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RUTHERFORD APPLETON LABORATORY

INFORMATICS DIVISION

SOFTWARE ENGINEERING GROUP NOTE 95

ALVEY SE VISIT TO USA OCT 85

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(see next page)

1. INTRODUCTION

2. SUMMARY

3. VISIT TO THE COMPUTER SECURITY CENTRE, THURSDAY 10TH OCTOBER 1985
C33 (Office of modelling (sic), verification, risk analysis)

3.1 Present:

Alvey	CSC
RWW	Tad Taylor (Verification advancement/research)
HKN	Dr Larry Hatch (Chief C33)
	Dr Sylvan Pinksley (Risk analysis)
	Guy Hunt (Hardware/precode verification
	Theresa Kilheeney(Application of verification)
	Tracy Scheffing (Application of verification)
	Karen Ferraiolo (Application of verification)

3.2 Alvey Presentation to CSC

RWW and HKN gave CSC the standard overview of the whole Alvey Programme and the SE Programme.

3.3 CSC Presentation to Alvey

The CSC began as a DoD activity, but recently its role has been widened to national responsibility for spreading verification technology into USA industry. The initial DoD role was to support verification research towards the goal of proving the security of systems; this role continues to be a major thrust.

Larry Hatch's branch, C33, sees that security is a 'driver' for verification research of an extremely taxing nature and that it is wise to push less extreme requirements when dealing with the general problem of technology transfer.

CSC/C33 currently has an 'open' stance; it speaks freely about its work publicly and documents are published openly. CSC/C33 were very open and friendly in the course of the meeting.

CSC's general policy over the last 10 years has been to concentrate on the development of verification tools, especially Gypsy. They made the specific contrast between the USA's 'integration' approach (build tools first and experiment) with the UK's 'innovation' approach (use Z, VDM with pencil and paper; no tools till theoretical basis well established). CSC stated that their USA tool building projects were now impeded by their lack of elegant, formal theoretical basis and CSC was looking at UK/European work to gain this theoretical improvement - integrate European research into USA tools!

CSC's concentration on verification has meant that they have not developed or pushed Formal Specification as a technique independent of mechanical verification. This is a major contrast to UK strategy. USA firms are probably a bit behind the UK in their awareness and experience of formal specification (CSC view).

During discussion two additional topics which cropped up were the problems of verification when the 'configuration' dimension is included, and concurrency. CSC asked about work on concurrently in Alvey. RWW outlined the Barringer and the Transputer work.

3.4 GYPSY

CSC's biggest (known) project has been GYPSY, started in 1975 by Don Good at the University of Texas, Austin. This is Floyd-Hoare VCG approach realised by a VCG/theorem prover operating on a Pascal derivative.

GYPSY is a mature tool. Recent work at Texas has concentrated on tidying up things more than innovation. Progress has been made by developing a code optimiser which preserves the semantics, so preserving proofs. This optimiser works on data flow analysis which is being used for information flow analysis for proving presence/lack of information leaks. GYPSY to Lisp and GYPSY to Ada translators have been produced.

GTE are making a substantial investment in GYPSY. They maintain and modify it in-house. They may be using it for a network project.

Honeywell too (see below) also make use of GYPSY in house for SCOMP and SAT.

3.5 SRI

CSC are funding Carl Levitt, John Rushby and Mike Mellor Smith to produce a new HDM language and theorem prover aimed at Multi-level security.

CSC are also about to start funding Rushby's attempt to produce a Secure Operating System Kernel prototype.

3.6 EVES & EUCLID, IP Sharpe, Ottawa

CSC is involved with this project which is jointly funded by the Canadian version of MOD and the US Navy. Dan Craigen is the principal investigator.

The language is Verifiable EUCLID; EVES is the EUCLID Verification Environment (?). TTCP TLG-5 have been/are being briefed on this.

GYPSY has been a model for this project so it is in some ways a 'professional' engineering development of viable technology rather than a pure research project. Craigen wants to produce a formal semantics for the language before getting too far into the tool building. Slow progress on this aspect has put the project one and half years behind schedule. The first prototype was due late 84 but is not yet complete. The EVES verification approach is the VCG/theorem prover strategy like GYPSY.

3.7 AFFIRM

Over 5 years ago Dave Musser developed the rewrite rule prover, Affirm, with Knuth Bendix at its heart. Musser left ISI and has worked for GE for the last 5 years. RADC have put a small amount of money into this and GE have put in significant internal resources but "not much has been developed". Affirm can now handle hierarchy and generate simple Pascal programs.

3.8 VERUS

RCA are developing VERUS/Verlangen. Led by Dianne Britain they have added concurrency and object orientated features. Little has been published. The funding is RCA internal. Project is at RCA HQ, Moorstown, Philadelphia.

3.9 Actual Applications

3.9.1 FDM

"Not very active at the moment".

SDC are using FDM for Formal Specification, having been forced to in a DOD (?) contract. This has resulted in their 'conversion' (in the religious sense) to the Formal Specification cause. The Blacka project is using FDM for a 'design verification' project.

3.9.2 Certifiable Minicomputer Project

Don Good produced 5000 line program, verified by GYPSY, to implement network encryption/decryption

This duplicated the 'production' black box produced by BBN. The CMP and BBN box are 'interoperable'. HKN's question about comparing the two implementations to get life cycle data on costs, reliability was greeted as 'gosh what a good idea' so no data was offered.

Don Good has spoken in the UK about just how much effort it took to produce this CMP (Hoare's FRS colloquium).

CSC see the CMP as a "Major success story" for verification. They are looking for others!

3.9.3 SCOMP

Part of the CSC's mission is to get industry to produce secure products with its own money not theirs ie to make it a natural part of the requirement.

To lead the way CSC funded Honeywell to do a Secure Communications Processor which has verification at the design level.

GYPSY was used for the verification (see SAT).

3.9.4 SAT

The Secure Ada Target (SAT) is another Honeywell project definitely using GYPSY. They have one of Don Good's people acting as link man between Texas and Minneapolis.

Honeywell are aiming for A-1 classification. Verification will be down to the actual code level.

3.9.5 VDBMS

SRI (D Denning, P Neuman, Roger Schell) have just got a contract from Rome ADC to produce a 'verified DBMS', probably using HDM. There will be no prototype.

3.10 Verification Assessment Project

CSC are coming to the end of an exercise to

a. evaluate Affirm
GYPSY
HDM
FDM

b. get all 4 teams to share ideas and experience.

