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Albert Hamilton
BSc, CEng, FICE, FIMechE,
FIEI, FAPM

is senior consultant and professor at the National Centre for Project Management at Middlesex University in London

Project management: turning engineers into team players

Delivering outcomes in today's business world is increasingly achieved through undertaking a collection of projects, which frequently involve teamwork with multiple experts and organisations. But not all civil engineers are naturally comfortable working in this way. For some of us it involves a potentially cataclysmic shift towards 'softer' sciences, increasing our behavioural skills and getting things achieved through people. This paper examines the skill range needed to be an effective project manager and reports on an on-the-job training programme that was run successfully for four years in Sweden and Ireland.

Managing is an activity undertaken by people who may or may not hold the title of manager. It can be grouped into a number of 'schools'; for example, the 'classical school', the 'decision theory school' and the 'work activity school'. These schools need to be briefly summarised as their respective approaches to management influence both the development and evaluation of managers.¹

- *Classical.* During most of the twentieth century the classical approach based on the work of Fayol (1841–1925) and others has been the conventional wisdom. Planning, organising, staffing, directing, coordinating, reporting and budgeting (POSDCORB) are the stated activities of managers.
- *Decision theory.* A more recent approach is based on the work of Simon (1916–2001) that emerged from economics and is the ability to make the right decision in conditions of uncertainty. 'Management science'

and 'operational research' are two academic disciplines that support the activity of decision-making.

- *Work activity.* Based on the work of Henry Mintzberg (1939–) the work activity of managers was observed to be anything but POSDCORB and was characterised by brevity, variety and fragmentation. Managers, he observed, do an enormous number of things in a day and have a preference for spontaneous action.

Since then there have been a number of attempts to reduce all the complexities of management into a series of prescriptions about what managers should do and how they should do it. Each of these frameworks helps to heighten understanding but none of them provide the definitive answer. Numerous studies carried out during the 1970s, 1980s and 1990s identified what constitutes effective management.

In a recent study of over 400 managers who had been identified as highly effective

Table 1. Project skills most required by engineers, based on a survey of 227 UK chartered engineers in 2002⁶

Topic	Group average: %	Skills and expertise
Leadership	86	Make formal presentations, plan/chair formal meetings, motivate, supervise
Projects	84	Costing, estimating, evaluate projects, analyse project risks, plan/schedule projects
Business	53	Project financing, analyse corporate risks, plan/control budgets, company accounting, corporate strategy, company law
Personnel	51	Employment law, negotiate with employees/trades unions, plan personnel requirements, human resources recruitment and selection, appraise personnel
Commercial	46	Marketing products/services, draft contracts, negotiate contracts
Research and development	36	Plan new products, patenting, plan research, design and development
Operations	32	Construction, production, maintenance, services, stocks and materials planning, health and safety law, negotiate with public authorities
Training	27	Employee training
Techniques	21	Statistics, operational research, systems analysis, organisation and methods, work study, data processing

tive,² about 60 characteristics were identified and distilled into ten primary skills that would be found in effective managers

- verbal communication, including listening
- managing time and stress
- managing individual decisions
- recognising, defining and solving problems
- motivating and influencing others
- delegating
- setting goals and articulating a vision
- self-awareness
- team building
- managing conflict.

These skills compare favourably with the results of other studies undertaken in the last 15 years or so. It can be concluded that there are three characteristics that typify these skills

- *behavioural*—an important implication being that as an identifiable set of actions they can be learned and improved on
- *contradictory or paradoxical*—for example some are hard driving while others take account of human feelings
- *interrelated and overlapping*—for example to motivate other people skills such as communication and delegation are also required. It would appear that effective managers develop a range of skills that are supportive, overlap and are flexible enough to manage a wide range of situations.

Protocols for managing projects

Although there are characteristics that are common, there are three things that distinguish project work from non-project work.

- *Unique.* Projects are unique undertakings. The totality of the human endeavour required is not a replication of past achievements.
- *Uncertainty.* In almost all project work there is uncertainty or risk, which is usually proportional to the complexity and/or the extent of human effort required.
- *Impermanent.* Project work is impermanent. There is a closed period, a life cycle, between the start of work and a definable finish date.

Since projects, led by project managers, are becoming the fundamental internal building blocks through which most organisations satisfy their requirements, it is axiomatic that project managers require the same behavioural skills as effective managers.

