Using Groupware in Quality Management Programs

Nereu F. Kock Jr.
Robert J. McQueen

Abstract
Quality management programs and ISO 9000 certification efforts accomplished by organisations are typically based on group work and generate large amounts of written documentation. Groupware technology can improve group work and process documentation, but few organisations seem to be benefiting from its use. This paper tries to fill this gap by suggesting possible applications of some groupware instances - namely electronic-mail, computer conferencing, workflow control and group decision support systems - to each of the several steps of a typical quality management approach called PQMP. An illustration is provided for a company manufacturing truck parts.

GROUPWARE SYSTEM FUNCTIONS

There are several taxonomies for groupware. One of the most commonly accepted is the application-level taxonomy, based on the main function the system provides to its users (Wilson, 1991; Ellis, Gibbs and Rein, 1991; McQueen, 1993; Kock, 1994). Some of the most representative categories of the application-level taxonomy follow, along with a brief discussion on experiences with their utilisation:

**Error! Bookmark not defined.** Electronic-mail. Electronic-mail is by far the most successful and the most used groupware instance (Easterbrook et al.; 1993), and was one of the first computer systems to be developed with the aim of supporting communication among people. It is easy to use due to its strong analogy to the ordinary postal system. Several kinds of improvements have been reported from the use of electronic-mail ranging from reduction of time on processes which involve intensive communication to reduction of costs with common mail. For example, it is claimed to have saved IBM from sending 7.5 million envelopes by airmail in 1987 (Toffler, 1991).

**Error! Bookmark not defined.** Computer conferencing. The main function of computer conferencing is to allow people to exchange electronic messages about a given topic in the context of a group discussion. It is different from electronic-mail to the extent that messages are presented to the user in a contextually organised, topic structured manner, and access to the messages can be restricted to only members of
the group engaged in the discussion. A conferencing system can be of two types: asynchronous and synchronous. In asynchronous conferences, people can participate in the conference by reading and sending messages at different times, while with synchronous conferences, they must all be connected to the system at the same time. One case study in an organisation suggests that asynchronous computer conferencing can support post and pre-meeting discussion quite effectively, which can therefore generate time savings of expensive staff such as executives (Kock, 1993).

**Electronic calendaring.** Electronic calendaring supports improved group coordination through the use of shared access to appointment diaries on networked computers. Through it people are allowed not only to record information about their own appointments but also can access other people's information. This information sharing functionality is normally extended with features that enable one person to book appointments for another and even to find out if a meeting with several people is possible regarding their own particular appointments. As an outcome of its use, improvements have been observed in the coordination of activities mainly from managers. However, as pointed out by Grudin (1988), those improvements are only achieved when most of the people involved use the system to record information about most of their activities.

**Workflow control.** Workflow systems coordinate the flow and processing of electronic documents, often across functional boundaries in an organisation. One frequently cited example is order processing, where entering and checking of data can proceed in parallel, rather than the sequential process of paper based systems. Great importance has been given lately to this class of groupware as it is closely related to the concept of process. As the awareness about this concept has increased in the management community in the last few years, especially due to the business process reengineering wave, some technical discussions have been taking place to link workflow control system to process redesign (White and Fischer, 1994).

**Group decision support.** Group decision support systems assist the type of activities that normally take place in structured business meetings, such as development of plans and budgets. Discussions usually take place in a special decision room, which has a networked computer available for each user, but also supports visual and verbal interaction among participants. The main purpose of group decision support systems is to aid in sharing of information, ideas and opinions, and making these available to all participants. Brainstorming, voting, ranking and classification of ideas are examples of tasks supported by a typical group decision support system. A fundamental element for its effective use is the "facilitator" who provides technical and procedural support to the members of the group. Some studies suggest group decision support systems can improve the overall quality of decisions as well as reduce the time to reach them (Pietro, 1992; Sheffield and Gallupe, 1993).

**Collaborative writing.** This class of groupware allows two or more authors to jointly prepare and revise a document. The status of the document along with author's comments and identification of modifications are provided. Through collaborative writing systems any of the authors
is able to keep track of the document evolution and identify who changed the
document and to what extent. Comments associated to parts of the document can be
attached by some of the authors and viewed by the others. Collaborative writing
systems can be synchronous and asynchronous, respectively providing support to
same-time and disconnected-time interaction. One example of collaborative writing
system is a text editor designed to be used by a group of people simultaneously editing
an outline document during a work session, called Grove, which stands for group
outline viewing editor. According to Ellis, Gibbs and Rein (1991) while it presents
some advantages as time reduction, Grove was reported by some users as cutting
down social interaction and making discussion more difficult and boring.

