ACHIEVING CHANGE IN CONSTRUCTION

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ABSTRACT

It is generally admitted that there is a need for change in construction, and various initiatives and programmes have been launched in many countries for achieving that change. However, only few have a track record of consequent and significant successes, even if success in small scale has been reported. This paper considers the scope of change needed, the big foundational ideas of change, as well as the initiation of the change and keeping its momentum. The discussion draws on theoretical, empirical and action research carried out by the authors. The reasons for the sluggish results from change initiatives are also briefly analyzed.

KEYWORDS

Construction, organizational change, learning

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INTRODUCTION

Consider the following account[4] on the state of one country's (let's call it Ruritania) construction industry:

> In 1998, the Ruritanian building industry had another *Annus Horribilis*. A number of large projects were presented in the media as nearly continuous disasters. A large rail tunnel project in Ruri City will be delayed by approximately one year and the budget will be exceeded by billions of dollars (RUR). The new state hospital in Ruri City is another example from the public sector, creating serious discussions at the top political level. The situation in the private sector is not very much better, but only a few projects are discussed in the media. These situations leave the industry with a bad reputation among most people, and with a big problem in recruiting good young people to the building and construction sector. Unfortunately again, the situation in Ruritania is not extraordinary compared to other countries.

When reading this account, we are neither surprised nor curious - a crisis in construction, in slightly different variations, has become a commonplace and a lasting issue in most countries. Indeed, it is generally admitted that there is a need for change in construction, and various initiatives and programmes have been launched in many countries for achieving that change (Table 1). However, only few have a track record of consequent and significant successes, even if success in small scale has been reported. - At the same time, it has to be acknowledged that in the shadow of the general problematic tendencies, there surely are successful projects and firms that seriously and productively have tackled the generic problems of this industry.

This paper discusses the possibility of realizable and effective change, drawing on theoretical, empirical and action research carried out by the authors. The reasons for the sluggish results from change initiatives are also briefly analyzed. Given the long history of mostly failing change efforts, the authors do not aim at providing final solutions. Rather, the goal is to widen the options available.

The paper is structured around four questions. First, which kind of change? Second, how can the change in principle be achieved? Third, presuming that construction, as a fragmented and fluid industry, cannot be changed overnight, where should change start? Fourth, how can the change momentum be maintained, after the start? At the end of the paper, initial policy advice, derived from the preceding discussions, is suggested.

WHICH KIND OF CHANGE?

WHAT IS REQUIRED FROM THE CHANGE?

Even a superficial investigation of literature shows that there have been numerous calls for improving construction from the point of view of its direct impacts on the other part of economy and society: costs and productivity; quality; safety; sustainability.

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[4] This quote from (Haugen 1999) is disguised because the phenomena described are generic, and there is no reason to pinpoint the country in question.

Table 1: Current and recent construction renewal programmes in different countries

Country	*Programme or initiative*
Australia	Building Regulation Reform, Building for Growth
Denmark	ProjektHus
Finland	Vision 2010
Hong Kong	Quality Reform Initiatives
The Netherlands	BouwBeter
Singapore	Construction 21
United Kingdom	Rethinking Construction
U.S.A.	FIATECH

These calls raise questions: What are the problems and what is the scope of change needed? Can we locate the thrust of change? Especially, is the question about individual problems that can be cured though respective intervention in some aspect or part of the construction sector, or is rather a holistic change needed, pertaining to all parts and aspects of the sector? The difference of these two approaches is aptly described by Papert (2000) in relation to school reform:

> One can take two approaches to renovating School - or indeed anything else. The *problem-solving approach* identifies the many problems that afflict individual schools and tries to solve them. A *systemic approach* requires one to step back from the immediate problems and develop an understanding of how the whole thing works.

CURRENT SOLUTIONS

The majority of recent and current solutions address some particular aspect or part of the industry. First, there are initiatives addressing directly the problem in question: quality, productivity, safety, and sustainability programs etc. The problems tackled in this way are typically understood as more or less isolated failures within an otherwise effective management system. Solutions offered are not expected to have lead to reform. For example, local organizations that provide public utilities like water and natural gas establish "call before you dig" programs to reduce the disrupted services.

