Research Journal of Applied Sciences, Engineering and Technology 4(6): 649-659, 2012
ISSN: 2040-7467

Submitted: November 03, 2011 Accepted: December 09, 2011 Published: March 15, 2012

A Framework for Sharing Knowledge in Product Development by E-collaboration through Project Management

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Abstract: In this study, the author has purposed electronic collaboration (E-collaboration) through a project manager between different departments in a factory can create a favorable environment to development the projects in terms of time and cost. In fact, the E-collaboration is a tool in hands of project managers. For this concept the author purposes, a conceptual model for sharing knowledge, which support development product. The model uses four factors, namely, design, planning, procurement and production. In addition, these factors consist of several items separately: For design department, there are four categories: (1) standard materials (2) teamwork (3) expected level of production (4) process restrictiveness. For planning department, there are three categories: (1) schedules (2) Inventory control (3) Receive progress reports. For the procurement department, there are three categories: (1) information gathering (2) background review (3) negotiation. For production department, there are two categories: (1) check on the incoming raw materials (2) change volume of production. The performance of the conceptual model tested in terms of some objectives. This test has done by interview with 20 project managers in electronic industry in Iran. The result indicated the model has accuracy for development new products in conditions of time and cost.

Key words: Development time, E-collaboration, knowledge sharing, new product, project management, reduce cost

INTRODUCTION

Delivery of projects according to schedules has been a goal for companies (Mohammadjafari *et al*., 2011a). Because, completing projects earlier create many benefits. Additionally, earlier completion of projects generates time and cost saving. Many prior researchers have been purposed several models to development time and cost saving (Mohammadjafari, *et al*., 2011b). For example, Callahan pointed out that sales and marketing involvement in defining product requirements, supplier involvement early and late in the development cycle, frequent load builds and system tests are useful for reducing software product development times (Callahan and Moretton, 2001). Zirger elaborate that cross functional and overlapped development activities are effective at acceleration techniques on product development time (Zirger and Hartley, 1996). Bashir illustrated involvement of partners in the development process has a good accuracy for estimating development time (Bashir, 2008). Ali proposes that product innovativeness moderate the link among development time and initial market (ALI, 2000). Meyer and Utterback found the need to integrate multiple tec hnologies necessary to extend development performance in product development (1995). Kusar illustrated concurrent engineering lead the product to development time (Kusar *et al*., 2004). Selvaraj proved Design for Manufacture, and Assembly (DFMA) is important in product development and it considerations to standardization and simplification of manufacturing processes also it facilitates integration of function and from the workflow (Selvaraj *et al*., 2009). Swink proved Marketing-Manufacturing Integration (MMI) is useful in new product development (Swink and Song, 2007).

Gerwin found Integrated Product Development (IPD) generates contact between activities and overlaps activities in the new product development process (Gerwin and Barrowma, 2002). According to Lifang, designing products by modular component parts help the producer to produce in shortening time and speed up new products in the marketplace (Lifang *et al*., 2009). Rauniar pointed out the joint collaboration in the processes of product development reduce the glitches of projects and

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Table 1: Some description for development time and reduce cost

Source information		Performance effects		Description
No	Author (s)	Development time	Cost saving	
1	Callahan and Moretton, 2001	√		Sales and marketing involvement in defining product requirements, supplier involvement early and late in the development cycle, frequent load builds and system tests
2	Zirger Hartley, 1996	√		Cross functional, overlapped development activities
3	Bashir, 2008	√		Involvement of partners in the development process
4	ALI, 2000	√		Initial market
5	Meyer and Utterback, 1995	√		Integrate multiple technologies
6	Kusar *et al*., 2004	√		Concurrent engineering
7	Selvaraj *et al*., 2009	√	√	Design for Manufacture and Assembly (DFMA)
8	Swink and Song, 2007	√		Marketing-manufacturing integration (MMI)
9	Gerwin and Barrowma, 2002	√		Overlap and interaction between activities
10	Lifang *et al*., 2009	√		Designing products with modular component parts
11	Rauniar *et al*., 2008	√	√	Joint collaboration
12	Thomke and Fujimoto, 2000	√	√	Front-loading
13	Roemer *et al*., 1999	√	√	Overlapping of design
14	Kong *et al*., 2006	√		Assembly line
15	Guniš *et al*., 2007	√	√	Research and Implementation of the Virtual Enterprise Model -(RIVEM)
16	Liberatore and Stylianou, 1995	√		Merges knowledge-based expert systems
17	Herrmann and Chincholkar, 2001	√		Guidelines, capacity analysis, estimating throughput time
18	Petersena *et al*., 2005	√	√	Integration of material suppliers
19	Wang, 2002	√	√	Fuzzy scheduling
20	Choi and Cheung, 2008	√	√	Versatile virtual prototyping (VP)

