DISCUSSION ITEM

SOFTWARE ENGINEERING AS A PROFESSION

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Board of Governors Member

"MOVED, that the IEEE Computer Society Board Of Governors appoint an ad hoc committee to initiate the actions to establish software engineering as a profession. This work should include:

a. "Determining, in coordination with the Standards Activities Board. appropriate definitions and establishing those definitions as approved standards in accordance with IEEE Standards Board policies and procedures.

b. "Determining, in coordination with the Educational Activities Board, the body of knowledge required for a four-year undergraduate curriculum for a Bachelor of Science in, Software Engineering and establishing this as an approved curriculum at the Accreditation Board For Engineering Technology (ABET).

c. "Determining. in coordination with the Membership Activities Board (MAB), a set of software engineering ethics.

d. "Encouraging, in coordination with the MAB and the EAB, states to establish software engineering as a registered engineering field consistent with current practices in civil and electrical engineering."

[Updates to the 9 March 1993 draft are indicated by hats

BACKGROUND TO THE MOTION

1. BACKGROUND

In 483 B.C., Xenes. King of Persia and Media, as part of his campaign to conquer Greece, ordered two floating bridges to be constructed across the Hellespont to provide passage for his army from Asia to Europe. After the bridges were completed, a storm arose and the bridges were destroyed. Xerxes had the engineers re-do and another set of bridges constructed, thus demonstrating all that time, the existence of standards of personal accountability for professionals working in the fields of their competence.[1]

1.1. Current Situation

Today, we have a concept that holds professionals (doctors, lawyers, civil engineers, etc.) personally accountable for work in their fields. One major exception is software engineers. Today, we do not appear to have for software engineers:

a. A defined body of knowledge that software engineers should have mastered.

b. Any formal requirements for a technically-competent person to formally attest (certify) the validity of the design of critical software, that is software whose failure would impact safety or cause significant social or financial losses.

c. Any established criteria by which a judgment of the professional competence could be made of those individuals engaged in designing critical software.

1.2. Questions

In examining this state of affairs, several questions arise:

a. Is there a professional field of technical expertise for software engineers?

b. Is there a need to make a judgment on the professional competence of those who develop and maintain critical software?

c. Is there a need for standards of competence for those who design critical software?

d. How should we come to a judgment concerning the professional competence of such personnel?

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1. Herodotus, "The Histories", Penguin Books, Ltd. 1954, p 428

2. WHAT IS TO BE DONE

Examining the above, it appears that we need to do four things:

a Define the professional field

b Identify the technical expenise required to be a member of that profession

c Determine the entry-level requirements for the profession

d. Establish a common set of professional ethics

2.1. Defining The Professional Field

The first step appears to identify a term that describes what a being done. This is not a trivial task as the definition of that term provides the basis for the remainder of the steps that follow. As in most efforts, a top-down approach appears to be productive and so that approach is taken here.

To design a system, we do system engineering. The system, in turn, is divided into hardware and software. To design the hardware portion, we do hardware engineering which, in turn, may include mechanical and electrical engineering. To design the software portion, we do software engineering which may, in Nm. include database engineering and others.

The term 'software engineering" also has a certain amount of existing stature.

a In the 1991 membership survey, over half (54%) of the current full members of the CS polled indicated that they considered themselves software engineers as did 40% of the affiliate members [2]

b The term used at this location is "software engineef and I keep seeing that term in the "help-wanted" advertisements

Assuming that we can use the term "software engineering" to describe what is being done. The next task appears to be to define that term. The IEEE definition is [3]:

> "Software engineering: (1) The application of a systematic, disciplined, quantifiable approach to the development, operation and maintenance of software; that is, the application of engineering to software. (2) the study of approaches as in (1) .

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2. "Survey Of Members, Former Members, And Potential Members For The Computer Society Of IEEE", Washington, DC: Lawrence Leiter And Company, May 1991, pp 13, 21.

3. ANSI/IEEE Std 610.12-1990, IEEE Standard Glossary Of Software Engineering Terminology.

That definition is currently under study to be modified and one proposal is that it be defined as follows:

> "Software engineering: That branch of engineering that is concerned with the development, operation and maintenance of software."

