

# Quality Infrastructure – A Different Approach

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## SYNOPSIS

In the past fifteen years or so a transformation has occurred in the construction industry, mainly driven by new concepts of economics under the local banner of “economic rationalism”. It is timely to take stock of the impact of these changes on the quality of our built infrastructure, on the personnel responsible for its design, construction and maintenance, and on the public served by it.

The paper will discuss some aspects of this impact on the viability and product quality of the design and the construction industry, viz. the lack of profitability, of new investment and of R&D funding, downsizing and the associated failures of corporate memory, outsourcing, lack of personnel training and development, reduction in quality of design, construction and planned maintenance, and finally, the high incidence of accidents in the workplace, pointing to overall shortcomings in safe work practices.

These trends were probably most pronounced in UK, under the Prime Ministership of Margaret Thatcher. It is not surprising that the resulting unsatisfactory state of the construction industry is producing a reaction. The paper will refer to recent work by Sir John Egan and Prof. David Blockley. Essentially, this work is based on the notion of co-operative leadership, and on a systems approach, incorporating the whole of the creative process. It is similar to the model advocated by Dr. W. Edwards Deming and promoted in the Japanese car industry in the 1950's, with outstanding results.

The paper will outline the main characteristics of this process, which is essentially a co-operative one across all the stakeholders in the system, contrasting it with the current adversarial practice. The paper will demonstrate the economic fallacy of the practice of compulsory competitive tendering based on the assumption that this gives expression to the “free market”.

## 1 PROBLEM OUTLINE

### 1.1 Present Situation

The advent of the compulsory competition policies embraced by the Commonwealth Government some fifteen years ago under the banner of macro-economic reform has had far-reaching effects on the construction industry. As an example, where formerly clients would choose design consultants on the basis of submissions highlighting past performance and expertise in the particular field required, under “open” competition this choice is largely governed by lowest tender price, often without duly considering the consultant's expertise.

The same situation prevails in the civil construction field, although the practice of pre-qualification of contractors still exists. In some instances this practice has reached considerable sophistication, contractors being classified according to both magnitude of contract and type and level of expertise. Often though, the pre-qualification procedure is performed solely on the basis of the financial capacity of the contractor.

Two other facets of concern regarding economic reform are, first, the reversal of any policy which envisaged Public Authorities performing design and/or construction activities themselves and secondly, an aversion to public debt.

The first saw the “downsizing” of the Civil Design and Investigation Sections of the Public Authorities. The second saw the advent of various so-called BOOT schemes, whereby public infrastructure was designed and constructed through private funding, privately operated as a toll facility and after some 30 years of operation transferred into public ownership.

Simultaneously, and focussing on the nation’s bridges, we are dealing with an ageing (and deteriorating) bridge-stock, which has to absorb ever higher design loads. This latter is yet another facet of economic reform: the move towards deregulation, self-regulation or privatisation, as appropriate, of most aspects of the transport industry is giving rise to a tendency towards ever larger transportation units to gain competitive advantage by economies of scale.

The developments sketched above are international in extent and mostly affect those countries that have embraced what has been termed the “anglo-saxon” model of neoclassical economics. There are some four other models to which the above applies to varying, generally far lesser, degrees.

Downsizing of the various Bridge Authorities’ field staff, and privatisation of their work have had two effects: first, the enthusiastic embrace of Quality Assurance (QA) procedures of one type or another and secondly, various moves by the Authorities to replace the expertise and experience of their redundant field staff by computer-based systems. A number of papers presented at this Conference bear witness to this.

## **1.2 Industry performance**

### ***1.2.1 Economic Indicators***

The economic performance of the construction industry is generally as well as may be expected from a body of men and women who are generally dedicated and competent. Their motivation cannot be the hope of material wealth or even job security: the industry is not noted for either the generous remuneration of its employees or guarantees of their employment beyond current projects. The nearest I can come to describing the motivation of people of any nationality and any position in the civil construction industry is a very simple one: We like building things. Actually, we do not just like it; we derive a deep satisfaction from it. This point is not made lightly; it is based on some 60 years design and construction experience in ten countries, including working with the polyglot workforce on the Snowy Mountains hydro-electric project.

