies but a recommended time of 15 minutes is the standard recommendation on the case companies. The companies argues that the frequency of the meetings should be adapted to the current phase's intensity and can vary from twice a day to monthly, but most common is three times a week. Even if the recommendation of having more frequent meetings in busy times, this was not always the case. The team members needed to have enough time for new information to occur between the meetings, but too few meetings increased the risk of misunderstandings and incorrect assumptions. One risk that was mention by having meetings too seldom is that decisions will be taken in a parallel process.

During the meeting the focus should be on the team and not the team leader, and it is encouraged to rotate the facilitator for the meetings. Every team member should answer the following questions ("By constantly ask the same questions again and again, we learn to answer them" – interviewee at case company F):

- What did you learn since the last meeting, what is left to deliver?
- What work will you accomplish before the next meeting, what are the risks?
- What do you need from other attendees to achieve your goals?

The VP-meeting enables early problem solving through the frequent meetings in combination with the visualization of activities. Lastly a VP-board is continuously updated, which makes it more dynamic, and presents real-time information making it possible to follow team members' workload and work proactive.

Digital VP

A common view on IT-tools from the companies that uses the physical VP-board is that it will risk losing the advantages of the physical board - a dynamic management tool to create a common view and commitment. Lindlöf and Söderberg [2011] see a risk with less team communication when a software is used, however this was not confirmed by this study, but remains a valid risk as more and more planning activities are being digitalized. Instead a few companies experienced successful examples of IT-tools being used for VP and believe it can be used in a similar way as a physical VP-board during meetings, as long as these risks are acknowledged and managed (see Figure 3). All companies highlight the need for the existence of the meeting and clearly state that even if a digital board makes it possible to interact whenever wanted, the meeting is an important aspect of VP.

One common risk that are seen when moving to a digital VP-board is the wide possibilities of features that are possible to implement, which makes the trade-of between easy to use & high visualization and

a feature-rich board difficult. Some companies also mention that it is too easy to just focus on the technical aspects as "which colors and notes to use", and highlight that the goal with VP is to change the behavior of people. They believe that the challenge with VP is to change the culture within the company, and not only the technical aspects.
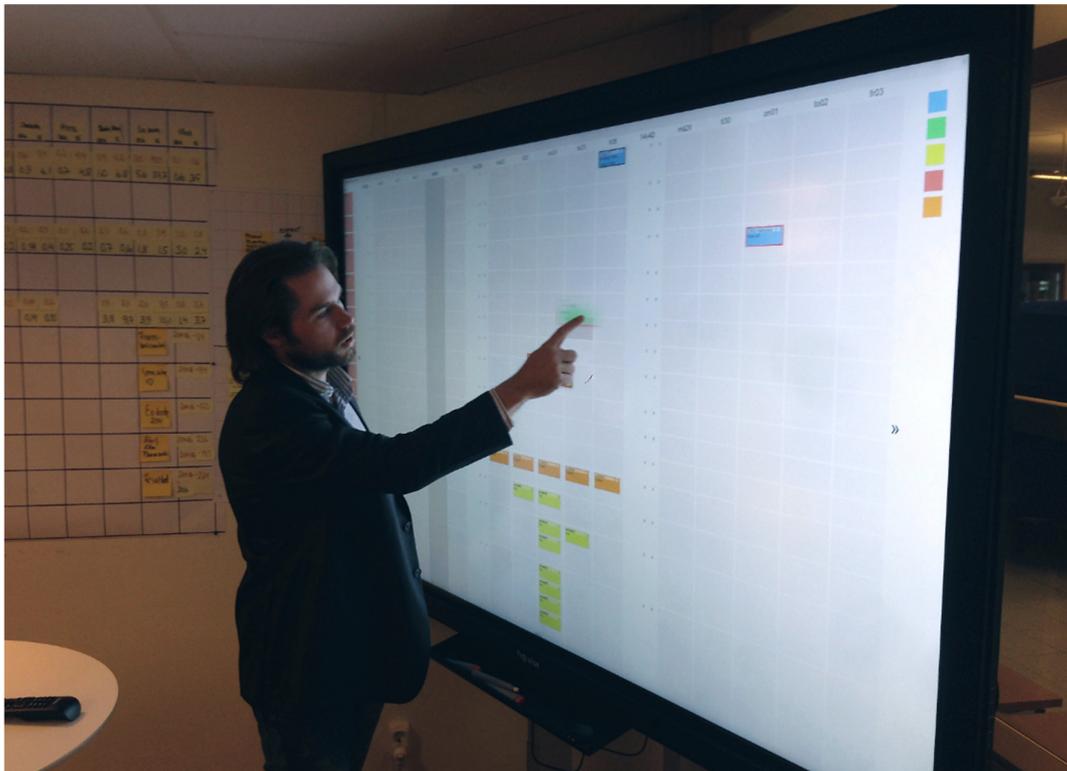
Figure 3. Example of digital Visual Planning at case company E