The Assessment has taken the form of

a. each method tackles the same set of small benchmark verifications eg symbol table

b. a one week workshop per site, with all researchers present, evaluated the systems and problem solutions

c. a report of this assessment is due out end October 1985 and will be public domain.

It will include the benchmark problems.

The moderator of this assessment was Don ? who published January 1985 Trans on Software Engineering Ina-Jo Symbolic execution for validation of specification. (Tad is keen to fund work on executable specifications - an example of the 'integration' culture again!).

3.11 Moore, Good

DARPA are funding J Moore and D Good to produce a new applicative language called 'ROSE' (guess what completes the trio!) This has been strongly influenced by David Turner's (Univ of Kent, UK) work at Burrough's Austin Research Centre.

Moore and Good will build an all singing all dancing environment to support 'ROSE' integrating Boyer-Moore theorem proving, Xerox PARC type tools, etc.

4. VISIT TO TRW - FRIDAY 11 OCTOBER

The day concluded with a visit to Dr Ann Marmour-Squires, Chief Technologist at TRW in Fairfax. The purpose of the visit was twofold; we were aware that she headed a new software section in TRW, and had also been involved with the SPC.

4.1 SPC

Ed Jones of TRW had taken the lead on this consortium. He had been principally interested in configuration management. The consortium needed 10 companies to sign up. There were 4 major thrust areas

1. Reusable Software

2. Knowledge Based Development Process

3. Rapid Prototyping

4. A wider 'Systems' area , which included Metrics.

They had near, mid and long term objectives, with the first products being produced within 2-3 years. They are currently looking for a Director (in the mould of Bobby Inman) and a Technical Director (a la Barry Boehm). The members were principally aerospace companies, and 'membership' was $1M/yr for 3 years. The set up was broadly similar to MCC, but there was little membership overlap between SPC and MCC.

We then discussed the interaction between the various initiatives that had appeared. Dr MS said that there was no real USA National Programme, just 3 efforts + SEI. The relationships of each with the others was still to be established, as was the SPC relationship to DARPA.

MCC had of course been a major milestone vis a vis the anti trust laws, and currently consortia (pronounced consortshia in the USA) are being encouraged. IBM were 'barred' from both MCC and SPC, but whether by edict of the Justice Dept, or by the cold shoulder from the

other potential members was not clear. One of the problems with this sort of collaboration (apart from anti trust) has been the practice of DoD to get unlimited data rights on any of their contracts. SEI is taking the lead to change this (their main interest was said by Dr MS to be Technology maturation and transfer).

4.2 TRW

Two and half years ago, Dr MS was asked by TRW to provide an East Coast presence by establishing a Laboratory in Washington. She had set up an internal R&D programme, which had been initiated by technology transfer from the West coast TRW facilities. The particular concerns she was tackling were AI; Ada; computer security; advanced support development environments; advanced graphics and rapid prototyping. Her particular area employed some 250 people, whilst TRW now had two divisions in Washington (2000 people) doing Systems and C3I. Further expansion was expected with the proposed creation of a Defence system group, which would also include work in VHSIC and Electronic Systems. Current TRW interests included intrusion detection (compsec) and Navy AI work, with rapid prototyping.

Dr MS is hoping to do work on a Project Management KB assistant. RADC has let a contract with Kestrel in this area, and TRW are subcontracted 'for free'. STARS had wanted TRW to do a research proposal for work in this area, but intended barring them from participation in a second phase. This was not acceptable to TRW, and so they had not participated.

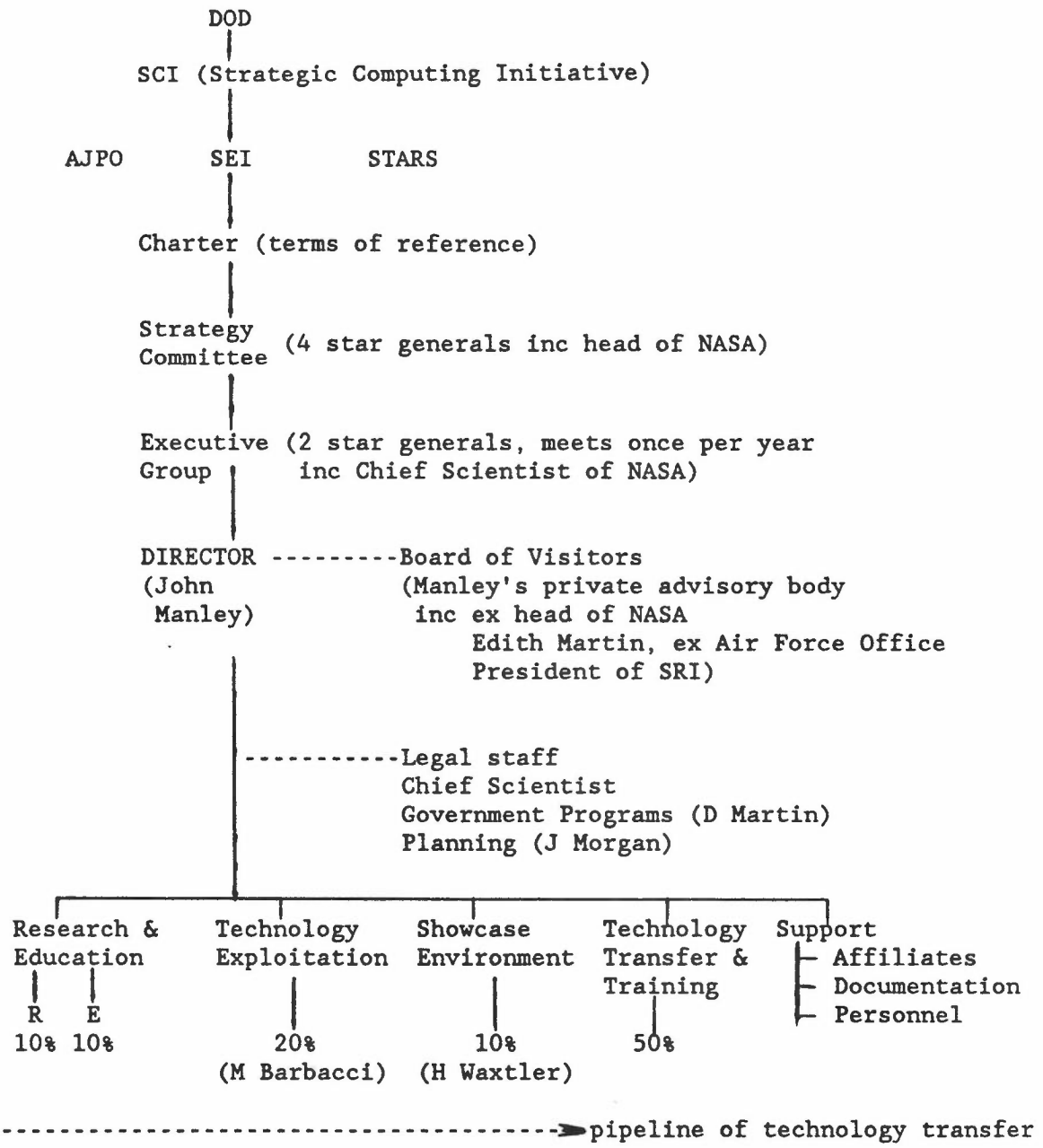
TRW will be holding a technology forum (whether internally, or with other companies and government agencies was unclear) in the near future.