However, it is not an industry noted for its high financial returns. Generalising, we may conclude that the industry is characterised by:

- low profitability,
- low return on invested capital,
- low expenditure on research and development (R&D),
- relatively high bankruptcy rate.

At the core of this situation lies the practice of accepting lowest priced tenders. This has become general practice, to some extent driven by regulation and the policies of the ACCC. The economic principle involved is the requirement of neo-classical economics that “one should not interfere with the free operation of markets”. There is an anomaly here: it is the subject of mathematical proof (1,2) that in the presence of more than four bona fide tenders, the lowest tender will be priced at or below cost. It is well known internationally that acceptance of this low bid creates a number of problems for both the contractor and the principal. Quoting Ioannou(3):

*“This often results in excessive claims and disputes and claims during construction that lead to schedule delays, compromises in quality, and increased costs”*

To this litany may be added a high incidence of litigation and ultimately, client dissatisfaction. The authors suggest that acceptance of the average bid would lead to better project outcomes.. It may be concluded that the presence of one buyer of a commodity in a given locality and time and a number of sellers of this commodity in the same locality and time may cause the market mechanism to fail. The above quotation originates in USA and Taiwan, and contains a reference to practice in Italy..

A similar problem exists in the civil consulting profession, of which Troup(4) remarks:

*“It might also be true that this schedule-driven mentality, and the pressure of naïve owners on design fees and scope of work, have also tended to diminish the quality, or at least the completeness, of construction documents.”*

Similar comments have been made to me during interviews in UK, the Netherlands, Germany and France. From observation and interviews in Australia, this situation also exists here.

### **1.2.2 Quality Indicators**

A similar situation has been observed with regard to the finished product, the constructed facility. Quoting Troup(4):

*“Many structural engineers have noted a deterioration in compliance with construction documents and overall structural construction quality. The schedule-driven fast-track project delivery system has strained the care with which structures are fabricated and constructed.”*

The “flight” into the application of ever more complex and formal QA systems must be viewed with suspicion. They do not seem reliable tools for maintenance of required quality. From interviews both here and overseas it has transpired that a substantial number (over 75%) of civil engineers and construction professionals interviewed have considerable reservations regarding the efficacy of the present ISO 9000 series of Codes. Their main concern appears to be that the application of these Codes produces a cumbersome paper trail while their

contribution to the overall quality of the work is problematic and variable. Schneider(5) remarks that the different definitions of Quality Assurance could well lie behind the problem. In the IABSE Rigi Workshop(6) QA was defined as “the application of a comprehensive set of measures and activities aimed at assuring desired quality of the product...”. In the ISO 9000-series of Codes, QA is defined as “part of Quality management focussed on *providing confidence* that quality requirements will be fulfilled” (my italics)(7). Schneider makes the point that providing confidence is not the same as providing the required quality.

If “quality” is specified it must be possible to measure it. This quantification is what has led to an enormous number of checking operations, which seem to have the purpose of checking everything that lends itself to quantification and measurement. The very quantity of checking operations that have no influence on the ultimate quality of the facility tends to obscure those checks, which have a direct bearing on it. It follows that the “bureaucratic” manner of conducting checking operations tends to be self-defeating and costly.

Modern personnel management practice suggests that better results may be obtainable by giving teams of workers the responsibility to see that their work is properly executed. Deming(8) in his “14 points for management” lists as no. 3: “Cease dependence on inspection to assure quality by creating quality products in the first place”. Similarly, Brammar(9), Director of the Australian Technology Transfer Council (since defunct), defined the purpose of his “Value-Added Management” package as “the elimination of all waste by the creative co-operation of all personnel”. Significantly, he listed “inspection” as one of the waste operations, in the sense that inspection does not add value to the product. It is significant that both Deming and Brammar operated in the manufacturing industry. Schneider, operating in the construction industry, sees the necessity of an effective QA system to be conducted in a way that is thoroughly attuned to the characteristics of the building process. These characteristics differ materially from those applicable to the manufacturing process.

### ***1.2.3 Problem Definition***

From the above it is possible to define a few leading problems which beset the civil construction industry:

- The practice of tender acceptance by lowest price.
- The practice of extensive outsourcing of work to small specialist sub-contractors, again on the basis of lowest price.
- Low labour skill base.