The Project Management Institute (PMI) in the USA and the Association for Project Management (APM) in the UK have each created a project management body of knowledge (PMBOK)^{3,4} and these bodies are the basis for developing project managers through certification programmes. A recent comparison of the PMBOKs in *Civil Engineering*⁵ demonstrates that although there is a fairly high level of commonality, the APM's seven-knowledge-area document is very general,

offering 'overall scope' or guidance, whereas the PMI's nine-knowledge-area document is more definitive in what it deals with but the extent of its coverage is not as all-embracing.

Management competencies

A 2002 survey, also published in *Civil Engineering*,⁶ showed that 76% of engineers held roles that were either predominantly managerial or equally balanced between managerial and technical. The sample size was 227, which represented about 1 in 1000 of all UK-based members, not retired, covering ten of the UK's most significant engineering institutions.

The sample in distribution by age and sex was representative of all UK chartered engineers registered with the Engineering Council. This survey generated an indication of skills and expertise from a list of 47 topics that might be required for management. These topics were grouped into headings along with the analysed percentage of engineers who believed that such skills and expertise are required for their present job role (see Table 1).

An earlier study of 170 practising construction project managers in the UK,⁷ with close to 90% of these managers having engineering degrees, provided some interesting results. The elements that impact on competency were grouped into project management functions that are explained by tabulating the associated knowledge and skills (see Table 2).

The study found that the knowledge and skills necessary to maintain a project manager's competency were provided primarily through their working experience. As engineers are educated to be engineers, the extent to which post-education training enables engineers to become more effective managers is considered to be an absolute necessity; experience alone is inadequate.

Management learning approach

The aim of training for any organisation is to help the organisation achieve its purpose by adding value to the people it employs. Training means investing in people to enable them to perform better and to empower them to make the best use of their natural abilities. Training is defined as the act of teaching individuals the

knowledge they need to function properly on the job.

Developing highly competent management skills is complicated because there can be no standardised approach to managing human beings. What all management

skills have in common is the potential for improvement through application and practice. Any approach to developing management skills should therefore involve practical application. Competence in any management area presumes both a strong

knowledge base and the ability to apply that knowledge base effectively on the job.

Individuals learn through a process of conceptualisation and experimentation.^{2,8} In conceptualisation, the individual uses theory to build mental models of the knowledge domain. Experimentation is the process of testing conceptual knowledge by applying it to specific situations. This approach was used but modified using the author's experience over an eight-year period during the 1990s of training approximately 500 engineers and other technical practitioners to be project managers.

The approach consists of six stages as shown in Fig. 1. This learning template provides for measuring individual competency before the commencement of skills transfer and shows which elements to improve and to what target level (stage 1). The presentation of principles and methods using traditional instruction methods (stage 2) and a demonstration of how the principles and methods work through the use of cases or actual experiences (stage 3) is then followed by the opportunities for the practice of the principles and methods through exercises (stage 4) and the challenge of applying the classroom knowledge to a participant's current project (stage 5). Finally, individual evaluation of the learning process and skills transfer (stage 6) is compared with the initial assessment of competency (stage 1).

Traditional training lasting a number of days is where individuals are taught and exposed to issues and methods relevant to their work environment. After training, participants typically return to their job role and are expected to improve their performance by applying the new knowledge and know-how. It is reported that a loss of knowledge of about 40% can be experienced after a delay in application of one month,⁹ rising to a 90% loss after a six-month delay. The loss of new knowledge is directly proportional to the delay in practical application.

Model training programme

A training model was developed based on the learning template. This model was used from 1998 to 2002 to train around 100 Swedish technical specialists to become effective project managers. The model uses the classroom for traditional

Table 2. Competency and skills of construction project managers, based on a survey of 170 construction project managers in 2000⁷

Project management function	Knowledge and skills (examples)
Technical skills	Planning and scheduling, basic technical knowledge in own field
Managerial skills	Leadership, delegation, negotiation, decision making
Financial skills	Establishing budgets, reporting systems
IT skills	Project management software, spreadsheet, computer-aided design
Legal skills	Drafting contracts, health and safety issues
Communication skills	Presentation, correspondence, report writing
General skills	Chairing meetings, understanding the organisation