improve product development time and cost (Rauniar *et al*., 2008). Thomke defines front-loading (to concentrate costs or benefits in early period) be able to decrease development time and cost (Thomke and Fujimoto, 2000). Roeme has illustrated overlapping of design and development phases are regarded as a good strategy to reduce product development times (Roemer *et al*., 1999). According to Kong, it is essential for manufacturers to building an assembly line in order to shorter time of production (Kong *et al*., 2006). Guniš presented "Research and Implementation of the Virtual Enterprise Model (RIVEM)" to apply collaboration tools to complete activities electronically joined with product development (Guniš *et al*., 2007). Liberatore crated a modeling framework that merges knowledge-based professional systems and considered to development of a new product (Liberatore and Stylianou, 1995). Herrmann believed making some tasks early in the process of product development can reduce product development time like design guidelines, capacity analysis, and estimating throughput time (Herrmann and Chincholkar, 2001). Petersen found the integration of material suppliers into the new product development offer some advantages to smooth the progress of new products and reduce the cost of new products (Petersena *et al*., 2005). Wang illustrated to develop a fuzzy scheduling methodology in order to develop an algorithm to find out a schedule with the minimum schedule risk and the start time of each activity to reduce the required development time and cost (Wang, 2001). Choi found a versatile Virtual Prototyping (VP) system smooth the progress of product design and assist to reduce development time and cost (Choi and Cheung, 2008) Table 1 shows some description for development time and reduces cost.

By investigation in the previous studies, the author found a gap in new product in terms of time and cost. This gap is the lack of E-collaboration through a project manager between related factors for production. Although the categories for collaborative tools through the internet used in many industries during the whole word like: Group file and document handling, computer conferencing, electronic meeting system and electronic workspace. And of course there are several internet connections in many companies like: Dial up, ISDN, Broadband network, DSL (digital subscriber line), and direct satellite connection. However, there is not existing a defined E-collaboration between a different department in a factory in order to reduce time and cost.

In this research, the author tries to create a model and suppose E-collaboration between four departments through a project manager in a factory helps to reduce time and cost in new product.

LITERATURE REVIEW

Since the main of this survey is the effects of E-collaboration by project management for development time and cost by sharing knowledge between different departments of factory, the concepts and history of E-collaboration and project management and some important factors for production line according to literature review are of major important in this section.

E-collaboration: E-collaboration is collaboration among different individuals to accomplish a joint task using electronic technologies (Cai and Kock, 2009).This technology helps many industries to achieve the goals. The history of technology of E-collaboration dated back