The same set of problems has dogged the UK construction industry, but more severely, due to the more intransigent stance of the then conservative government and its compulsory competitive bidding legislation. I was informed during an interview with an expert in the field, that the lack of quality and the resulting lack of durability of bridges and overpasses constructed in the UK during the ‘60s and ‘70s had reached a requirement for remedial action that was beyond the financial and technical resources of the government instrumentalities concerned.

I understand that somewhat the same situation prevails in USA, where the extensive use of de-icing salts during winter has caused deterioration of concrete bridge decks and steel girder bridges to the point where bridge closures and imposition of load limits occur relatively frequently, as do bridge collapses.

## 2 STRATEGY FOR SOLUTIONS

### 2.1 The UK Experience and Solution

A group of major industry clients together with some of the major civil contractors were concerned with the state of the construction industry and its comparative lack of performance as regards product quality, time lines and construction costs. They commissioned Sir John Egan to investigate and report on the state of the industry and the manner in which the situation could be improved. The result was the Egan Report, “Rethinking Construction”(10).

Of course, the problems surfacing in the industry had produced a profusion of suggestions, which were purported to bring improvement. Blockley et al.(11) mention Quality Assurance, Quality Management, Total Quality Management, Partnering, Value Management, World’s Best Practice, Benchmarking, etc.

The Egan Report’s findings, as summarised by Blockley et al.(12), states:

*“The industry must improve working conditions and improve management and supervisory skills. The industry must replace competitive tendering with long-term relationships based on clear measurement of performance and sustained improvements in quality and efficiency.*

*In summary, the Task Force emphasised that it is not inviting UK construction to look at what it does and to do it better, but that the industry and Government should join with major clients to ‘do it entirely differently’.” (My emphasis)*

The Egan Report sees as the drivers of change:

- Committed leadership
- Focus on customer
- Integrated processes and teams
- Quality-driven agenda
- Commitment to people

These same points emerge from Demings’s 14 points(8), and from ATTC’s Value-Adding Management(9). Interestingly, they also emerge from the Introduction to AS/NZS ISO 9000:2000(11), where it states that “eight ... management principles have been identified that can be used by top management in order to lead the organisation to improved performance”. These eight principles are:

- Customer focus
- Leadership
- Involvement of people
- Process approach
- Systems approach to management
- Continual improvement
- Factual approach to decision-making
- Mutually beneficial supplier relationship

Again, it is important to note that these recommendations originated in the manufacturing industry, ISO 9000 being a Standard developed in US military aircraft manufacture and procurement.

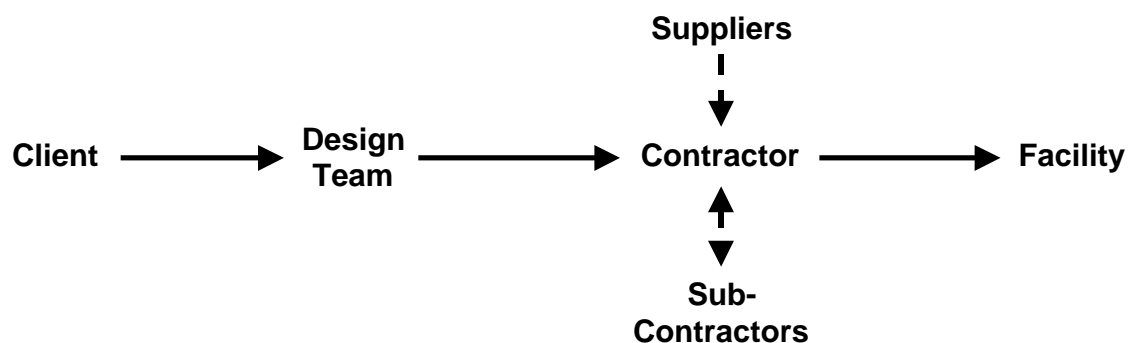
It is the work of Egan, Blockley and Godfrey that has adapted these principles of management and organisation for use in the construction industry.

## **2.2 The Australian Application**

Following the Egan Report's 'Drivers of change', but not necessarily in the order given above, we have:

### ***2.2.1 Integrated Processes and Teams***

Figure 1 shows diagrammatically the main participants in the development of a facility. Various combinations are possible and have in fact been used. In design-and-construct processes the design team and the contractor are combined into the one enterprise, although these often employ specialist consultants as sub-contractors.