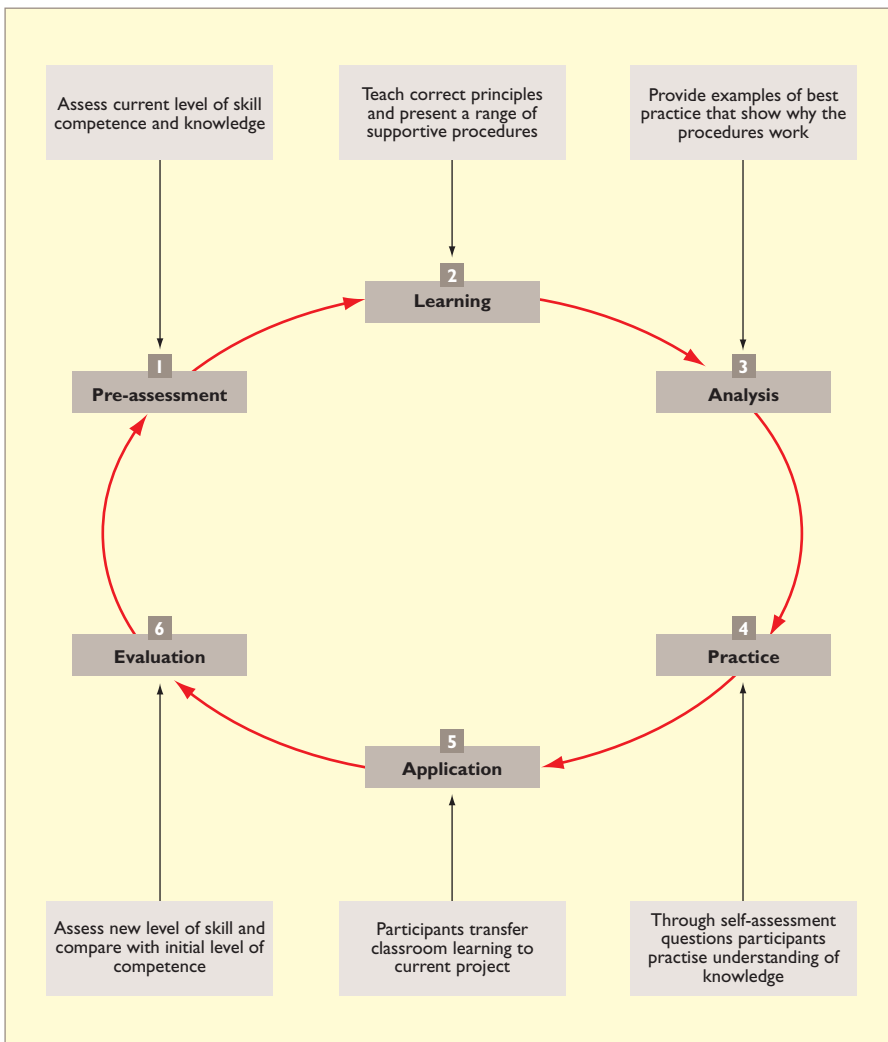


Fig. 1. A six-stage learning template for would-be project managers

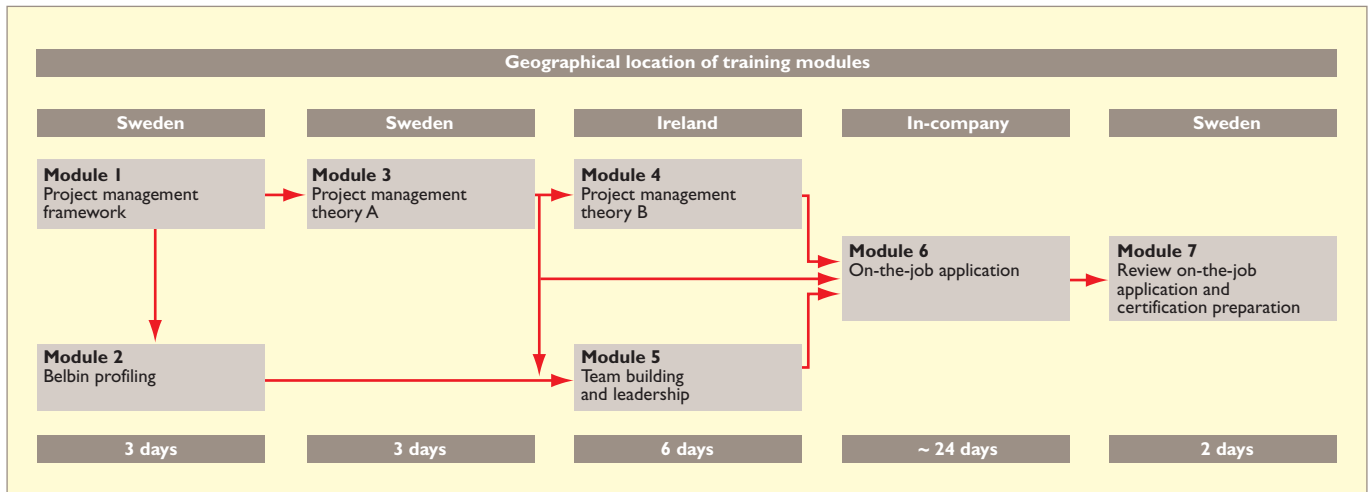


Fig. 2. Seven-module, 28-day training programme which was successfully used to help around 100 Swedish engineers and technical specialists improve their project management skills between 1998 and 2002 (see Table 3)

instruction methods, the workplace for on-the-job application and the outdoors to identify and develop team-building and leadership skills.

The participants' organisation required the facilitator to plan the training programme and agree the planned locations, facilities, techniques and so on. The organisation required the programme to be conducted in English to enhance the participant's ability to operate globally; part of the programme was to be held in an English-speaking area. The facilitator and the organisation were to review and agree programme amendments after training each cohort of about 16 participants.

The training model (Fig. 2) was entitled 'Effective Project Management' (EPM) and was delivered in Sweden and Ireland. The seven-module programme developed from this model is shown in Table 3. In-class sessions totalled 10 days, the outdoor session was four days and the on-the-job element totalled between 10 and 14 days. The model required up to 28 days of participant effort over a calendar period of between three and four months.

For all in-class modules the facilitator presented best-practice procedures contained in a training workbook following which the participants answered workbook self-assessment questions. Each cohort was divided into 'buddy' pairs who were required to work together in answering these questions. At appropriate times during these in-class modules each participant developed templates for their donor

Table 3. Outline of the Effective Project Management training programme that was successfully used over a four-year period in Sweden and Ireland

Reference	Module title	Module description and comments
Module 1 (2 days)	Project management framework	Module deals with systems thinking and the related approach to the discipline of project management. Projects within the larger business enterprise (management by projects) and projects that an organisation has to deliver for its customers (project management) were examined and debated. Content of various project management bodies of knowledge dissected, compared and explained.
Module 2 (1 day)	Personality profiling	Module focuses on determining the positive behavioural strengths and allowable behavioural weaknesses of each participant through individual evaluation of personality and intelligence profiling using team-role characteristics ¹¹ in conjunction with a '16 personality factors' test. Individuals profiled their 'behavioural role' and this role is used in a one-on-one session with the facilitator to discuss the individual's natural role in teamwork. A plenary session discussed team role combinations that are found to work and those that do not.