TRW is expanding rapidly in the Washington DC area. We saw a model of their huge new building complex, built around a lake, due to open in 1987.

4.3 Misc

We were struck by the general increase in High Tech companies in the Washington area, and in the obvious expansion that is taking place. It gave us the impression that there is more floor space devoted to IT in Greater Washington, than in all of the UK.

5. VISIT TO SEI (SOFTWARE ENGINEERING INSTITUTE, CMU MONDAY 14 OCTOBER



5.1 People

John Manley, Director of SEI

PhD in Technology Transfer (says M Squires)

Worked long time for ITT (knows P Cropper and David Brown). Then worked for own consultancy (Nastech?) working for DOD. Did much of design and lobbying for setting up SEI. Offered job as Director; accepted as "something to go on tombstone" ie national service.

Joe Morgan, Assistant Director, Planning

Unofficial deputy director.
Recently retired from Air Force. Was head of an Air Force Lab.

Dick Martin, Assistant Director. Government Relations

Appointed September 1985.
Joined from MCC, Austin, Texas where ran AI programme.
Ex Captain of USS Carl Vinson (latest nuclear powered aircraft carrier with lots of computer power which involved PERQs and CMU).
Rumoured to have done Computer Science degree.

Mary Shaw, Assoc Director, Academic Relations. CMU academic.

Mario Barbecci, Assoc Director, Technology Exploration. CMU academic.

5.2 Manley's Overview

JM began with the statement that SEI is a 'national initiative' but this cannot be publicly stated for legal reasons. Because of NIH problems between Gov Depts (and between Services) cannot get Alvey type collaboration so DOD carries national initiative.

SEI's major role is to improve the competitive capability of US industry. SEI will turn itself into an IPSE showcase where US companies (esp defense contractors) can come to see software technology demonstrated, participate in cooperative development projects via the Affiliates program, second staff to SEI and get company trainers trained. Objective is for companies to take away more than they bring to SEI.

SEI is an FFRDC, Federally Funded R&D Centre. This means it is a National Lab; the first to be set up for 20 years. Other FFRDCs include Sandia Lab (atom bomb). Manley's goal is to see SEI grow strongly and be around in 40 years time. SEI is a fledgling National Lab to fight the software crisis (this cannot be said publicly).

FFRDCs are associated with Universities but are Military outfits eg JPL/Caltech, Lincoln Lab/Hanscom AFB

SEI is sponsored by DOD and serves DOD, all 3 forces and NASA. It is on a 5 year renewable contract (at end of 5 years) from the Air Force. (The AF, later all 3 services, have a contract office in SEI itself). The initial contract is for $103 million, with $73m coming directly and $30m to be 'won' from DOD programme managers. (They already have $500K from the Army for WIMICS upgrade). SEI is not allowed to take money directly from industry.

SEI is to pull together and promulgate the technology to build mission critical software of scale 2 million lines of code built by 1 MLOC toolsets.

Manley also thought that SEI should tackle DP, but had not been given this mandate.

Manley regards 'mission critical' eg C^3I as encompassing all software development (C^3I is same as real time banking!)

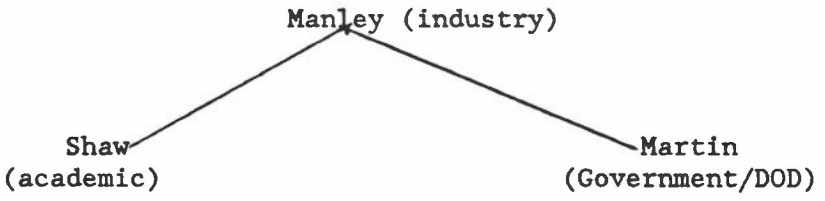
The SEI is a secure establishment but Manley wants to classify to the minimum and promulgate to the maximum (but only to US firms). He is in the middle of the expected tension between academic freedom and military security/embargo.

Manley is staying away from SDI because it is too big and too dangerous politically. He wants to prevent SEI staff being sucked away onto other military projects which get into trouble and cry out for help from his good people.

SEI is the showcase for STARS generated research. Conversely, although SEI cannot sponsor research, it can get STARS to let the contracts it needs.

Manley is organising SEI on a 'corporate' basis. He regards Congress/DOD as venture capitalists! He is an architypical USA business manager.

The key external relationships and views of the world are handled;



The major activity (50%) will be technology transfer into US industry. The essence of SEI is its role as a SSFF, Showcase Software Factory of the Future, analogous to MCC's Leonardo project, the Alvey ISF concept. All of the people, equipment, software, services and the building itself will be on show to industry at all times. Howard Waxtler has the job of building the SSFF and operating it. Mario Barbacci has the job of identifying and importing the technology. The SSFF will evolve continually. SEI will not sell or maintain it.

SEI will try to recruit top quality people "from all over the world" and operate to top quality standards. Recruitment is ahead of schedule (62 in place plus 10 secondees). Max staff in first 5 years contract is 250. Additional staff will be obtained by subcontracting via STARS, the Affiliates programme and subcontracting secretarial and support services to maximise the number of professional staff within 250 complement limit.

SEI's charter prevents it taking on non DOD sponsored work so it is prevented from competing with industry. Industry is being very cooperative as they see it as national facility.

SEI are not allowed to contract out technical work. This will be done by affiliates.

SEI's charter also limits the amount of research it can do to very little; just things associated with technology transfer issues.

Manley stated explicitly that SEI will produce products.

SEI will set up an information service for industry consisting of databases of abstracts, bibliographics, tools etc.