Table 2: The related factors in production line

Source information		The related factors in production line			
No	Author(s)	Product	Design	Procurement	Planning
1	Clark, 1989	√		√	
2	Kelly *et al*., 1995	√			√
3	Munns and Skibniewski, 1996	√			
4	Westfechtel, 1996				√
5	Cohen *et al*., 1996	√			
6	LaBahn *et al*., 1996	√			
7	Söderquist 1997	√			
8	Luiten *et al*., 1998	√			
9	Herrmann and Chincholkar, 2000	√			√
10	Browning, 2001	√			
11	Herrmann and Chincholkar, 2001				√
12	Callahan and Moretton, 2001				√
13	Moore and Antill, 2001		√		
14	Willoughby, 2001		√		
15	Gunasekaran *et al*., 2002	√			
16	Kobayashi, 2003	√			
17	Tan and Wisner, 2003	√			
18	Rubiano Ovalle and Crespo Marquez, 2003				√
19	Ozer, 2003	√			√
20	Zha and Sriram, 2004	√			
21	McCain *et al*., 2004	√			
22	Curran *et al*., 2004				√
23	Kusar *et al*., 2004	√			√
24	Nitithamyong and Skibniewsk, I 2004		√		
25	Li and Geiser, 2005		√		
26	Dangelmaier *et al*., 2005				√
27	Carbone, 2005	√			√
28	Ozer, 2005				√
29	Gunasekaran and Ngai, 2005		√		
30	Olsen *et al*., 2005		√		
31	Kim *et al*., 2005	√			
32	Liu *et al*., 2005	√			
33	Koufteros *et al*., 2005	√			
34	Hong *et al*., 2005	√			
35	Ozer, 2005	√			
36	Björk, 2006				√
37	Yeo and Ning, 2006		√		√
38	Hines *et al*., 2006		√		√
39	Welsh *et al*., 2006		√		
40	Schätz 2006		√		
41	Yujun *et al*., 2006	√			
42	Mulebeke and Zheng, 2006	√			
43	Telukdarie *et al*., 2006	√			
44	Lu *et al*., 2007	√			
45	Saccani and Perona, 2007	√			
46	Brews and Tucci, 2007		√		
47	Elia *et al*., 2007		√		
48	Brown *et al*., 2007		√		
49	Arshinder *et al*., 2008	√	√		
50	Rauniar *et al*., 2008	√			
51	Chen *et al*., 2008	√			
52	Kanda and Deshmukh, 2008		√		
53	Gunasekaran and Ngai, 2008		√		
54	Karjalainen and Kemppainen, 2008		√		
55	Dulluri and Raghavan, 2008		√		
56	Closs *et al*., 2008	√			
57	Rauniar *et al*., 2008	√	√		√
58	Wu *et al*., 2009	√	√	√	
59	Johnson and Filippini, 2009	√			
60	Kodama 2009			√	

Table 2: (Continue)

Source information		The related factors in production line			
No	Author(s)	Product	Design	Procurement	Planning
61	Lehner, 2009			√	
62	Marion and Simpson, 2009	√		√	
64	Gunasekaran *et al*., 2009		√		
64	Bals *et al*., 2009		√		
65	Hadaya and Cassivi, 2009	√			
66	Kim and Kim, 2009	√			
67	Revilla and Rodríguez, 2009	√			
68	Crespin-Mazet and Portier, 2010		√		
69	Hicks *et al*., 2010			√	
70	Ilgin and Gupta, 2010	√			√
71	Andersson *et al*., 2010		√		
72	Eriksson and Westerberg, 2010		√		
73	de Sousa, 2004			√	

to an invention of the telegraph by Samuel F. B. Morse in the mid-1800s. Another E-collaboration in 1870 promoted with the invention of th telephone by Alexander Graham Bell. The first commercial computers used during World War II and after that E-collaboration became a reality. E-mail as the father of all E-collaboration technologies was detected during the 1970s and 1980s. In the 1980 ARPANET, LAND and personal computers, created E-collaboration technologies. In 1990s the ARPANET was changed into today's present the internet, which is a global network of computers made up of several LANs, interacting through the same general correlation protocol (Kock and Nosek, 2005). Today there are four categories for E-collaboration like Group file and document handling, computer conferencing, electronic meeting system and electronic workspace (Bafoutsou and Mentzas, 2002).

Project management: In the 20 the century the management became the subject of many studies, and then manages of projects is not new. In 1944 the first paper of management published in UK and emphasized the planning for projects by Civil engineers. In 1950 US Navy consider to project management for development the projects. A few years later, NASA attended to a project manager to complex Apollo's program. With improving the technology, complexity of projects has increased and the use of a project manager for scheduling, controlling project, planning and monitoring increase. Today, project management has percolated in many districts, for example, systems development research and development banking, educations and corporate management (Wideman, 1995).

Related factors in production line: In view of the fact, the author wants a purpose a conceptual model according to related importance factor for production line. Then, understandings about previous studies around these factors are necessary. According to the previous studies, there are many factors for implementation the projects but four of them are important and necessary for production in companies. These factors are departments and process of design, planning, procurement and production. The importance of existing of these factors is investigated by many researchers in different years. The summary of this allegation shows in Table 2.

Proposed conceptual model: Our research of E-collaboration, project management and development time and cost in new product formed the basis for this proposed model.Prior research has illustrated many method for development time and cost (Meyer and Utterback, 1995; Herrmann and Chincholkar, 2001; Kusar *et al*.,2004). However, a few of research discuss about E-collaboration through project management for development time and cost.