Table 3 presents some of the main existing and remaining challenges, which needs to be addressed regarding VP performed in distributed teams.

Table 3. Identified challenges with VP in distributed teams for physical and digital board

Cate-gory	General issues for Distributed meetings	Physical board (Assisted by video conferencing)	Digital board (Assisted by video conferencing)
VP meeting	• Difficulties to follow the meeting. Due to bad sound, video and interference. • Limitations in communication such as body language.	• Difficult to know what is in focus, "which activity are we talking about?" • Large risk for misinterpreting, and talking over each other's head. • Using a photo, spread sheet or protocol to mirror the information requires more work (after the meeting is finished) compared to single site planning.	• Complicated to write on the digital board, compared to paper notes (e.g. by using onscreen keyboard or hand recognition), which sometimes affect the meeting process. • A risk that people will underestimate the importance of the meeting and only focus on the digital board (e.g. by not going to the meeting).
Room design	• If the team has unbalanced number of members on each site, the site with fewer members	• Project rooms and the VP-boards require a significant area. • Increased space required when different projects cannot share the same project room (e.g. in defense sector).	• Requires more technology to work, not only video conferencing but also connected boards, computers etc.

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		Multi-site meeting. requires mirroring of boards and equipment	• Requires (sometimes) expensive hardware e.g. 4K large panel touch screen.
VP-board	• Finding the right trade-of between standardizing the layout of the board while still keeping the possibility for develop best practice. • Local vs. global efficiency. What is allowed to modify and to what benefit of the organization.	• Historical data is difficult to capture and therefore seldom used for follow up. • Being a member of several projects, make it difficult to get an overview of individual tasks and deliveries. • Poor handwriting decreases readability. • Moving a task or deliverables several times will result in deprecation of glue and notes will fall off the board. • Difficult to visualize connections between e.g. deliverables and tasks. (Even more difficult with connection between different boards, see Figure 2). • Difficult to manage large amount of notes (looses visibility due to stacking)	• Accessibility might be decreased for different reasons e.g. problems with authentication. • Board might become difficult to use and limit the original methodology as too many and unnecessary (nice-to-have) functions are added to the software. • Requires more training to operate compared to a wall based VP-board. • Higher cost compared to wall based.

4. Conclusions

VP and other lean methodologies are increasing in popularity and are currently being adopted by industry in quick pace. As some methodologies originally has been developed to work for co-located teams, the physical, wall based solutions often generates challenges when being introduced in distributed teams. In this research project it was found that seven of the nine case companies used some kind of digital solution (digital photos, spreadsheets or digital whiteboards) to support the VP-meeting as a result of these deficiencies. The studied companies expressed a strong need for capturing the essence of the lean methodology before digitalizing as their experience had shown on many problems with going digital too fast. In this strive to stay true to the physical methodology, attempts had been made to keep the whiteboard and post-its in distributed teams, however with a low success rate at the connected sites, due to e.g. bad videoconferencing sound and low resolution cameras. In Table 3 the challenges with distributed meetings in general as well as the physical (e.g. whiteboard) and digital support tools are presented separately. The trend in PD of distributed projects is currently strongly moving towards the digitalization of project rooms and meeting tools, however there are major benefits with the VP meetings that must not be overlooked. An example of a major risk with digital boards, is that the meeting disappears as engineers feel that the digital tool replaces the meetings entirely.

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