Module 3 (3 days)	Project management—theory A	In-class study module, working in small interactive groups, deals with the conceptualisation and value management of projects, time and cost planning and development of control templates, assigning resources for projects and determining team role specifications. Participants work independently in progressively developing their donor project's templates.
Module 4 (2 days)	Project management—theory B	This module follows the same format as module 3. The topics covered include managing project quality, turning assigned team roles into human resources processes, procurement 'best practice' and its management, and the use of risk-management processes. Each participant develops and further enhances his or her donor project templates.
Module 5 (4 days)	Team building and leadership	Module held at an outdoor location. Participants assembled into teams of five or six and engaged in a series of team-building exercises through the use of problem solving. The result of behaviour profiling is used to select functional and dysfunctional teams. One person selected to lead a team for an exercise; the leader for subsequent exercises being rotated from other team members. A special night exercise is enacted that adds to the team-building experiences. An environment is created that facilitates individual leadership skill to be displayed through outdoor exercises. All exercises follow a pattern of in-class briefing, outdoor exercise and a closeout through in-class debriefing and discussion.
Module 6	On-the-job application	This self-directed module is undertaken in a participant's own time over a period of approximately 6–7 weeks between modules 5 and 7. During this period participants have hotline, electronic or voice support from the facilitator. Each individual is required to refine the various project management templates they had commenced or developed in earlier modules and complete the application to their donor project.
Module 7 (2 days)	Review on-the-job application and certification preparation	Electronic presentation by each individual highlighting benefits and difficulties experienced by applying formal project management processes and procedures to their donor project. The other participants (the peer group) critique each participant's approach, outcomes and their presentation. The presentations and critiquing normally fill the first day. During the second day the participants sit a mock examination as preparation for either PMI or APM certification.