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*Shared work space.* These systems provide
shared access with editing capabilities to objects and text as might be presented on a
computer screen, but to participants in different physical locations. One example is
Boardnoter, an electronic whiteboard used as part of a meeting room designed and
implemented at Xerox Parc (Stefik et al., 1987). Shared work space systems are
normally used together with other groupware, such as group decision support
systems, to support non-structured communication among members.

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*Shared media space.* A shared media space
can be viewed as a computer conferencing system with multimedia features. Cavecat
is an example of shared media space system which uses integrated video, audio, and
computers to allow spatially and temporally distributed individuals and groups to
work together (Mantei et al., 1991). Through Cavecat each member can see other
members through video cameras installed in their rooms and talk to them via
microphones and speakers.

This list of categories provided is far from being complete and will continue to develop as
more group functions are supported by computer systems. The combination of features of
several of the above categories could create a new category, which could be added to the
taxonomy. However, for this discussion the simple taxonomy presented is more than
enough, since only few of those categories will be considered as enablers for quality
management activities. These are electronic-mail, computer conferencing, workflow
control and group decision support. They were chosen due to their relatively widespread
use and commercial availability.

**GROUPWARE AND QUALITY MANAGEMENT**

After the second world war, Japan underwent an economic revolution that had its major
impact around 1980, when Japanese products poured into United States due their
superior quality and lower prices (Juran, 1989; Walton, 1989). It has led to an
intensification of the studies over quality and aspects related to its improvement. It has
been perceived that quality improvement is achieved through changes in the
organizational structure, mainly in managerial practices. Based on this assumption, a new

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1A description of several commercial groupware products can be found in the frequently asked questions (FAQ) files of products of the Usenet's "comp.groupware" newsgroup.
management methodology called Quality Management was developed. Juran, Deming and Ishikawa are among the authors of pioneering works on it.

It is proposed that Quality Management can be made easier and more productive through the use of groupware. At this point, it is helpful some discussion about what actually is understood as Quality Management and how can groupware be used to improve it. There are a considerable number of organizations running formal quality improvement programs today. In August 1994, for example, Exame (1994) published the following list with the number of companies certified by ISO 9000 per country: England (30,500); Germany (2,600); United States of America (1,600); Canada (1,500); Italy (1,500); Singapore (500); Japan (400); Malaysia (400); Brazil (355); Hong Kong (200); Mexico (150); South Korea (120); Argentina (15). By the same time, Minchin (1994) pointed out that 400 organisations had gained certification in New Zealand.

**Quality Management**

Quality Management is the planning and coordination of activities to guarantee and improve customer satisfaction. It is normally accomplished by the interaction with customers, from which changes in the planning, production and distribution of "products" (i.e. goods, services, information or software) will be devised in a continuous and gradual process. The modern vision of quality management has expanded the concept of "customer", viewing her/him not only as the final purchaser of the products generated by an organization, but as anyone who receives products, inside and outside an organization. From this perspective all the employees of an organization are customers, and all of them have their vision of what is a product with good quality and what is not, in their respective areas.

A number of approaches for implementing quality improvement programmes have been recently proposed (Voehl et al., 1994; Arnold, 1994; Lock, 1994). One of these is called PMQP, which stands for Quality and Productivity Improvement Methodology (in Portuguese), proposed by Kock and Tomelin (1994). The PMQP methodology is aimed at introducing quality management in organisations and is partially illustrated in Figure 1, where each rectangle represents one step towards the introduction of PMQP². The steps are shown in a top-down temporal order and are described as follows:

**Error! Bookmark not defined.** *Quality audit.* A verification of how the organization conforms with a standardized quality management system is performed. This is done through the use of a set of standards which can vary with industry. The most generic set of standards is the ISO 9000 series, which comprises ISO 9001, ISO 9002, ISO 9003, ISO 9004 and ISO 9004-2. These standards are published by ISO (International Organisation for Standardisation) and are used for certification of quality systems.

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²Only part of PMQP is discussed here. A brief discussion of all PMQP's steps can be found in (Kock, McQueen and Fernandes, 1994).
Train all employees. In this step is performed a series of lectures about PMQP's basic concepts as well as practical exercises employing basic statistical tools and group work techniques.

Following those two steps there are two major paths, "Quality groups" and "Generate manuals", in implementing the PMQP methodology.