Manley stated that he will collaborate with non USA countries if it is "within the law". Foreign collaboration is being tested by the Australian MoD making a request to collaborate. Cooperation between SEI and the UK MoD is therefore not impossible where 'NATO' is the benefactor. UK industry is 'the competition' and will not be able to cooperate.

5.3 Joe Morgan Presentation

Joe is the Assoc Director responsible for planning and de facto stands in for Manley when he is away. Morgan is Secretary to the Board of Management.

The SEI's equipment includes

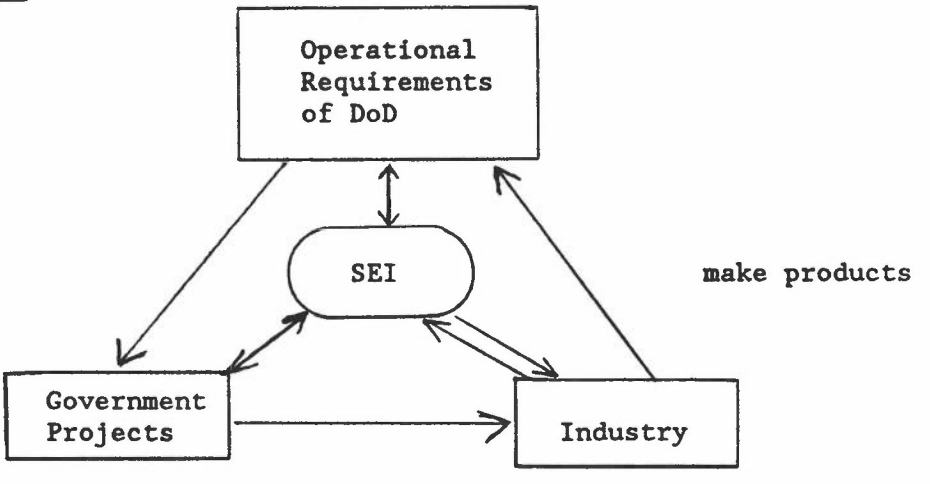
VAX 11/785
Access to CMU networking inc Arpanet
MACs and IBM PCs
300 pixel per inch laser printer
Micro VAXs II
Apollos
SUNs
Ethernet (TCP/IP +Kermit for MACs)

(CMU has just ordered 196 MicroVAX IIs!)
(SEI buys via CMU to get educational discount)

The SEI is putting significant effort into documentation support including phototypesetting (new equipment soon) and slide production.

SEI is currently housed in a 100 year old warehouse which is being extensively and expensively refurbished ie the environment is of a high standard because this is part of showcase. A new building is due in 1987 costing $21 million. We saw the footings. Local industry and the City of Pittsburgh have contributed generously to the setting up of the SEI.

Dick Martin



Dick is responsible for Government/DoD relations. He has to get DoD programme managers to contribute the $30m from their budgets which SEI needs to do projects which are right for SEI to do (this latter is the difficult bit).

Dick is looking for a small set of projects which each reflect some key aspect of SEI's work; a so called "spanning set" of one problem/project per life cycle phase.

With all the various US initiatives springing up SEI see themselves as the 'corporate memory' for Software technology development. However they are keen to stay away from becoming coordinators of the entire US activity which would divert much effort(!).

5.4 Affiliates Programme, Clyde Chittister

Manley wants the Affiliated Programme (AP) to generate gearing of SEI: outside work of 1:3. To get outsiders to work with SEI, Affiliates should take more away than they bring ie make a 'profit' out of their SEI association. People can be seconded into SEI projects from all sectors; industry, government and academic. Industry pays salary of secondee and gets early view of technology and is well placed to exploit.

Some 4,000 companies are involved in DoD software development.

SEI encourages 'active participation' in its projects from Affiliates with following requirements.

1. staff are right quality to be seconded. They are 'vetted' by SEI and can be 'fired' by SEI.

2. Affiliate must bring something to SEI ie up front contribution.

Someone from industry seconded into SEI is paid for by industry. Academics are either paid by SEI or by normal government grants.

The SEI' 'spanning set' of problems will be 'advertised' publicly to recruit Affiliates.

The results of Affiliates projects are owned by DoD. Contributors must negotiate with DoD on a case by case basis to get any rights.

When the Affiliates Programme is used for training purposes then SEI will insist on only training teachers who will go back to their firms to give other training courses.

SEI will be a test site for research project output and will organise test sites in situ in industry.

Affiliates programme also supported Academics, but it was not clear how this would take place. The motivation of appitudes and downstream problems did not seem to have been considered.

5.5 Mario Barbacci, Assoc Director Technology Exploration

SEI will only do a small amount of research, and that will be into technology transfer mechanisms.

Mario will do 'technology identification' which means

1. state of the art reports in first year of SEI

2. ongoing early identification of new developments and trends.

SEI have the objective of building their SSFF so that it can continuously and gracefully evolve. SEI want to demonstrate that an IPSE can be built which does not commit its purchaser to one technology for 20 years. SEI wants to investigate 'lock in' effects and publicise them when they come across them in SSFF construction so that they can be avoided/tackled by researchers.

As an initial pre-SSFF activity SEI are building an Ada Browser now. This is based on the Verdix Ada compiler and CMU's Gandalf syntax tree editor. This is regarded as a short term 'show and tell' project. (This is not connected to CAIS.)

Manley strongly supports the Ada initiative.

5.6 Gary Ford, Education

Education Division has 2 staff (to be 3 from Jan 86); Gary Ford reports to Norm Gibbs. They have brought in 3 visiting scholars for one month each so far. Education Div feels its is more important to have Affiliates than permanent staff.

There are presently 4 specialist MSc courses in SE in the USA (lots of CS ones). SEI wants to influence existing courses in CS to do more SE and bring new SE courses into being.

SEI are targetting at Masters level now but Manley keen to influence the Batchelors level 'to get the numbers up' to reduce the shortage of SEngineers, but at reduced skill levels.

SEI will see if it can build a 'model SSFF' to enable students to learn about sophisticated tool use because the real thing will be too expensive.

SEI aims to teach and help the teachers not the students.

SEI will produce
1. syllabus
2. book list
3. SEI 'stimulated' book writing
4. student toolkit
5. class exercise
6. other teaching material

There will be no degree awarding courses at SEI.