Second, there are suggested solutions that address an underlying and "obvious" cause for the problems, this cause being located in a specific aspect or part. To say the problems are obvious means that there is an accepted preunderstanding about the nature of the problem or opportunity. This preunderstanding is determined for each person mostly by their perspective within the guiding paradigm. Four commonly understood solutions; structure, behavior, information management or physical machinery reflect this:

- Structural solutions: To address the "obvious" inability of classic design-bid-build contracting to maximize constructability and cope with uncertainty, such solutions as design-build, build-operate-transfer etc. are advanced. Structural solutions arise when people holding a motivationist[5] view believe, "We would

[5] The motivationist view assumes that incentives provided are the overriding explanation to his/her behavior and achievement

have success if we can get the right contract incentives in place to force people to get their work done."

- Solutions related to behavior: The mentality and motivation of people is seen to be a root problem and hindrance, and teamwork and partnering are suggested[6]. Team building and partnering efforts are usually increasing cooperation by identifying shared goals and establishing communication rules. This sort of solution typically arises when contract structure only rewards indivivual performance and people agressively pursue it. This is another version of the motivationist view but here the focus is on cooperation. Oddly proponents of partnering also advocate structural solutions that reduce the incentive for cooperation.
- Solutions related to information technology: Surely, computers could help us communicate and keep track of the vast amount of information required to design and build facilities and identify responsibility for failures. These solutions arise when people believe that access to information and clarity of communication is the issue.
- Solutions related to machines: The problem is seen to be in the low level of mechanization, and either industrialization (off-site prefabrication) or on-site construction robotics and automation are proposed. These solutions arise when people believe that industrial production is more efficient and can be adopted in project settings.

Each of these solutions can lead to improved performance. But shifting the balance of competition and cooperation, or applying new technology does not change the more fundamental way work is done. Thus the impact of these solutions is limited by the range of solutions possible within the theory in place.

Third, there are at least two suggested solutions requiring more holistic changes. One is concerned with the low rate of innovation in construction. An increased capability of innovation (along with increased investment in R & D) across the whole sector would be the solution. The other suggested solution is related to the peculiarities of construction: site production, one-of-a-kind production and temporary organization. By eliminating these, it is argued, problems would be alleviated.

EVALUATION

When considering whether a problem-solving approach or a systemic change is needed, the interest is on the second group of solutions mentioned above. If solutions of that group work well, it might be that no systemic change is needed. Accordingly, let us consider structural, behavioral and IT solutions, which have recently been most forcefully advanced.

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[6] Examples of such initiatives range from the well-known British Latham Report to the recent Swedish governmental investigation "Sharpen up, guys!" (Skärpning gubbar! 2002).

Structure

That structural change alone does not provide a solution is extensively discussed in (Koskela 2003a). Let's here look at fresh evidence from the study of Lahdenperä and Rintala (2003), where British experiences on design-build-finance-operate (DBFO) projects were analyzed. This research found that the overall performance of DBFO projects is at least equal to conventionally procured projects. DBFO has delivered noticeable improvements in the working relationships between the public and the private sectors, in the operational certainty of accommodation services, in the predictability of future accommodation costs and in the speed of construction. However, the cost of procuring accommodation services has only marginally reduced. The marginality of cost savings achieved in DBFO projects was found to result from the public and private sectors continuing to use some of the conventional practices in the framework of DBFO[7].

Behavior

A successful initiative for solely changing people's behavior in construction is simply unknown to us[8]. One explanation for this lack of success is given by Ekstedt and Wirdenius (1994) who compared a time compression program in construction with a corresponding program in manufacturing. They concluded that for builders with their project culture it is easier to implement renewal efforts. However, at the same time this means that a fundamental mental change was hardly needed in implementing the construction time compression program, and thus its cultural and mental influence was limited.

Another, related explanation is provided by Higgin and Jessop (1965) who observed that: '…any lack of cohesion and coordination is less the result of ill-will or malignancy on the part of any groups or [individuals][9], but more the result of forces beyond the control of any individual or group and which are affecting all'. This can be interpreted so that it is the system, or the context that to a great extent determines the behavior - trying to change behavior without touching the context is more or less futile.