From our particularity literature, we found 12 success factors (related to independent variables) can lead the projects to achieve the success according to time and cost (dependent variable). After that we developed a model that integrated this comprehensive. For developing the model at first we found the Fig. 1 according to literature review and after that add one moderator namely, E-collaboration by project management for achieving the purpose of this study as shown in Fig. 2.

Figure 2 demonstrates the conceptual model for development time and cost in new product by E-collaboration through project management. The 12 identify success factors arranged into four dimensions: design, planning, procurement and production.

The following is the concept of these factors and their categories.

- **Design:** For implementation the projects, the designs of product especially design for new product is essential. According to Ralph in 1999 there are four

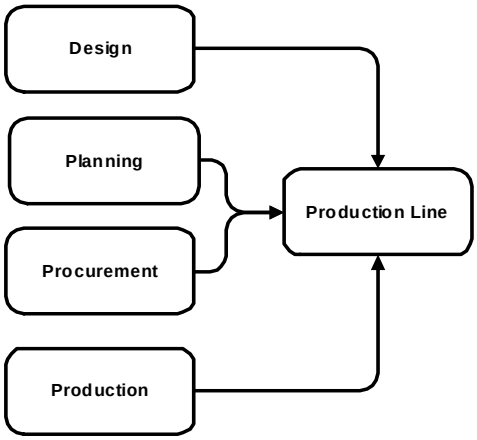

Fig. 1: The related factors in production line (according to literature review)

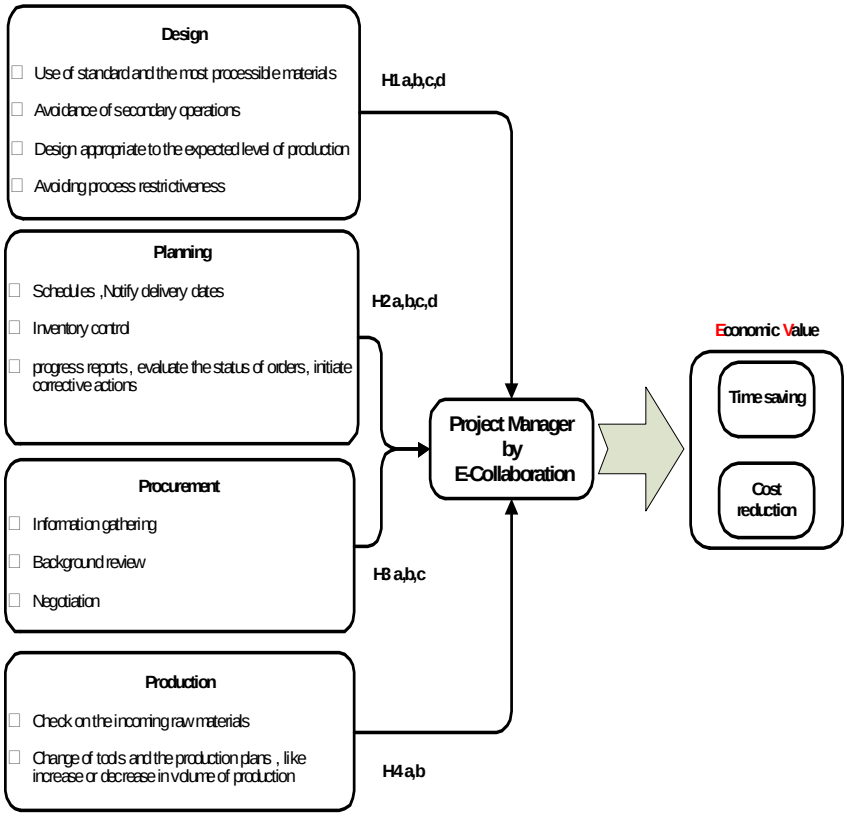

Fig. 2: Conceptual model

mechanisms that we must to be considering in a process of design (Bralla, 1995). And with these categories we arranged four of our hypothesis in the framework.