Lots of better US companies encourage employees to do MSc level courses. Courses are very modular. Typically get up to 20 hours per week off for MSc. Takes 2-5 years depending on student and evening/day release split. Half day release per week means MSc on 5 years. One day per week means 2 years for good student.

The Academic Affiliate programme will fund people to spend the summer at SEI developing courses and writing books (this can be done 'at home' and offer extends to best UK people).

SEI hopes to publish a core curriculum in Spring 86 and then do evolutionary development on this. This will be freely available to all world wide.

SEI sees payback not less than 5-10 years downstream for this work.

5.7 Legal and Technology Transfer

Manley is very keen to sort out the legal side of technology transfer. He has set up a 'legal' project at SEI. SEI have hired Ed Jones who was a lawyer with DoD for 20 years. He handles SEI's legal work and the technology transfer issue. SEI also retains the services of a Pittsburgh law firm, a Washington DC law firm and the Un of Pittsburgh legal dept (Pamela Sammelson).

Manley sees technology transfer as 'a problem' in the sense of the US wishing to stop leakage of strategic defence technology, and keeping a commercial edge. Manley says the people of Pittsburgh, having seen the steel industry hit hard, are very protectionist. "The people of Pittsburgh are pro-DoD which is one reason they got SEI. MIT's anti DoD stance went against it." (CMU is the second largest employer in Pittsburgh!)

SEI will only cooperate with foreign initiatives "within the law". This means things like formal agreements between DoD and MOD. The Australian MOD is testing this route via TTCP.

5.8 Miscellany

1. Manley offered deal to swop all publicly available publication between Alvey and SEI.

2. JOHN.MANLEY@SEI.CMU.EDU (new Arpa address)
JOE.MORGAN@SEI.CMU.EDU

3. Manley reports to Provost of CMU.

4. IBM not interested in doing projects with SEI ('frightened of getting sued'!) but they are interested in education and information exchange service.

5. Peter Hibbard now works for Adobe in California.

6. Ric Rachid is still at CMU on the Super Computer Workbench project (a distributed system).

6. VISIT TO DATA ANALYSIS CENTRE FOR SOFTWARE AT ROME AIR DEVELOPMENT CENTRE, GRIFFIAS AIR FORCE BASE - TUESDAY 15 OCTOBER

6.1 DACS

	RADC		Alvey
Present	Joe Cavano	RADC/COEE	DET
	Andy Chruscicke		HKN
	Mike Mayer	S/W Measurement	RWW
	Dick Siringo	S/W Quality	
	Dick Motto		
	Gene Tiorentino	RADC/RBET H/W-S/W Reliability	

We visited DACS and RADC chiefly at the request of the Alvey Software Data Library Project, who had attempted unsuccessfully to meet with, and obtain public documents from, this team.

We gave the standard introduction to Alvey, with particular emphasis on our Reliability and Metrics programme.

Joe Cavano introduced his team work at RADC as the third of three areas in SE.

1. Front end work ie formal methods, specification engineering, Rapid prototyping.

2. Integrated Environment and Data base.

3. S/W Measurement programme.

Reliability, Quality, Reusability, Maintainability. There was a relationship with H/W Reliability, and the goal was to integrate H/W and S/W Reliability.

DACS was a new one of about a dozen "IACS" (Information Analysis Centre) (including nuclear and hardware) and had been in existence since 1979.

JC did not state the DACS charter very clearly, but it was apparent that its intention of maintaining a central database of S/W had not been as successful as was originally hoped. They could perform literature searches for SE documents; produced reports, and were setting up a 'repository' of S/W data.

They hoped to have had some 5-6 databases (why this number was not clear). but the necessary cooperation of industry had not occurred. The reasons for this come out in discussions:

> Problems with confidentiality of data
> Firms were not prepared to share good models
> Firms did not want DoD to publish a 'league table' of how reliable the software was.

There had been some cases of data sharing, but the definition and meaning of data from different sources were generally inconsistent.

DACS were going to produce a guidebook, which would be agreed by industry, and which would characterise a software product in terms of Resources, Schedule, Function, Quality, Performance, Personnel, Methodology and Environment. In response to a direct question as to whether the UK could obtain this document, we were referred to STARS Director.

DACS said they needed to show industry why they should provide data, and they needed to persuade DoD project officers to provide data.

They did not seem to have thought about obtaining advice from neutral bodies who collected data, eg nuclear regulatory bodies.

Again in response to questions DACS said that currently firms only made subjective comments about their S/W reliability.

DoD had stated that Quality and Reliability should be on an equal future footing with cost and schedule.

DACS future work was based in four main areas.

1. Reliability goal specification
2. Reliability prediction
3. Reliability estimation
4. Reliability assessment benchmark.

(It was not clear whether they could use any of their current data, or whether it was useless in this respect.

They had to

1. sell the framework to project officers
2. use assessments to go back and look for predictors (this was over the next two years, a back to front approach)

(After prodding)

3. Investigate 'Front to back'

(After even more prodding, and mention of UK TS and QM project)

4. collect data and cost of data collection

The goals were

1. Definition of terms and models
2. Demonstration of models on actual projects
3. Automated collection and analysis
4. Data repository
5. Technology transfer.

They were not very concerned about tools interface, and hoped that their work would become part of SEI showcase.

During discussion it was agreed that the possibility of working towards a standard set of definitions should be investigated, the initial task of which was investigating formal methods of cooperation. We were able to obtain a list of unlimited DACS documents, but with no assurance that we could obtain others.

6.2 Doug White

Following up a remark that RADC had a contract with Kestrel for some KB work, we managed to talk briefly with Doug White.

Originally RADC had funded research at SRI into automatic programming, which lead to a report on how AI could be introduced into S/W maintenance. Broadly speaking this said that AI was only of use if introduced at the beginning.

After this, the subject was dropped for a while, until in 82/3 there was a high level report on what a KBS/W assistant might do.

In May last a project to provide this in the Programme Management area was underway.

Following this, SDI had suddenly provided some extra money for KB, and had led to DW producing a 15 year programme in excess of $100m which would formulate the process rather than the products.

There were 3 iterations

1. Innovation)
2. Standards)
3. Integration)

Some $10m was so far committed, and they had experienced no difficulty in contracting enough useful people. Kestrel and Bob Balzer, TRW and Lockheed were formulating a 'radical' new approach': putting AI power behind the conventional methods with the goal of providing a corporate memory of why things had been done. Problems with the 'ivory tower ?' had been experienced, and DW said that the researchers were expected to come up with what Knowledge Base they themselves needed.