Table 4. The Effective Project Management training programme substantially covered the topics of the PMI and APM bodies of knowledge

Reference	Body of knowledge sub-structures	Effective project management (EPM) training programme module (• = included, ◦ = partly addressed)						
		1	2	3	4	5	6	7
Project Management Institute (USA)								
4	Project integrated management	•					•	•
5	Project scope management			•			•	•
6	Project time management			•			•	•
7	Project cost management			•			•	•
8	Project quality management				•	•		•
9	Project HR management				•	•	•	•
10	Project communications management			•			•	•
11	Project risk management				•		•	•
12	Project procurement management				•		•	•
Association for Project Management (UK)								
1	General	•					•	•
2	Strategic			•	•		•	•
3	Control			•			•	•
4	Technical			•			•	•
5	Commercial				•		•	•
6	Organisational	•		•	•		•	•
7	People		•			•	•	•

project, working initially from flipcharts and a white-board. Outside normal class time these templates were transposed into electronic files onto the participant’s notebook computer.

Techniques used by the facilitator in the classroom included computer-projected views, overhead projection of acetates, and flipcharts. The classrooms and breakout rooms used were purpose-built and part of a comprehensive facility that included hotel-type accommodation. The participants’ organisation’s excellent training facilities in Sweden were used and the teambuilding and leadership module was held at an outdoor centre located in the west of Ireland.

It is not possible to state that the EPM training programme fully addressed all knowledge areas of both the UK and USA bodies of knowledge, but the programme was substantial in its coverage (Table 4). The content of the EPM programme was felt more than adequately to address the top two topics of leadership and projects, arguably the two most important from a project management perspective as gauged by engineers. The project skills of leadership, particularly presentation, motivation and team supervision, and the skills needed for projects, identified in the 2002 survey of skills required by engineers, were appropriately covered by the programme.

Programme evaluation

Organisations spend large sums on project management training without knowing the resulting benefits. Evaluating project management training is more than measuring the results of improved or reduced project performance. It should measure the impact

- on the department, or section, where the learner works
- on the organisation or business in a wider sense
- on the learners themselves.

This normally entails establishing indicators that describe the situation before and after training.

It appears the reasons why organisations implement project management training programmes are either in reac-