Information technology

It has been difficult to produce evidence on the productivity effects of information technology both at the level of the national economy and at the level of any sector (Strassman 1997). Construction is no exemption (Koskela & Kazi 2003).

A fresh study (Maliranta & Rouvinen 2003) into the impacts of ICT (information and communication technology) on productivity in Finland gives interesting insights to this issue. The penetration of ICT was measured by the share of employees using computer equipment in general, Internet, and LAN (Local Area Network). In an econometric analysis, the

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[7] Similar observations on the persistency of conventional practices in the framework of design-build have been made by Miles and Ballard (2001).

[8] At first sight, it would seem that the success of partnering contradicts this claim. There is evidence that partnering has reduced the extent of legal action and is generally related to improved project outcomes. However, in the framework of partnering, besides behavioral change usually also operational inter-firm processes are improved, and thus the success cannot be attributed to behavior change solely.

[9] There is a misprint in the original; the word in brackets has been inferred from the context.

improved productivity of ICT-equipped labor ranged from eight to eighteen per cent. The improved productivity seemed to be somewhat higher in services than in manufacturing (construction was not analyzed). The effect is often manifold in younger firms and in ICT-providing branches and at least the immediate effect can even be *negative* in older firms[10]. The effects of ICT are by no means direct or automatic. Even if not addressed in the study, the authors argue based on other case studies and statistical evidence that the full benefits of ICT are only unleashed with supporting organizational changes.

Summary of evaluation

A striking feature in the evaluation of all three cases is that the initiative in question, when solely advanced, has produced marginal, if any, results. Complementary initiatives in neighboring or related subsystems would have been needed.

DISCUSSION

At the outset, we have to define a number of concepts. Ranta (1993) states that *production paradigm* is the prevailing rationality, which controls the development of production as well as the use of production methods, tools, and knowledge. Production paradigms are based on implicit or explicit *theories of production*. Historical analysis shows that exemplars of new production systems, such as the Ford production system and the Toyota production system have played a crucial role in the succession of production paradigms (McLoughlin 1999). In these exemplars, all major aspects of production have, for the first time, consistently been realized on the basis of a new theory of production. Such concrete embodiments of a production paradigm are called *production templates*. The distinguishing feature of production templates is the fit or synergy between the various parts of the production system.

It is argued that industrial history indicates that improvements in the range required in construction happen only when the whole production template is changed. Thus, the question is about a systemic change that pervades all aspects and parts of the production system and is based on new big ideas, new theories. The limited impact of structural, behavioral and IT related initiatives to date points to the same limit to change – the current mental model of production. Likewise, the attempts to increase the rate of innovation or somehow create a less project related industry have limited success. It is sobering to realize that this state of affairs is the result from a widespread attempt to solve problems and improve performance in a very mature industry. We are as trapped by circumstances as the airlines were before the advent of jet aircraft. Innovation in the piston driven world was limited and those proposing jets were considered unrealistic and a bit off centered.

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[10] The authors refer to a statement by the CEO of Cisco Systems Inc., John T. Chambers: "the greatest payoff doesn't come until seven to nine years after an [ICT] investment is made." (Business Week, 17 Feb. 2003, p. 45).

HOW CAN THE CHANGE IN PRINCIPLE BE ACHIEVED?

THE PROBLEM

Thus, given that we accept the thesis that a systemic change is needed in construction, how can we, in principle, achieve such a change?

CONVENTIONAL SOLUTIONS

The mainstream thinking, when accepting the need of a systemic change, relies on external ideas or impacts, and refers to industrialization or information technology as drivers for change. Regarding industrialization, the target is to transform construction into manufacturing. Regarding information technology, the big idea is that the increasing use of computers leads to a renewal of the organization and operation of the sector.

Unfortunately, a positive proof of concept is lacking for both these ideas.