When the fact that AI is capable of of building small systems quickly, but that large systems are difficult, was raised DW said that they were not specifically attacking that problem, although there was some concern about it.

RADC were hoping to let a contract with Mitre for a graphical approach to auto programming at the development stage of the life cycle. This would be at a higher language level than Ada, and would give reuseability. The worker would be Richard Brown. In response to more questions, it became apparent that there was no specific activity related to the design stage of a project. It was considered as part of the specification phase!; Robinson was working for RADC part time, aiming for a successor to Loglisp, SUPER.

The University of Mass were working on intercommunicating multiple sources of knowledge.

The statement was also made that RADC lacked money for support projects.

DW gave us the number of the unlimited KBSA report. Report AD-A134699 August 1983 RADC TR - 83 - 195.

7. VISIT TO IBM FEDERAL SYSTEMS, WASHINGTON, WEDNESDAY 16 OCTOBER

7.1 Harlan Mills

RWW, DET, HKN and RF met Harlan in IBM's palatial FSD building (Good working environments are a real feature of good companies and Labs this trip).

In the mid 1970s IBM realised that due to their paternalistic employment policies (no layoffs, lots of training etc) their programming costs were 30% higher than the 'body shop' outfits tendering to DoD. Thus IBM made the decision that they should continue to charge this premium price but aim to produce better software than their competitors. John Jackson (the VP of FSD and now Quality for all IBM) and Harlan Mills decided on an active campaign to improve IBM's capability in SE. This has led to IBM using structured programming, PDLs, Chief Programmer Teams, informal verification, the massive 'formal methods' course, IBM's Software Engineering Institute which teaches courses in SE and H Mill's latest idea of the 'Clean Room'.

Jackson ordered the total retraining of FSD staff, starting with the senior management, then middle management and lastly the programmers ("pass/fail requirement"). All staff had to take the 'basic formal methods' course (set theory, functions, recursion, verification by case analysis and loop invariants for SP control constructs) and had to pass the exam.

Mills saw that most of the senior managers had mathematical training so he know they would all pass! Senior management did pass and pushed middle management into the scheme with enthusiasm and commitment.

This testing of managers was a new thing. Whilst the senior management (and the troops) were enthusiastic about the courses and exam, middle managers were resistant to the introduction of new SE techniques and the training scheme because

a. they wanted to get the job done not spend the troops' time in training
b. they themselves had to do the course and pass the exam.

Quite a lot of FSD Middle managers voluntarily transferred to other less technical parts of the company before the exam date! Thus the introduction of new techniques and the exam had the following beneficial effects:

1. senior management better informed and committed to better SE techniques

2. middle managers weeded out so remaining ones better trained and committed

3. promotion opportunities for good junior staff created by weeding out

4. marked increase in morale all round because staff enjoyed joining the 'clubs' of 'IBM qualified staff' who had 'passed the test'. "Something money could not buy".

5. better software produced.

Currently 15 of the top 20 FSD executives have come up through the ranks of the software side (and passed the exam!). These include Sam James, the Technical VP whom we met later.

Harlan estimated that 2,500 people in FSD have taken the course with 7-10,000 in total in IBM. IBM Hursley in the UK is the site of the European training centre. The IBM SEI in New York trains teachers to spread the course.

7.2 China

IBM is opening a branch of its SEI in Bejing to teach 3 month courses to non IBM Chinese. There will be 30 in the first class which Harlan will run in November 1985. Harlan does not like travelling too much so has resisted invitations to China previously.

Harlan says the Chinese have been buying computers but then not using them. "They have just discovered the software problem". (David Thomas confirms the under utilisation due to lack of trained staff in some institutions). Harlan admitted that IBM had "selfish" motives in educating the Chinese.

7.3 Clean Room

When he visited London at Alvey's invitation, Mills spoke about his Clean Room idea. Programmers may design and write code but may not compile it (let alone test it). So no unit/module testing allowed. The code is inspected and reviewed by the team. It is informally verified ie team makes sure that simple Floyd-Hoare type proof can be constructed 'in the mind's eye'. Nothing is written down unless a problem is detected.

Complete systems or large subsystems are given to a separate testing team who perform 'random testing' a la Bev Littlewood to test the code against its likely operational use. The code is designed according to SEI practices extended to include the data equivalent of Structured Programming ie banning pointers so Clean Room projects do not use arrays or pointers; programs are designed using a restricted set of higher level structures - sets, queues stacks. (Harlan is slowly introducing a simplified form of abstract data type ideas?). These are obviously implemented in the traditional way having been carefully reviewed and 'verified' in the SEI way.

Clean Room =
1. SEI design principles
2. team inspection, review and verification
3. no compilation or unit testing

4. no array or pointers just sets, queues, stocks
5. first test at system build time
6. testing is statistical random testing from expected user input set
7. change control from first execution.

Because the code is not tested until system test phase the code is under change control from first execution. IBM said that Littlewood style random testing is very good when used with code which is verified in advance of execution but bad for old style 'buggy code'.

Rick Linger, who wrote a book with Harlan (Linger, Mills, Witt) gave a presentation of the results of a Clean Room project he had led, consisting of himself and 3 "bright" 'new hires' with little project experience. They had developed a new IBM product (to be released soon so we were not able to learn what it was). This has the complexity of a compiler. A prototype was built (20K LOC). This was developed into the product in 19 incremental steps (35K LOC). It took 2 years. The details of the projects statistics are given on the appended viewgraphs.

The experience was that on initial test a few "stupid" errors were found eg types which prevented the system running at all. As soon as these were cleared (5 mins to fix each) the system ran. It has run reliably for 8 months now. The error rate (of non typo type errors) was 2 errors/K LOC prior to clean room testing (49 errors total in 20,000 LOC). Overall productivity was 400 LOC/man month.

The original estimate from experienced managers was 100K LOC as against 35K LOC delivered.

The Clean Room is pushing 3 ideas:

1. Design

   State machines, functions (SEI stuff)
   ie put effort into getting clean design

2. Design Analysis

   do not accept the first design
   analyse, rework and simplify; make smaller, cleaner, easier to verify. This conscious attempt to work at improving design is key benefit of Clean Room.

   By making design smaller and simpler also means less text to verify. Verification in CR is costly human process. Design expressed in IBM's PDL. Verification of functional correctness is at PDL level then verify translation of PDL to PL/1.

3. Disciplined Data Access

   limit to sets, queues, stacks; no pointer (Pl/1!) (gentle introduction of abstract data types?)