Use of standard and the most available materials: Since the process of production start with designing the project and the material for manufacturing choose and sometimes prove in this section then in the process of design using of widely available materials and standard components simplify inventory management, eases purchasing, avoids tooling and equipment investments, and speeds the manufacturing cycle. And if the chosen material is available their functional characteristics and cost are suitable. Then the first hypothesis in this research is:

Hypothesis 1a: E-collaboration between the production design and materials procurement units used by a project manager can create a favorable environment to reduce the production time and cost of production in new product.

Teamwork with manufacturing personnel to avoidance of secondary operations: When the designer and manufacturing engineers work together as a team and collaborate with each other the success of designs will be provided. Then our second hypothesis in this research provides as below:

Hypothesis 1b: E-collaboration between the design unit and production unit used by a project manager can create a favorable environment to avoidance of secondary operations to reduce the production time and cost of production in new product.

Design appropriate to the expected level of production: For better the quality in production the design must be appropriate for a production method. The third hypothesis of this research is:

Hypothesis 1c: E-collaboration between the design unit for appropriate design to the expected level of the production and production unit used by a project manager can create a favorable environment to reduce the production time and cost of production in new product.

Avoiding process restrictiveness: In the design and drawing process, the designer should prepare the final characteristic that needed for manufacturing engineers in the production line and specify surface finish, dimensions, and other characteristics needed. And the design should be avoiding some restriction in the production line. Then the fourth hypothesis arrange as below:

Hypothesis 1d: E-collaboration between the design unit and production unit used by a project manager can create a favorable environment to avoiding process restrictiveness to reduce the production time and cost of production in new product.

- **Planning:** The entire project needs planning and schedule for a better organization. In fact, not only the planning is essential for projects, but also it is necessary for success the projects. In accordance with Gaither (1982), there are four devices that we must to be considering in a process of planning and with these categories we arranged three of our hypothesis in the framework.

Schedules and notify delivery dates and cost estimates: The orders of customers are received by the planning department, and they will decide for these orders. The company must be produced or ship from stock. Also the planning departments inform other departments about the promised delivery dates of the project. If the ordered product doesn't exist in the store the planning department arranges schedules and sends to the other sections. The material for supporting the schedule of production detect step by step by the department of planning. Then the fifth hypothesis is:

Hypothesis 2a: E-collaboration between the planning unit with design, procurement and production units used by a project manager to know about schedules and delivery dates can create a favorable environment to reduce the production time and cost of production in new product.

Inventory control: For supporting the production of product the company needs the inventory control and it implementations in the department of planning. This section get ready material stokes requests for inventory control. Then the sixth hypothesis is:

Hypothesis 2b: E-collaboration between the planning unit with procurement and production units used by a project manager to inventory control can create a favorable environment to reduce the production time and cost of production in new product.

Receive progress reports, evaluate the status of orders, and initiate corrective actions: The planning department receives progress reports from different departments and receives a progress report on production orders and finally evaluates the status of orders and corrective actions as required. At that time, we can arrange the seventh hypothesis:

Hypothesis 2c: E-collaboration between the planning unit with design, procurement and production units used by a project manager to receive progress reports, evaluate the status of orders, and initiate corrective actions can create a favorable environment to reduce the production time and cost of production in new product.

- **Procurement:** All the factories need some material and tools for accomplishment the projects. Duty of the department of procurement is, applying the needed instruments according to ordered tools from another department. There are three steps in procurement process. And with these categories we arranged three of our hypothesis in a framework.

Information gathering: Maybe the department of procurement knows about the different suppliers for products and services. Otherwise it is essential for searching other suppliers who can satisfy the requirements. When the suppliers identify, they contact with them and invited them to collaboration. Then our eighth hypothesis is:

Hypothesis 3a: E-collaboration between the procurement unit with design, planning and production units used by a project manager to information gathering can create a favorable environment to reduce the production time and cost of production in new product.

Background review: Any suggestions for product/service quality are gathered, and some works like installation, maintenance, and warranty are investigated for follow-up services. The ninth hypothesis is as below:

Hypothesis 3b: E-collaboration between the procurement unit with design, planning and production units used by a project manager to background review can create a favorable environment to reduce the production time and cost of production in new product.