DISCUSSION

We argue that a major share of the problems is connected to the current production paradigm in construction. The development and evolution of one important aspect of this paradigm is aptly described in the following quote (Butler 2002):

> I've seen a lot of changes in the construction industry in the past 30 years. Construction systems have become more and more complicated. Disciplines have divided and subdivided and whole new trades have sprung up. The whole concept of the general contractor, like the master architect, is becoming a thing of the past. When was the last time you had a project that didn't have a project manager, a project engineer and a superintendent? Did any of them do anything more than push paper? Did any of them walk the jobsite to make sure that the folks with the hammers and nails weren't putting holes in the roof?
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> Today's general contractor seldom self-performs a substantial portion of the work, and functions instead as more of a construction manager than a GC. To make matters worse, subcontractors are beginning to do the same by hiring their own subs to actually perform the work. With tier upon tier and with responsibility spread around, whom do you deal with when you have a problem on site?

In a similar vein, Allen (1996) describes the impact of increased subcontracting on production control:

> Suddenly there was a contract between the manager and the production process and yet we still acted as if we directly controlled the work face. The contractual problems that inevitably arose required a fix, and we started down the road to managing contractors, not production.

Indeed, at the end of that road, Bennett and Ferry (1990) found a total lack of production control: "...the specialists [contractors] are just thrown together and told to sort things out between themselves".

Another side of the same issue is interestingly illustrated by Gallo et al. (2002). They note the tendency to select designers on the basis of lowest price. Even if they do not directly

connect this to reductions in design fees, we assume such a relationship. Further, they state, based on the extensive studies of Tilley and McFallan (2000):

> Key research conclusions based on data collected and analysed are:
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> - design and documentation quality have worsened over time apparently in direct relationship with reductions in design fees; and
> - at the same time there have been increases in project time, costs and non-desirable elements of construction including inter alia disputation, project delays, and cost overruns.

We have repeatedly (Koskela 1992, Howell & Ballard 1997, Koskela 2000) contended that the phenomena described result from the progressively more forceful application of the *transformation* model of production. The first principle of this model suggests decomposing the total transformation hierarchically into smaller transformations, or tasks, and minimizing the cost of each task independently. This equates to buying the execution of each task on the basis of lowest price. However, this more or less directly leads to two major problems, at least. First, in the case of design, where it is difficult to assess the completeness of design drawings, the total design effort, and consequently also the quality of design and documentation tend to decrease. Second, regarding site construction, the cost of each contract being fixed in advance, production control tends to degenerate into contract control, as two of the authors have previously argued (Ballard and Howell 1998):

> The construction model of control is actually a model of project control, not production control. Direct control of production itself occurs only within the production unit, and is not addressed by the disciplines of project or construction management. In other words, how the contractor, subcontractor, or department gets the job done is their own business and is irrelevant as long as they meet their "contractual" commitments. Construction can thus be said to have no theory of production control proper.

Thus unfortunately, construction management, when carried out in the transformation mode, becomes of a mill of self-inflicted problems, due to lacking recognition of uncertainty of and interdependencies between tasks. This was observed already in the remarkable study of the Tavistock Institute (Tavistock 1966). In this study, the disparity of the characteristics of the formal and informal systems in relation to the needs of the real task with which they are concerned is pointed out as the root cause of problems. The formal system (contracts, plans, etc.) does not recognize the uncertainty of and interdependence between the operations of the building process. The informal system of management is geared towards handling uncertainty and interdependence, but it produces a climate of endemic crisis, which becomes self-perpetuating. In some cases, more forceful application of the transformational model are put forward in project management software, In others, the attempt to solve the resulting behaviorial problems through behaviorial approaches leave participants resigned that no real change is possible.

Thus, we have an explanation for the problems. In prior work, we have argued that the flow model of production (together with the value generation model) should be adopted, because it explicitly addresses what the transformation model leaves out: uncertainty and interdependence (Koskela 2000). For lack of space, we do not extend the justification of the flow model further here.

How can we switch to the flow model? Again, let us take industrial history as our teacher. There are two well-known examples of new manufacturing templates: mass production and the Toyota Production System. In the latter case the question was exactly of abandoning the transformation model and adapting a new, flow model (Koskela 2000). In both cases, the template was developed in one point, based both on a new theory and continual experimentation. After that, the template diffused through imitation, where unfortunately the theoretical understanding of the template was eroded.