This defines the term by identifying (1) the next larger class (engineering) of which software engineering is an element and (2) the essential difference between software engineering and the other elements of that class.

Looking about for another definition has not yielded useful results. Consider, for example, the Final Report of the ACM Task Force on the Core of Computing Science. This identifies "software methodology and engineering" as one of the eight areas of "Computing As A Discipline". 'Computing As A Discipline' appears to be defined as The systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation and application." There does not appear to be a simple definition of "software methodology and engineering", nor a definition of "software engineering' per se.[4]

2.2. Identifying The Technical Expertise

The body of knowledge encompassed in other branches of engineering appears to be reasonably well-defined. Not so for software engineering and the first question that arises is can such a body of knowledge even be defined?

There is a group that holds the view that the body of knowledge for software engineering should be complete, and then and only then can we progress in defining the profession. However:

a. From a historical view the Romans were building roads, bridges and viaducts long before the mathematical foundations for stress/strain analyses became available. They did heuristically what they knew what worked and extrapolated from there - and a number of those roads, bridges and viaducts are still in use today.

b. Magnificent software systems (for example, airline reservation systems) have been built using the same heuristic techniques.

c. From a pragmatic viewpoint given that there is a need for software, what has to be done, will be done -- and it will be done with the tools and the knowledge available at that time.

2.3. Defining Entry-Level Requirements

Given that the field exists and that critical software is being built today, society, in order to protect itself in the use of a product, will eventually insist that persons who construct critical software have a modicum of competence in the field. This implies judgments to be made on what subjects should be mastered by those working in the field and it is at this point that good people can differ.

Simplifying the problem states that there should be a four-year undergraduate course in software engineering and not more than half the course should be subject specific; the rest is negotiable. To those who are concerned that more is needed and that those who mme out of any such four-year curriculum will not be competent, there is only one response. No one who comes out of a four-year academic curriculum is competent. The only thing that they have gained is a sari foundation for entry into the field. There is a definite need for on-the-job training and there is no substitute for experience.

The determination of what a core curriculum of a four-year course in software engineering should be, is a difficult one, and one that will take considerable effort.

2.4. Determining Competence

In examining this situation, the next question that arises is: how should we go about determining the competence of those building critical software? Looking for analogies in the hardware field, we find state boards both:

a. Requiring that engineering designs be certified by registered professional engineers, and

b. Establishing requirements for registration in specific engineering spmatny. These [illegible] graduation from a specified curriculum at an accredited engineering school, passage of one or more examinations in the speciality area, and a specified amount of time in the practice of the profession.

Now there are many unanswered questions about this topic, but one thing appears certain: sooner or later, the states, national governments, and/or the European Community are going to require that the design of critical software be certified by those already judged to be competent to do so. So either we must establish appropriate machinery to judge competence in the software engineering field, or it will be done for us, by others.

4 yr + Test + OJT

2.5. Establishing Professional Ethics

The ethical aspects of our work have been explored in ... previous issues of the Standards Department (March '90 and Feb '91), and Section 7.8 of the IEEE Policies and Procedures Manual could perhaps provide an initial starting mint. But the issues associated with ethics are too important to expect that an appointed committee's work could represent a consensus of the concerned professionals in the field.

3. INITIATINGTHEPROCESS

3.1. Overview

To obtain a consensus of the concerned professionals in the field on the norms of the software engineering profession, it appears that we need to form a group to formulate these norms. As a first reasonable approach for that group, consider that:

Participation should be open on an equal basis to all persons who are directly and materially affected. Further, we should actively solicit membership both inside and outside the Computer Society.

(1) It is not dear that we should solicit organizational memberships for this group Rather, it appears preferable that members should represent themselves as mncemed professionals in the field.

(2) If organizations desire to send an organizational representative, they should be accommodated, a m their inputs valued and processed as would be any other input However, no organization should be given a veto cower over results that reflect the consensus of the concerned professionals in the field.

b. The group should not be dominated by any single interest category

c The conduct of the group should be governed by written procedures

d. Prompt consideration should be given to the written views and objections of all participants and that each objector should be notified of the disposition of an objection and the reasons therefor

e Unresolved objections and the associated reasons should be reported to the entire membership

f. The conclusions of the group should be supported by a consensus of the membership This would imply a ballot an the final products probably run as draft standards ballots are currently run.