**Formation of Quality Groups**

In the path "Quality groups" the steps in which actions towards the formation of quality groups are completed. A quality group is formed by employees that voluntarily meet to solve specific problems of their specific areas. Those steps are summarized as follows:

**Define an internal support area.** Here is defined a staff that will be responsible for the general support to the program and for reporting on the execution of the steps proposed to the high management staff of the organization. Some organisations also settle a Quality Committee at this point, which meets regularly to analyse the evolution of the overall program.

**Train facilitators.** Here the facilitators are trained. They are chosen from among the best performing employees in the basic training and are expected to master the tools and concepts that will be used by the quality groups and, therefore, to support them.

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**Figure 1: PMQP's Steps**
Spread quality groups. In this step the quality groups are formally started and propagate throughout the organisation. Each quality group will be created to solve a specific problem and will be finished when some solution is reached and implemented. This implementation can be carried out by the group members or by other employees by request, yet in this latter case the group leader or an appointed member will be responsible for its completion. A quality group is spontaneously formed by 3 to 7 employees who elect a leader and perform its activities in a structured way. Yet some suggestion from managers of problems to be addressed by quality groups is useful at the beginning, it is important that the organisation find ways to motivate employees to spontaneously take part on quality groups (e.g. a reward system), for one of the goals sought is to increase employee participation.

Quality groups control. Here a record for each quality group will be maintained, describing its activities from the creation to the extinction. These records will prevent others groups from duplicating efforts as well as serve as a demonstration of the existence of a set of structured actions to handle non-conformities in the quality system, which is a requirement of several quality standards such as ISO 9000 (Minchin, 1994).

Generating Manuals

In the path "Generate manuals" are the steps related to the generation of manuals that will define rules to perform tasks so that their outcome have optimal quality. Those manuals embody the description of the organization's own mission and general quality standards. Those steps are given as follows:

State organization's mission. Here is generated a statement of the organization mission and some general quality standards to be followed by all members. The statement of the mission is typically as paragraph where the main goal of the organisation is summarized. The quality standards should not be more than 10 and state general criteria related to the mission accomplishment. They must be comprehensible and should be understood by all the employees.

Generate QFDs. In this step are generated the quality flow diagrams (QFDs). A QFD is a graphical representation used to show how quality flows inside and outside the organization. That tool is discussed in (Kock and Tomelin, 1994).

Define responsibilities. Here the sources in the QFDs are defined as roles (i.e. functional positions such as president, plant manager and welder) played by members of the organisation. These are the responsible for the satisfaction of their customers, being them inside or outside the organisation.

Generate quality manuals. In this step, quality manuals are generated in several levels addressing from strategic to operational aspects of the quality system. They state how tasks must be performed to guarantee
quality throughout the whole process ranging from product generation to delivery. They document from the organisation's "constitution" and the quality system manual, which describe the quality system in a general form, to the procedure specification manuals, where the low-level processes are specified.

The Role of Groupware in Quality Management

The adoption of new managerial methodologies, of which Quality Management is an example, has led to an increasing awareness of computer based systems to support these new methodologies. There is a potential of synergy when coupling these managerial methodologies with computer systems technologies, such as groupware.

In Table 1 is shown a relationship between groupware, defined by its Application-Level Taxonomy, and PMQP's steps. In the column "Groupware Tool" groupware tools are given in order of usefulness. They are represented by mnemonics where EMAIL stands for electronic-mail, CONF for computer conferencing, GDSS for group decision support and WFLOW for workflow control.

<table>
<thead>
<tr>
<th>PMQP's Step</th>
<th>Groupware Tool</th>
</tr>
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<tbody>
<tr>
<td>Quality audit</td>
<td>EMAIL</td>
</tr>
<tr>
<td>Train all employees</td>
<td>CONF, EMAIL</td>
</tr>
<tr>
<td>Define an internal support area</td>
<td>GDSS</td>
</tr>
<tr>
<td>Train facilitators</td>
<td>CONF, EMAIL</td>
</tr>
<tr>
<td>Spread quality groups</td>
<td>CONF, EMAIL, WFLOW</td>
</tr>
<tr>
<td>Quality groups control</td>
<td>CONF, WFLOW</td>
</tr>
<tr>
<td>State organization's mission</td>
<td>GDSS</td>
</tr>
<tr>
<td>Generate QFDs</td>
<td>CONF, EMAIL</td>
</tr>
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</tr>
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</tbody>
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Table 1: Groupware and PMQP's Steps