Thus, it seems that there are two ways of achieving a new industrial template: (1) deliberate design and (2) imitation. As far as we know, there are no Fords or Toyotas in construction that could be imitated, and thus the only possibility is the deliberate design of a new template. However, the underlying theories of manufacturing templates can be applied when fit for the situation in construction. Theories should be used for explaining why problems exist and how they could be avoided (Koskela & Ballard 2003). Experimentation should be used for translating the theories into practical methods and tools.

Factually, the design of a new template has been initiated in the framework of the International Group for Lean Construction (Alarcon 1997). The progress up till now is described in (Ballard & Howell 2003, Koskela 2003b).

Finally, it has to be noted that the switch from the transformation model to the flow model is just one, even if important, part of the paradigm shift needed. In recent years, new distinct elements of the theoretical foundations of production management have been progressively found, and we anticipate that this evolution will continue, along with a quest for unification of the theory of production and production management.

WHERE SHOULD CHANGE START?

THE PROBLEM

Presuming that construction, as a fragmented and fluid industry[11] (Dubois & Gadde 2002), cannot be changed overnight, where should change start? A closely associated question is: Who should initiate the change?

CURRENT SOLUTIONS

Two approaches dominate the mainstream thinking. Procurement methods by owners are often presented as one key triggering issue. For example, if the owners would procure based on performance instead of cost, the suppliers could compete with functionalities of their products. The other view is that the advantages of working in the new model by those who actually manage production such as subcontractors will lead to their dominance.

DISCUSSION

We acknowledge the importance of appropriate procurement methods. However, we argue that more effectively the change should start from the operational processes where the end

[11] Also Groák (1994) has challenged the view that construction can be considered as a coherent industry with definable boundaries and characteristic problems.

product is created: design, prefabrication, and site. There are two grounds for this suggestion. First, it is here that costs, quality etc. are concretely formed. Thus, by acting on the operational level, we are able to get swift and visible gains. Examples of this are given in (Ballard, Harper & Zabelle 2003, Thomassen, Sander, Christoffersen 2003)

Second, in the framework of changing these processes, we learn what should be next changed upstream and in the superstructure made up by procurement modes, contracts, information systems, etc. So, this start helps in moving forward - this will be discussed in more detail below.

HOW CAN THE CHANGE MOMENTUM BE MAINTAINED?

THE PROBLEM

But how can the change momentum be maintained, after the start?

CURRENT SOLUTIONS

The conventional thinking does not address this directly, but it can be inferred that change is assumed to happen automatically given a favorable environment.

DISCUSSION

We have to address two interrelated levels of maintaining change: firm level and industry level. Regarding the firm level, there are two generic approaches to organizational change (Beer & Noria 2000). One approach focuses on formal structures and systems, and it is implemented in a top-down manner. The main purpose is the creation of economic value; hence it can be called theory E. The other approach focuses on the development of a culture of high involvement and learning. Its purpose is the development of the organizational capability; hence theory O. It is implemented in a participative manner.

We suggest introducing such methods into the operational processes that transcend this dichotomy, i.e. develop systems and learning simultaneously. In this way, both opportunities and demand for further change are created by each step of change. Especially, we draw on the work of Weick (1984). He has defined an approach to solve major social problems, called *small wins*. Major social problems are often defined in ways that overwhelm people's ability to do anything about them. Instead, if a larger problem is redefined as a set of smaller problems, people can identify a series of controllable opportunities of modest size that produce visible results that can be assembled into wider solutions. When a solution is put into place, the next solvable problem may become more visible. A pattern is built that attracts allies and deters opponents. Also, small wins may be seen as miniature experiments that test implicit theories about resistance and opportunity. They can uncover resources and barriers that were invisible at the outset. A series of small wins is also more structurally sound than a large win because small wins are stable building blocks. Instead, a large win requires much more co-ordination and may fail due to a missing critical piece. Thus, in summary, there are a number of characteristic features in this approach such as (Meyerson & Fletcher 2000): it names the problem; it combines changes in behavior with changes in understanding; small wins have a way of snowballing: one small win begets another, and eventually these small

changes may add up to a new system. In fact, this kind of change has later been known as *emergent* (Johnson 2001)

Initial evidence indicates that the method of the Last Planner provides a structure for triggering such small wins (Vrijhoef & al. 2001).