***Figure 1: Participants in Project Development***

From the diagram it is obvious that the various parties have, at the outset, a common interest: that of creating a high-quality facility, “quality” being defined here as “fitness for purpose”. Having a common purpose, the participants can be united into a team, given proper leadership that accentuates their commonality and avoids raising self-interested differences. Two necessary conditions would be that all participants see their remuneration as being fair and sufficient, and that the leadership is focussing the participants’ performance on quality of work.

The client must take an active part in the whole process, defining and refining his expectations as the project proceeds. It also requires the construction team (the contractor and his sub-contractors) to be appointed well before the design is finalised. The contractor’s early input into questions of constructability and detailing is vital to the constructed quality of the project. A process that commends itself is that of inviting expressions of interest from qualified contractors and developing a Schedule of Rates contract. Note the recommendation in the Egan Report, which is worth repeating here:

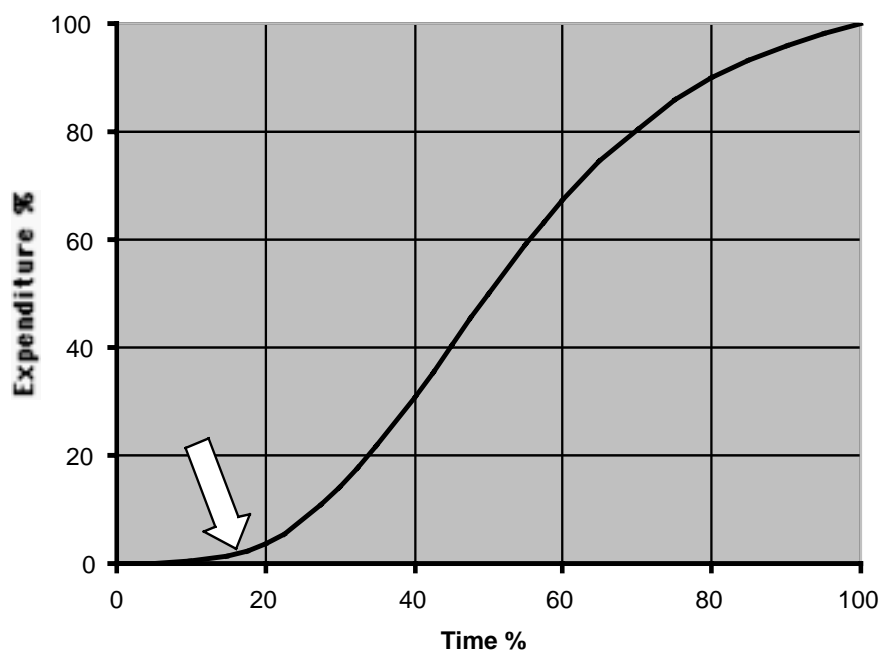
*“The industry must replace competitive tendering with long-term relationships based on clear measurement of performance and sustained improvements in quality and efficiency”.*

Competitive tendering is destructive of any team formation and creates an adversarial atmosphere. As noted before in Par. 1.2.1, the much-vaunted “free market”, generally advanced by economists can be seen to fail in a slow economy, where there is, in a particular location and at a particular time, one buyer and a number of sellers, thus creating a buyer’s monopoly.

The creation of an integrated team implies the free exchange of information between the parties, making for greater efficiency in the design phase of the project, at a time when this information is being developed. It avoids re-working designs and the development of the “Now they tell us” syndrome, which is destructive of morale and efficiency.

In this regard, it is well to remember that facilities are generally designed from the top down, but built from the ground up. In an integrated design-and-construct environment, this means that the geotechnical, civil and structural design activities are always on the critical path of the CPM schedule, as these are last to receive the required design information, but first to be executed in the field.

Figure 2 presents a typical project expenditure vs. time graph, with both axes normalised as percentages. The graph is also representative of manpower requirements over time. In the area indicated by the arrow, we see the slow development of information characteristic of the early design phase. This time is crucial to the project: If the information development is too slow or is error-prone, this phase tends to be lengthened. It will prove practically impossible to make up this time, resulting in probable cost and time overruns.



***Figure 2: Project Expenditure vs. Time***

*It is a project requirement that the initial information development is as fast as possible, but above all, complete and correct.* This means, that it is of the utmost importance that the project team is formed as early as possible, and that it is built on mutual trust between the participants, so that information flows freely and accurately.