3.2. Initial Schedule

A tentative schedule is as follow:

a March '93 -- A w l '93: Coordinate and revise this proposal based on the comments received

b. May '93: Gather in the collected thoughts of the CS BoG and its associated boards at the May '93 meeting. As part of this, I would ask the Chairs of the EAB, MAB, SAB, TAB, and COPP to reserve a time-slice on their agenda for a short presentation and comments on this topic.

c. June '93 -- August '93 Publicize the effort in appro,riate magazines (lor example, *Computer Communications* OL *The ACM, TCSE Newsletter, SigSoft News, Software* an3 *Crosstalk*) Further suggestions would be appreciated

d November '93: / Hold first meeting of me group during the week 018-12 November 1993 concurrently with the BoG meetings at Santa Clara, CA. This is projected to be a 1 1/2 day meeting beginning at 8 00 am on Monday, 8 November 1993 and ending at noon. Tuesday 9 November1993 This is projected to be hosted hy the CS at the hotel where the BoG meetings are being held

Further milestones to be projected as a result of the May - October efforts

4. ORGANIZATIONAL ASPECTS

Determining the organizational sponsor for this effort includes the following considerations:

a **One** thought that has been strongly consdered s that it should be a task force of the TC on Software Engneenng m e scope of the effort appears to be across so man, different CS BoG Boards, how ever, that it s not certain that such a placement would be correct

(1) There is a major locus in the Educational Activities Board lor me defin tion of the curriculum for a four-year undergraduate degree and its establ shment at ABET This also nvo ves the IEEE EAB s Accreditation Pol cy Committee

(2) The Membership Activities Board's Committee On Public Policy has a major role to play, particularly in the formulation of software engineering ethics and from their activity in software safety

(3) Bath the MAB and the EAB have a strong interest in registration as professional software engineers at the stale level This action also involves the USAB's Licensure and Registration Cornmmee

(4) The Standards Activities Board has been establishing standards for software engineering since 1976 and would be directly involved in the establishment and modification of definitions, among olher interests

(5) The Intersociety Cooperation Committee should be involved as this will go well beyond just CS interests and activities

(6) There may very welt be other CS interests that could contribute and should be involved (Your help in identifying these would be appreciated)

b In view of the above, and recogn z ng thal the desire lo accomplish a specific purpose, it appears that a better w o a d , would be the appointment by the BoG o' a specia (ad hoc) commmee to carry out at least the initial effort

5. FINANCIAL IMPACT

1993 Computer Society support requirements are projected as follows:

a Provide a meeting room at the November '93 BoG meeting to take place as indicated above

b Provide support lor mailings lo group members

c Provide room for an announcement in the July '93 or August '93 Computer

This support is considered lo be estimated at less than $2.000 and will be requested lo be provided by the President of the CS under his authority per section 17 2 3 of the CS PPL'

In a similar manner (assuming that the w o n shows sufficient promise thal it goes on into 1094). Computer Society support requirements for 1994 are projected for three sets of meetings (st the BoG meetng weeks) and associated mailings, and are estimated at $6.000

Should this effort prove to be a burden, then a nominal assessment will be considered to cover the cost of mailings and meetings. This might be in the range of $25.00/year. This will come more sharply into focus at the November '93 ad hoc committee meeting.

6. ADDITIONALITEMS

The following items have been brought to my attention since the initial draft of this paper:

6.1. REFERENCES

a. Ford, G., *SEI Report On Undergraduate Software Engineering*, CMU/SEI-90-TR3, ADA223881

b Parnas, D. "Education For Computing Professionals", *Computer*, Jan 90, pp 17-22

Comments by McGonnigal, **et al.** *Computer*, Apr 90. pp 8-9

6.2. INFORMATION

Contact should be made with:

The ICCP. They have worked on parts of this topic for some time now.

b The American Society For Quality Control (ASQC). Their Software Division has some activity in the certification field

c The British Computer Society They have a certification program and have published job-onenled descriptions