Part of the step "Quality audit" can be performed by the use of electronic-mail to collect basic information about the conformation of the organization with quality standards and to get further information. However, most of the information collection must be performed through interviews and local verification, since response time is relevant and correct answers must be guaranteed. Similar constraints are found in other steps which use electronic-mail combined with computer conferencing ("Generate QFDs", "Define responsibilities" and "Generate quality manuals"). Actually, electronic-mail and computer conferencing are useful tools to support communication among groups of people, but they lack functionally to classify and retrieve data. Particularly in the steps "Generate quality manuals" and "Generate QFDs" conferencing systems can play an important role in the reduction of paper, as both steps typically generate large amounts of written documentation. Quality manuals and QFDs can be attached as wordprocessor and spreadsheet files, respectively, to related topics in a conferencing system for public access, creating a simple collaborative writing system.

The steps "Train all employees" and "Train facilitators" can be done with the use of computer conferencing and electronic-mail to support pre and post-training discussions.
To allow a more intensive use of those systems though, there should be added some characteristics to the electronic-mail and computer conferencing systems commercially available today, to make them more suitable for training. Some researches show that multimedia and hypermedia characteristics are promising alternatives (Oz, 1993).

The steps "Define an internal support area" and "State organization's mission" can be enhanced through the use of group decision support systems since the outcomes are the result of a consensus. There are several researchers who have shown that group decision support systems can improve group meetings in several ways. These studies were performed in different contexts: national economic policy development (Sheffield and Gallupe, 1992), university laboratory (Nunamaker, 1991), air force (Beise, 1992) and service industry (Pietro, 1992; Dallavalle, 1992).

The step "Quality groups control" is a typical example of a set of tasks performed by others that must be controlled by one person. Each quality group can be viewed as one task performed by a group of people, that has a specific state at a time. Several quality groups might exist in an organization at the same time and a workflow system can be of much help to handle the problem of controlling and giving reports about the state of all of them. In addition, computer conferencing can help the controller document the work of quality groups, associating each one with a given topic which focuses on the problem to be solved by the group.

The step "Spread quality groups" can greatly benefit from the use of groupware. Here computer conferencing, electronic-mail and workflow control can be extensively used to help groups identify problems and set themselves up, analyse processes, propose and discuss solutions and keep track of their implementation. When identifying problems to be solved and proposing solutions, group members can avoid effort duplication by browsing through the topics associated to former groups in the computer conferencing system. Invitations to membership and reserved discussions can be accomplished via electronic-mail as well as public discussions can be performed via computer conferencing based on a member's analysis attached to the group topic as a document or graphic. The group leader or another member appointed by her/him can be keep track of the implementation of the solutions via workflow control.

The identification of the most useful groupware applications above supports the assumption that asynchronous groupware systems, rather than synchronous groupware systems, are more likely to improve the efficiency and effectiveness of quality management. The support to this assumption contrasts with the large amount of empirical research on groupware done so far. This research has been mostly focusing on the use of group decision support systems to support group activities, with potential application for quality management programs (Sheffield and Gallupe, 1992; Nunamaker, 1991; Beise, 1992; Pietro, 1992; Dallavalle, 1992).

**Illustration: A Truck Parts Manufacturer**

In this section we use the example of a fictitious truck parts manufacturer called KTP to illustrate how some instances of groupware can be used in quality management and ISO 9000 compliance programmes. This illustration summarises ideas drawn from the
experience of one of the authors (N.F.K.) with the implementation of quality management
and ISO 9000 compliance programs, based on the PMQP methodology and using
groupware instances, at two manufacturing companies:

- Magius Metalúrgica, a truck parts manufacturer based in Curitiba, 
south of Brazil, which manufactures parts for major truck
manufacturers - such as Scania, Mercedes and Puma - in Brazil, South
America and Europe.

- Westaflex Tubos Flexíveis, a multinational car parts manufacturer,
specialised in corrugated hoses for small car exhausts. The author
worked at one of Westaflex plants based in Araucária, south of Brazil,
which manufactures parts for large automakers - such as General
Motors, Ford, and Volkswagen - in Brazil, US and Europe.

The fictitious truck parts manufacturer called KTP, here used as an illustration, is based in
New Zealand. KTP supplies parts for several truck manufacturers based in Australia, Asia
and Europe, through two plants with approximately 150 employees each, located 300
kilometres apart. Each of the plants has a computer network primarily used to run
integrated financial and inventory control systems as well as general utilities (e.g.
wordprocessor and spreadsheet).