Contrasting Clean Room v Unit Testing approaches, Mills claims:

Clean Room

Get it right 'in the large' ie the design is right
Errors are 'small' ie slips and typos.

Unit Testing

Gets it right 'in the small' but because of lack of overall design effort and wider view of system, failure to consider ramifications 'in the large', then errors are big and difficult to fix at system integration and beyond.

Clean Room approach:

1. emphasises that effort should go into design not testing and modification

2. simplified abstract data type approach - data discipline

3. verification introduced in a non onerous way.

Harlan told us that FSD had done a helicopter flight control project, 35 K LOC, 10 people, built in 3 x 15K LOC increments. Entire team had 2 week SEI refresher course before began project which was done by the Clean Room approach to first released version (thereafter developed in traditional hacking way because of DoD). This project had a higher error rate than Linger's project but not seriously. They delivered the system early and within budget. The morale of the whole team went up noticeably due to feeling that doing a better job.

7.4 Sam James

Sam James is the Technical VP of FSD. He was at Huston for a long time. He did the Skylabs software. He championed structured programming when it was introduced in 1971. NASA's Space Programme has taught FSD to do evolutionary development ensuring high quality at each step.

IBM is going to teach NASA the Clean Room method, including the SEI courses. IBM are trying to get NASA to build this in as a contractural requirement in NASA's procurement policy. IBM feels that DoD buys lots of poor software because of the "Software Union" which teaches DoD that DoD should expect software to contain lots of errors. IBM is against this clique/approach and wants to educate its customers to expect zero defect code for 25K LOC to be produced in half the current timescales.

8. VISIT TO OFFICE OF COMPUTER SOFTWARE AND SYSTEMS/AJPO/SJPO WEDNESDAY 16 OCTOBER 1985

Present:	Ed Lieblein	- Director
	Joe Batz	- Deputy Director and Director STARS programme
	Virginia Castor	- Director AJPO

Ed Lieblein had received a late call to brief his Under Secretary of State and was present only for the opening and closing parts of the afternoon's meeting. The main part of the afternoon was spent with Ginny Castor and Joe Batz, both fairly recent appointees to their current posts.

8.1 Ada

A "prototype" Ada benchmark set should now be available. This has been assembled from a variety of tests submitted by various contractors who had designed the tests to assist them with the development and evaluation of the current generation of compiler systems. DoD have "scrubbed clean" the various modules in the sense of removing the identity of the contributor and strung the tests together to provide an initial set aimed primarily at testing performance. IDA (?) will act as the distribution authority.

We asked about their view of Ada being taken up by the "Civil" market. As would be expected they felt concerned primarily with take up by Defence contractors but they saw an increasing penetration of Ada into the Civil market as compilers and tools became available for IBM systems and as Ada contractors moved to spread their Ada take up investment over both "Defence" and "Civil"

Ginny Castor went through with us a list of compiler systems that were scheduled to become available over the next six months including at least one for the IBM PC.

There is at least one major Air Traffic Control System scheduled for implementation in Ada and IDA have produced a report on Ada (potential?) commercial applications. Ginny Castor was unable to say much about the findings of the report but Robert Foster will ring shortly after his return to the UK.

8.2 CAIS

Joe Batz announced that they had decided that CAIS 1 would be the STARS interface. (Rather as expected given the time and commitment given to its development).

Batz confirmed that a bid document was being prepared for the provision of a core environment supporting CAIS (a la PCTE). The document will be available for comment February 1986 with a prototype CAIS environment to be available at end 87/early 88.

The CAIS 2 work would proceed as planned. DET asked if CAIS 2 would be allowed to "change" CAIS 1. They agreed that this would be possible but only if quite exceptionally good reasons were put forward. Overall, the line, as to be expected, is that CAIS 2 will be "upwards compatible" with CAIS 1.

8.3 PCTE

They had little idea about PCTE. Ginny Castor knew of its existence but Joe Batz appeared to know even less. They appeared surprised when I told them that I knew that their people eg Patricia Oberndorf and Ficher had looked at PCTE and had appeared to compare it favourably with CAIS. Ginny Castor then said that she knew that a report on this had been recently presented but she was unaware of any conclusions or recommendations. (Later in the day we discovered that Ed Liebleing knew about PCTE and the reviews that had taken place!)

Considerable time was then apent going around the following question that DET raised:

> Given that there are many technical similarities would they think it worthwhile to encourage the converage of CAIS with PCTE.

For one reason or another this seemed to present them with great difficulties. We even managed to get into the "controlled technology" swamp in the course of our passage around this issue! Interestingly, Ed Lieblein settled the matter in minutes on his return. He confirmed that he would be keen to encourage convergence and at the very least provide a forum for exchange of information - KITIA a possibility?

8.4 Metrics and data collection

We told Batz that we had been at Rome on the previous day and had discussed the problems of product data collection and the development of useful metrics.

Joe Batz confirmed that NASA was also a big player in this area (possibly more important then Rome?). We discussed again our interest in these matters and the possible desirability of sharing views - in particularly definitions of data to be collected. He agreed after some discussion, to follow up the possibility of making the DIDS definition document available to our Data Library people. (Again Ed Lieblein, on his return quickly agreed to the idea of exchanging documents).

9. VISIT TO MCC THURSDAY 17 OCTOBER

We visited Dr Les Belady, Director of the SW Technology programme. He described the structure and set up of MCC.

MCC is 100% private enterprise, with no government funding at all. It is a legal corporation, with shareholders (the participating companies). It is controlled by a board of directors, one director per company, in the normal way. Reporting to this is an advisory board of Technical Directors, and then there is a Technical Advisory Council for each of the 4 programmes, consisting of 3 members for each company that has bought into the particular programme. They meet semi-annually, and are the means for high level technical transfer. Technical transfer is considered as important as Research.

Inman is the Director of MCC, and has 4 corporate heads (Note name of spelling may be wrong)

1. George Black - assigned from RCA : Human Resources
2. Bob Routesheiger assigned from CDC : Admin
3. John Incston ex Dir Computing NSA : Chief ?
4. Palla Schmedt : Tech Planning

There are a few more corporate staff, but not many. All of the programme directors report to Inman.

Overall there are some 200 people in MCC. All paid from MCC's budget. There are 3 classes.

1. Hired
2. Assigned from company indefinitely
3. Liaison officers - one per company per programme.

The seven programme directors are as follows.