Luigi Nervi, the famous Italian architect, remarked that he would not work for a client who did not know exactly what he wanted. This is an important point: the client must put in a considerable amount of effort to define what it is he wants, in such detail that this can be used as pertinent design information. Again, this information is vital, and inaccuracies at this stage will result in long delays and extra expenditure to affect corrections.

Integrated in the team should be the suppliers of goods and services. Again, it is Deming who sums up the preferred relationships with suppliers: *“Develop partnership arrangements with your preferred suppliers”*. It follows logically from the argument that lowest price tendering practice is detrimental to project quality. Therefore, if the project is quality-driven, relationships have to be built based on capacity to deliver, past performance and trust, i.e.. partnership arrangements, rather than on the outcome of lowest price tenders.

### **2.2.2 Leadership**

Following the lead of Blockley et al.(14) it is well to divide leadership issues in “soft” issues for which there is not one obvious solution and “hard” ones for which there is. “Soft” problems usually have a social (i.e. people-driven) content. Leadership largely consists of dealing with issues arising from peoples’ attitudes and therefore “soft” issues. It follows that there are many styles of leadership and that some are more effective than others in getting people to strive for the project objectives. “Leadership” forms the subject of a number of on-going debates, which are outside the scope of this paper. However, it seems obvious that leadership styles that emphasise personal initiatives and more personal freedom of action within the range of project objectives would yield better results, because they tend to satisfy needs of self-expression.

McGregor(15) studied the influence of management style on the performance of the workforce. He distinguished two management styles, which he termed Theory ‘X’ and Theory ‘Y’.

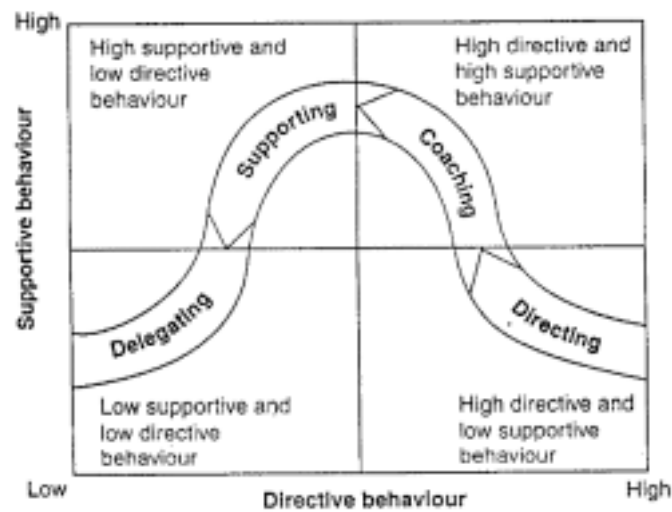
The Theory ‘X’ manager is authoritarian and manages in a military order style. The management system created is strictly hierarchical. Theory ‘Y’ managers tend to have a more relaxed approach, which includes allowing subordinates to use their own initiative and to suggest alternative methods of achieving the team’s goals. This style of management tends to fulfil the higher personal needs, like self-actualisation, according to Maslow(16).

It may be concluded that there are very few managers acting according to either “pure” Theory ‘X’, or Theory ‘Y’. Ideally, a manager will change his style in accordance with external conditions. A sudden emergency, e.g. due to equipment failure endangering work safety, would rightly call for a Theory ‘X’ response from the manager.

Blanchard et al.(17) clearly illustrate the point by showing that during different phases of a project different management styles are to be preferred. Refer Figure 3. This attitude tends to be at variance with much of the presently received wisdom that managers should adopt the leadership style that temperamentally suits them best. The objective should be for managers



to be capable of changing their style to suit best the prevailing personnel attitudes and circumstances.



**Figure 3: Leadership Styles**

(After Blanchard et al)(17))

One of Deming's '14 points' is: *Remove all barriers that prevent people from having pride in their work.* This points to the necessity for managers at all levels to strive continuously towards open, relaxed and encouraging relationships with their personnel. The aim of leadership is continuously to improve productivity, quality and satisfaction, for the benefit of both the client and the construction workforce.