As most of KTP's biggest customers require it to be certified by ISO 9002, which in turn
requires a documented system of procedures for production and quality inspection of
goods designed elsewhere\(^3\), it decided to introduce PMQP. A plan for the introduction
was outlined and the company started with three main steps:

**Error! Bookmark not defined** A training program on the PMQP's
basic concepts to all employees and on some basic statistical tools to
the facilitators, who were selected from among the more skilled
employees identified in the basic course.

**Error! Bookmark not defined** The introduction (i.e. installation and
training) of two commercial groupware systems to the plants: ProMail,
which embodies electronic-mail, computer conferencing and workflow
control features, and GroupDecision, a group decision support system.

**Error! Bookmark not defined** A preliminary audit performed by an
official certification institute based on ISO 9002 norm.

Quality and groupware training sessions were combined, showing through practical
examples how groupware could be used in the several tasks comprised in the PMQP's
implementation. The two networks in each plant were integrated with ProMail so that
users of the two plants could take part in computer conferences, control workflows
involving people from different plants and exchange messages with them.

\(^3\)If KTP was responsible for the design of the parts, along with their manufacturing and quality
inspection, it might be required to be certified by another norm - ISO 9001 - which is an extension of the
norm ISO 9002 (Minchin, 1994).
A Quality Committee was created by KTP's board of directors, constituted by the two plant managers, two representatives of the employees and two other members from the Internal Support Area, which was not formally created yet. It was decided that the Quality Committee would initially meet once a month to make strategic decisions concerning the PMQP implementation, such as assignment of people to certain roles, approval of detailed implementation plans and allocation of resources when special needs were identified. It was agreed that meetings would be performed with the use of GroupDecision, starting with the definition of the Internal Support Area (i.e. its main responsibilities and personnel).

The results of the preliminary audit, pointing out the main problems to be solved so as KTP could be certified, were distributed in the form of a report to all the employees via electronic-mail. The members of the internal support area, already selected, suggested some of these problems to be taken up by some groups of employees, forming the first quality groups. Topics describing the problems tackled by each group were created in the conferencing system, and group members were asked to carry out most of the discussion electronically. This was accomplished by the group members adding comments to the topic and exchanging messages among themselves through electronic-mail. When planned actions were required by a quality group (e.g. to put into practice agreed solutions) the group leader would schedule some activities and control their execution using ProMail's workflow control functions. All data generated would be attached to the topic, hence requiring minimum effort from the internal support staff to keep track of quality groups' development.

The documentation of the quality system was carried out at the same time as some changes in the manufacturing and inspection were accomplished so as these processes could comply with the general criteria set up in ISO 9002. The Quality Committee defined, through a meeting session with GroupDecision, the mission of the organisation and general quality standards to be followed by everyone. They were summarized in what was called the "quality letter" of the organisation and distributed via electronic-mail to everyone and later discussed among managers and front-line workers in face-to-face meetings. The QFDs were generated along with the definition of responsibilities through face-to-face interviews conducted by a group formed by external consultants and the internal support area. The results were held in ProMail as files attached to conference topics for revision, which was carried out by interviewees suggesting modifications through comments and electronic-mail messages. With this information available the same group wrote the quality system manual and the procedure specification manuals. Those manuals were attached as files to topics in the computer-conferencing system, for public access.

After approximately one year KTP was accredited by ISO 9002 on its two plants, both after the first visit of the auditors. It also had a remarkably small numbers of printed manuals being handled by employees, which was quite different from other certified organisations. As a result of its quality system implementation it expected to increase its international market share, and reduce costs, mainly as a result of changes proposed by quality groups. When compared with other similar organisations, KTP significantly reduced the duration of the certification time.
CONCLUSION

KTP’s case provides an illustration of groupware utilisation to support several different stages of a quality management program. This quality management program, despite being based on a specific methodology - PMQP, can be seen as a general example of a quality management program aimed at accreditation by ISO 9000. KTP’s case highlights the fact that both synchronous and asynchronous groupware can be used in supporting quality management, but that asynchronous groupware holds the most potential. One explanation is that most of quality management activities require data collection and analysis over time, which is better performed in an asynchronous way, and public sharing of information, which is particularly well supported by some conferencing systems.

Groupware use in quality improvement programs is new. Few studies have been reported, with the majority about experiences with group decision support systems to support quality groups. There is a huge potential application for groupware to support quality management procedures, as the number of companies seeking quality management certification is expected to grow exponentially in the next ten years. Groupware itself is a new and rapidly evolving set of technologies, and as these technologies move from the lab to the marketplace as commercial products, there is likely to be increasing use on quality improvement and certification.

REFERENCES