Negotiation: In the department of procurement delivery schedules, price and availability are negotiated, and a contract to acquire the P/S is completed. Sometimes the installation and training may also be including the contract. During the Consumption, any activity of the P/S evaluated. Finally decided about continuing a contract with this supplier or change this supplier. The tenth hypothesis is:

Hypothesis 3c: E-collaboration between the procurement unit with design, planning and production units used by a project manager to negotiation can create a favorable environment to reduce the production time and cost of production in new product.

Production: The department of production is necessary for each factory. In fact, this department arranges all the activity in the production process. According to Panneerselvam there are two main steps for production (Panneerselvam, 2006). And with these categories we arranged two of our hypothesis in the framework.

Check on the incoming raw materials: In different industries the types of inputs are varied. But the main inputs in product manufacturing are capital, materials and tools. These inputs are combined and covered into goods and services by suitable process technology. The material's input is the basis for the conversion process. The eleventh hypothesis is:

Table 3: Characteristics of responded

Characteristics of the respondents (n = 20)	Percentage of sample
Function	
Project manager/director	30
Project manager/senior advisor	25
Project manager/general manager	45
Education level	
Ph.D's degree	10
Master's degree	35
Bachelor's degree	55
Project management experience	
More than 20 years	5
15-20 years	20
10-15 years	15
5-10 years	60
Specification domain	
Business	45
Engineering	55

Hypothesis 4a: E-collaboration between the production and procurement units used by a project manager to check on the incoming raw materials can create a favorable environment to reduce the production time and cost of production in new product.

Change of tools and change in the production plans, like increase or decrease in volume of production: During the process of production maybe need to change some tools and production plan according to ordered of customers or destroy some tools. The twelfth and the last of a hypothesis is:

Hypothesis 4b: E-collaboration between the production unit with design, planning and procurement units used by a project manager to change of tools and in volume of production can create a favorable environment to reduce the production time and cost of production in new product.

RESEARCH METHODOLOGY

In the first stage of the survey, the author has done a face to face interview in 10 companies in Iran. The selected companies were a small and medium size, and the responsive were the project manager. The interview has done with 20 project management with high experience. During the interview, the author explains the conceptual model and the aim of this survey completely to the project managers. In fact, share knowledge has done between these project managers and author. The demographics of respondent and organization of them is presented in Table 3.

The value of a question for interviewing validated by previous questionnaire (Hughes, 1997). The author

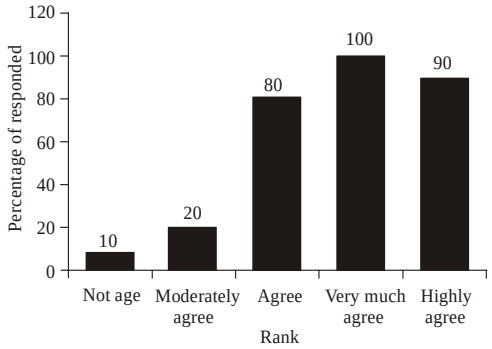

Fig. 3: The result of interview

measured every question by five scales from 1 (not agree) to 5 (highly agree). The basis of an interview was E-collaboration used by project management in order to create a favorable environment to reduce the production time and cost of production of new product. According to conceptual model, there are four main factors namely: design, planning, procurement and production and there are 12 subgroups. For Design department, there are four categories:

- Standard materials
- Teamwork
- Expected level of production
- Process restrictiveness

For planning department, there are three categories:
- Schedules
- Inventory control
- Receive progress reports

For a procurement department, there are three categories:
- Information gathering
- Background review
- Negotiation

For production department, there are two categories:
- Check on the incoming raw materials
- Change volume of production

Each of categories was obtained by one score through five point scales. And the results of this interview show in Fig. 3.

With this initially test the model and obtain the result, the author guesses the organization and the aim of this framework is correct.

CONCLUSION

The aim of this study is determining the relationship between E-collaboration and project management. The first objective is determining the relationship between different departments by E-collaboration in one factory. The second objective is a development a model to reduce a cost in new product and the last objective is a development a model to reduce time in new product. Following the conclusions of prior research there are many models for reducing time and cost. However, the purpose of this study is created a conceptual model to development time of new product and reduces cost of new product. Results produced through analysis of interviewed by 20 project managers in Iran in electronic industry showed the E-collaboration between four departments: design, planning, procurement and production through a project manager help the companies for new product in terms of development time and cost. And all four independent variables of a conceptual model have positive correlation with reducing time and cost.

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