### **2.2.3 Quality-Driven Agenda**

This agenda must emanate from top management, and has to be uncompromising. It brings to mind the motto that used to be printed in bold letters across John Holland's Computation Sheets: "*Let's do it right the first time*". There is a stark difference in management attitudes, depending on the style of leadership, promoted by top management. Referring to McGregor's Theories 'X' and 'Y' (Refer Par. 2.2.2, above), we may either take the view that our personnel on the ground is indifferent to how they perform their work and therefore have to be continuously directed and inspected (Theory 'X'), or we may assume that our workers have a desire to do their work as well as they can and therefore only need to be encouraged to do so (Theory 'Y'). This encouragement, according to Deming, is to be provided by management and takes the forms of:

- continuous on-the-job training for all,
- providing a comprehensive education programme and encouraging self-improvement,
- creating constancy of purpose for continual improvement of quality and service.

It corresponds to the ATTC's Value-added Management programme of progressively eliminating all waste, bearing in mind that any sub-standard work is a source of waste.

The combination of integrated teamwork and concentration on quality performance should greatly reduce the waste activity inherent in QA procedures. Schneider(5) sums up this notion as follows:

*“The case is that QA in this sense is a matter of individuals and mutually agreeing within the building process rather than a subject put forward by Building Authorities and enforced via Codes and Regulations. It is not a new and additional burden placed on the shoulders of the profession but a new basic attitude, improving in a positive sense the necessary co-operation of all people involved.”*

The supply chain has a special place in this process. Through the supply chain of a civil construction project materials and half-fabricates are supplied for incorporation into the project. The supplier as an integral part of its manufacturing process should perform testing and certification of these items, as appropriate. This would include testing and certification of all construction materials, like steel of all kinds, metal half-fabricates like bolts, pins, etc., and elastomeric bearings (which should each be tested and certified). Included in this routine should be formwork and falsework materials, including re-useable items like shores, which should come to the site inspected for straightness and with flat top and bottom plates.

#### **2.2.4 Focus on Client**

Construction teams are naturally and primarily focussed on performing their tasks to the best of their ability. However, these tasks have been formulated at the project's inception for the purpose of providing a facility that delights the client. Excessive focus on task performance tends to create an inward-looking attitude. There is a danger that this stifles interest in and understanding of the client's desires, thus tending to exclude the client from the construction team. This would be counter-productive: the ongoing input of the client from inception until completion of the project is required to ensure that it is satisfied with (and if possible, delighted by) the constructed facility.

If the construction team does not know exactly what it is the client wants, it is unlikely that the team will provide it. Project management should be able to put itself in the client's position and view the progress of the project from that angle. Most important at any time is the client's desire to obtain a high-quality facility on budget and on time. Any interference with these three objectives, for whatever cause, requires immediate and frank discussion with the client.

#### **2.2.5 Commitment to People**

Reflecting on what it is that differentiates enterprises engaged in similar activities, one must conclude that, given access to similar levels of technology, it is the personnel relationships. Furthermore, these relationships are determined largely by the attitudes of top management with regard to employees, clients and the community in which the enterprise resides.

Focussing on the construction industry, it is the employees, the design engineers, architects, draftsmen and construction workers who perform the value-adding work, who determine the outcome of a project, for better or for worse. It is the task of management to produce the

construction plans, to gather the required information and procure the required materials at the right time, in order to facilitate the value-adding work.

Reiterating Dr. Brammar's definition of value-added management "*The progressive elimination of all waste through the creative engagement of all employees*", we see that it is the task of management at all levels to see to it that all employees are indeed engaged in this fashion. The prime requirement to achieve this is fostering a climate of active co-operation between teams. This in turn requires clear lines of communication, a systems approach to organisation and clear lines of responsibility.

A most important facet of commitment to people is the necessity of management to be actively engaged in fostering a climate of healthy and safe working conditions. In the construction industry, the incidence of industrial accidents is unacceptably high.

### **3 CONCLUSION**

This paper sketches the problems of the construction industry's lack of performance as originating in the practice of acceptance of lowest price tenders and the existence of adversarial personnel relationships. It then suggests a way forward towards a general improvement of the construction industry, by the transplant of (suitably modified) modern management practices from the manufacturing to the construction industry.

The purpose of this paper is to put these problems on the industry agenda for dialogue.

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