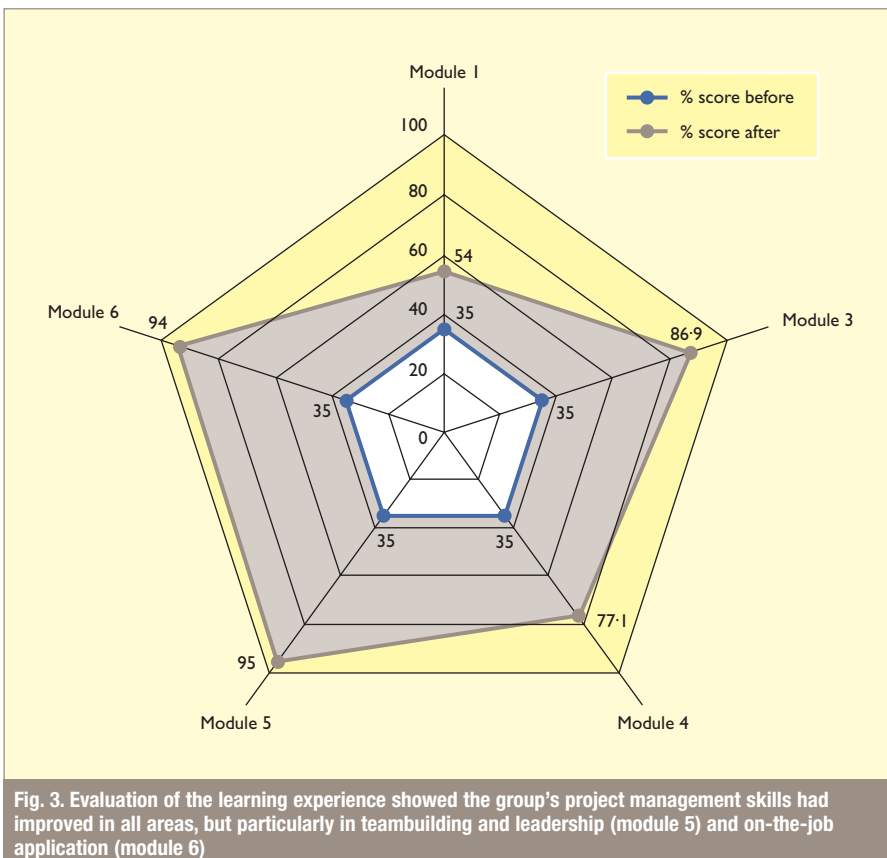


Fig. 3. Evaluation of the learning experience showed the group’s project management skills had improved in all areas, but particularly in teambuilding and leadership (module 5) and on-the-job application (module 6)

tion to specific needs or as part of a wide-ranging programme of organisational change.¹⁰ The EPM training programme was created to develop a critical mass of effective and certified project managers to satisfy a specific need. In such circumstances the only likely way of measuring impact is through change in a learner's ability achieved through the provision of training.

The evaluation of the EPM programme was carried out using the core modules (1, 3, 4, 5 and 6) but excluded modules 2 and 7 because they did not contribute directly to the learning process. Module 2 was input information for module 5, and module 7 was both a review of the programme and a test of participants' reactions to a subsequent stage—an examination leading to certification as a project manager.

Measurement of participant project-management knowledge and skills at course commencement and completion was carried out using closed questions in a questionnaire that used a five-point scale for responses. The pre-assessment knowledge was more difficult to assess than the participants' knowledge at the end of a programme. The group's project management skill base was generally assessed at 35% for all modules, covering theory (modules 1, 3 and 4), teambuilding and leadership (module 5), and on-the-job application (module 6).

Weighted averages of learning experience by all participants were plotted as a spider diagram (Fig. 3). The inner ring of plots shows the pre-assessment and the outer ring of plots shows the evaluation at the end of the training programme. The shaded area in Fig. 3 represents the group's improvement in project management understanding, theory and application.

Overall the improvement in participant learning was greatest in teambuilding/leadership and on-the-job application with scores of 95% and 94% respectively. The learning experience in project management theory was close to 87% for project scope, time, cost and communications, and close to 77% for project quality, human resources and risk and procurement. The learning experience in module 1, the project management framework, was 54%. This value probably reflected the participants' pre-knowledge

of their corporate project management guidelines which, although published at a very general level, did reflect aspects of the PMI's PMBOK.

Conclusions

Current certification for practising and aspiring project managers is directly linked to understanding the body of knowledge available from either the PMI or the APM. As more and more organisations are requiring certified individuals to lead projects, then the bodies of knowledge by default become a natural starting point for the design of training programmes in project management.

The bodies of knowledge currently available from the PMI and the APM are not in alignment. They are also somewhat inadequate in establishing and defining the elements that determine the theory of project management. Much work needs to be undertaken to consolidate what is meant by the discipline of project management.

Based on the author's 35 years experience of managing projects and project teams there is a limit to how much theory can be taught. It is how it is taught that is the significant factor. On-the-job training appears to be a very effective way of transferring skills because it is undertaken on real issues, skills transfer is not delayed and on-the-job offers added value to the learner's organisation by creating operational templates for immediate application.

In evaluating the programme, the 100 Swedish technical specialists were of the view that the combination of classroom theory assignments, outdoor leadership and team-building exercises and immediate on-the-job application was a powerful one that provided the vast majority with the best training, of any type, they had ever experienced.

How to evaluate the effect of training people is an extremely important issue. Organisations, management, academics and training facilitators need to be involved in research that will find methods and metrics for evaluating training impact. More comprehensive ways are needed that will adequately measure the benefits of different ways of delivering project management training.

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