Regarding the industry level, the distinction between deliberate attempt to change and emergent change, based on its own laws of evolution[12], is even more important. Given the fragmented nature of the construction industry, any change will rather be emergent than deliberate. We think that there are emergent change processes underway[13] - however, these processes are presently too slow for providing relief to the generic problems.

We hypothesize that even emergent change can be facilitated and nurtured, by providing theories and conceptual models fit with the situation encountered by the practitioners. However, it is only entrepreneurship[14] within the industry that will produce the change (Spinosa, Flores & Dreyfus 1997).

POLICY ADVICE

It is probable that in many countries, politicians and administrators struggle with the obvious need to do something about the current problems of construction. What advice can be given to them, based on the discussions presented?

SYSTEMIC CHANGE

We view that ultimately, a systemic change is needed for solving the problems of construction. We are not too optimistic regarding the possibility of achieving a systemic change as a top-down process. However, such a systemic change can be nurtured, and its preconditions may be prepared.

Systemic change requires understanding but only comes about by action. In science, understanding is called theory (or theoretical explanation). Thus, basic research into construction management is called for. However, instead of mere basic research, following Stokes' (1997) argument we rather advocate a close relation between reflection and action; integrating of research aimed at understanding with research aimed at action.

Another issue is that the state is a major client, which can use its market power for promoting new methods among the industry. Up till now, governmental agencies for procurement of buildings have only rarely shown such strategic leadership.

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[12] Interestingly, Papert (2000) views that deliberate change of School, called School Reform, is impossible; instead, emergent change is.

[13] This can be illustrated by the case of partnering. A survey of attitudes and experience on partnering among senior executives of construction contractors was recently carried out in the United Kingdom (Construction partnering in practice, 2002). A small number of companies had a highly formalized structure for partnering and its surrounding activities. However, for most respondents, the route into partnering had been evolutionary rather than revolutionary. The companies of such respondents - a significant majority - considered partnering to be an essential, pervasive and indivisible component of the company's corporate culture.

[14] Here entrepreneurship refers both to initiatives inside existing companies and to the establishment of new companies or company networks.

PROBLEM-SOLVING CHANGE

It is inevitable that various problem-solving changes are initiated for tackling the immediate problems. However, solutions seem often be selected without careful scrutiny. As a consequence, the efforts may be misdirected and produce marginal results, if any.

We suggest the following test questions:

- Is there a plausible explanation - at a sufficiently detailed level - why the candidate solution would work?
- Is there empirical evidence showing that the candidate solution brings the benefits sought for?
- Is the candidate solution self-standing, or does it rather require surrounding changes for working efficiently and providing manifest benefits?
- If the solution is imported from another domain: Has it been conceptually and empirically confirmed that the solution works in the context of construction?

CONCLUSIONS

Why is it so manifestly difficult to achieve change in construction? This issue has been addressed by discussing four derivative questions and considering the mainstream answers given to them. First, which kind of change? The mainstream thinking is mainly focused on solving specific problems in construction. We argue that a systemic change has to be achieved for eliminating the root causes of the problems.

Second, how can such a systemic change in principle be achieved? The mainstream thinking relies on external ideas or impacts, and refers to industrialization or information technology as drivers for change. We rather argue that a new big idea for managing construction has to be found.

Third, presuming that construction, as a fragmented and fluid industry, cannot be changed overnight, where should change start? The mainstream thinking suggests starting change from upstream decisions and stages of construction, contractual and organizational forms. Our viewpoint is that change be started in the operational processes that create the end product, i.e. in downstream stages.

Fourth, how can the change momentum be maintained, after the start? The conventional thinking does not address this directly, but it can be inferred that change is assumed to happen automatically given a favorable environment. Instead, we refer to the approach of small wins, by means of which initially small and fragmented initiatives may gather in strength and eventually achieve system-wide changes.

Thus, in substance we advance the view that the sluggishness of change in construction is due to limited understanding of change needed and resulting confusion regarding means of change. Based on wider understanding of change needed, new policy advice can be given.

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