Software Design Center

Software Engineering

As A

Profession

F. J. Buckley

32593

Software Design Center

Definition of Software Engineering as a Profession

- **Purpose:**
  - **Provide an overview of a proposal**
  - **Request your assistance, guidance and counsel**
- **Outline:**
  - **Motion**
  - **Considerations**
  - **Initial approach**
  - **Initial schedule**
  - **Other items**

Motion on Definition of Software Engineering as a Profession

- "Move that the IEEE CS Board of Governors appoint an ad hoc committee to initiate the actions lo establish Software Engineering as a profession. This work should include:
  - Determin ng, in coordinat on with tne Stanaaros Activity Board (SAB) appropriate aetin t.ons ana establishing those definitions, as approved standards in accordance with IEEE Standaros Board policies and procedures.
  - "Determining, in coordination with the Educational Activities Board (EAB), the body of knowledge required for a four-year undergraduate curriculum for a Bachelor of Science in Software Engineering and establishing this as an approved curriculum at the Accreditation Board For Engineering Technology (ABET).
  - 'Determining, in coordination with the Membership Activit es Board (MAB), a set of software engineering ethics
  - "Encouraging, in coordinalion with the MAB and the EAB, states to establish software engineering as a registered engineering field consistent with current practices in civil and electrical engineering."

Considerations

- Define the term "Software Engineering" and other terms, as appropriate:
  - IEEE Std 610.12 - 1990, IEEE Standards Glossary Of Software Engineering
  - Players include SAB, Parnas and others
- Determine the body of knowledge:
  - Four-year undergraduate course
  - Players include EAB, ABET, IEEE Accreditations Policy Committee (APC), Institute for Certification of Computer Professionals, (ICCP), The Software Engineering Institute (SEI) and a cast of thousands.
- Determine a set of Software Engineering ethics.
  - Major MAB Involvement -- Committee on Public Policy (COPP)
  - Other involvement – IEEE?
- Encourage registration actions as professional software engineers:
  - Critical software
  - Analogy with civil and electrical engineers
  - 1982 CS Policy Statement [illegible] etc
  - Players include COPP, IEEE USA [illegible] Committee, ICCP and NCEE!

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Initial Approach

Establish an Ad Hoc committee reporting to the BoG:

- Participation should be open to all
- Group should not be dominated by any single-interest category
- Conduct of group should be governed by written procedures
- Prompt consideration should be given to the written views and objections of all panicipants
- Unresolved objections and associated reasons should be reported to the entire membership
- The conclusions of tne group shoJ.d be supported oy a consensus of the membersh:p

Software Design Center

Initial Schedule

May '93:

- Brief EAB, MAB (including COPP). SAB (including SESC). TAB (including TCSE), BoG and others
- BoG approves motion

June '93 - August 1993:

- Publicize the effort and ask for participation (e.g.. computer, software, TCSE newsletter, communications of ACM. ACM SigSoft News, etc.)
- Organize - Prepare dratt procedures, dratt agenda,...

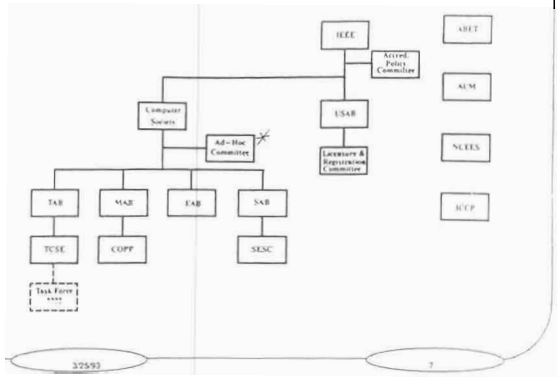
Nov '93: Hold first meeting (Monday - Tuesday of BoG week)

Feb '94: Hold second meeting (Monday - Tuesday of BoG week)

Other 199 ' meetings a: other BoG weeks (TBD)

Other Items (1 of 2)

- BoG Ad Hoc Committee



Other Items (2 of 2)

Financial

- Initially, CS provides meeting rooms and mailings
  - **1993** ~ $2K
  - **1994** ~ $6K
- If it becomes a financial burden, charge a nominal yearly fee to cover these costs - $35.00?