1.	Gene Loganthall, ex Intel	Database
2.	Steve Lunstrom	Parallel computing ex Burroughs and ?
3.	Woody Bledsoe Prof at University of Texas	AI
4.	Roger Allord Assigned from CDC	Human Interface

These four are collectively known as Advanced Computer Architecture, but there is no management structure to support this.

5.	Barry Whelan	ext TRW	Packaging (of VLSI)
6.	John Honne	Texas Instruments	CAD (of VLSI)
7.	Laszlo Belady	ex IBM	Software Technology

The first six of these programmes are officially 2 years old, ST is one year. Programmes are of 3 year duration, and companies can buy into any programme. Because the original membership of the first 4 programmes were the same, they were combined, and for the purpose of shareholders are treated as one programme. Companies can only withdraw at a programme end, and must give one year's warning of that intention.

Shareholders obtain the rights to exploit information received from the programmes they have bought into. MCC will hold licences to all prototypes after 3 years, and it is possible that they could then produce products for sale.

The shareholders in Software Technology are CDC; NCR; Sperry; DEC; Lockheed; Rockwell International; RCA; Morris Corporation; plus two new firms: Bell Communications Research and Motorola.

Software Technology has some 40 people, which will rise to 60. Their 'charter' is to increase productivity by 2 orders of magnitude in about 6 years.

LB had decided to do research in areas that are neglected and buy in whatever else is required. Most research is done at the end of the life cycle, so they will do research into design of complex systems; but not PP, PC's or applications. There will be a focus on how terms operate industry capturing the national behind decisions. Only activities which lead to formal design will be considered, anything to the 'right' of the life cycle process will be imported.

They are concerned not only with large systems, but distributed, parallel and realtime systems. The name of this project (and the name of the product it should lead to) is 'Leonardo'. LB team is divided into 4(3) groups, the divisions are not rigid (unlike those between the different programmes of MCC).

1. Mike Cunner, ex IBM Design environments (ie integration - architecture and construction of Leonardo prototype); technical transfer (through liaison personnel), and importation of S/W 'to fill gaps'.

2. Bill Curtis, a behavioural scientist ex GE, ITT Design process group. This group includes Susan Gerhart and Prof Vincent Shen from Perdue University.

3. Ted Bickestaffe ex Boeing, ITT. Design information group. This group will organise the information used and reused in the design process (should a database or knowledge base be used?). Research into distributed systems resides with this group.

4. Clarence Ellis ex Xerox, MIT. Design Media (graphics and animation, 2D languages).

The first 'output' from LB's area would be an experimental object server.

The shareholders will organise their own internal use of MCC outputs, as well as customising and vending. There is no official route for feedback from shareholders (liaison is only one way?), but LB hoped that in practice there would be some response.

We then discussed relationships with other national and international programmes. MCC intended to maintain informal discussions with ESPRIT, Alvey, SEI, STARS, SPC etc. MCC expected to use the outputs from SEI and their view of STARS was through SEI.

SPC were more of an unknown quantity; they were approximately 2 years behind MCC; will have shorter term goals, with a lot of overlap with MCC. LB listed three main thrusts for SPC work

1. Prototyping
2. Reusability
3. KB support.

MCC shareholders had to have a US based HQ, but research could be subcontracted from anywhere in the world. Having recently returned from overseas, LB noted that the staffing climate in the US had changed in the last 3 years, people were less dissatisfied with their lot, and were harder to extract from their current job. He anticipated that SPC and SEI (particularly SEI) would have difficulty in recruiting people. MCC's own recruiting had exacerbated this position.

LB then took us to talk with Ted Ralston from the International Liaison Office, based in the ACA area. He was already aware of Alvey through Dr R Sleep.

We asked about integration between the different areas of MCC. There were no formal links, and financially the areas were separate. Because firms 'bought in' to specific areas, great care had to be taken not to allow information to 'leak' across boundaries. It was recognised that researchers benefited from cross fertilisation, so this was encouraged (sic) and where it was needed, cross programme transfer (with, transfer of funds) was negotiated; each case being treated on its own merits.

In response to questions, TR said that there was an overall plan in ACA, but for the fact that the correct individual could not be found, there would have been an overall manager, integration had come through consensus. The programme included work on both 'core' and 'outsider' projects and the pressure from shareholders on MCC to produce short term results had to be resisted.

As a matter of policy, MCC has no dealings with SDI. No classified work is done at all. DARPA is informed of what MCC is doing but cannot enter the programmes. There was little likely hood of work being classified externally, but this would be handled if and when. As far as transfer was concerned, firms were encouraged to set up shadow programmes, ready to take advantage of MCC outputs. MCC cannot provide maintenance and support for prototypes because of the US auto transfer laws. MCC is intended to promote competition, and encourage the results of research to be used.

It is a 'for profits' organisation, hence its acquisition of royalties. Licences could not be passed to third parties if MCC fails as a company, then any rights belong to the shareholders.

Within MCC, CAD, Database and Packaging were the most advanced areas; as yet there was no integration between CAD and S/W, though complex issues would need solution inviting both H/W and S/W.

The visit closed with Alvey giving an update on the architecture programme relationship with Japan and ESPRIT.

10. VISIT TO UNIVERSITY OF TEXAS

During the rest of the afternoon and evening, we met variously with Dr Bob Boyer (at MCC) and Jay Moore and Don Good (at the University of Texas). Our discussions with them confirmed many of our own impressions regarding the USA Software Engineering scene. For example it was confirmed that there was no overall programme control in MCC, just the four separate areas. Advanced Computer Architecture was the only area where it was possible for the "workers" to meet together and talk informally to get feedback and prevent duplication, between the sub-programmes of ACA. Discussions across any other boundaries were prohibited.

We were advised of the main equipment provision for MCC;

AI symbolics,	DEC2060
Parallel computing	SUNS/LMI
Human Interaction	SUNS
Database	SUNS
Software Engineering	SUNS
CAD	LISP symbolic/ML

The University of Texas was providing the MCC with a purpose built building, at no cost to MCC. MCC were currently in temporary accommodation (ie well equipped office blocks - not portakabins. These were so organised that the separate parts of the programme were in separate blocks! Intention or accident?). The University of Texas was financed from oil. $250M was provided for basic upkeep, plus $8M from federal research plus $100M interest from a $2G "endowment".

The visit of Drs Boyer and Moore to Edinburgh in the summer had been very successful.

The Community at Texas had not been aware of the Japanese interest in theorem proving; nor of the Fujitsu work on alpha-lisp.

11. VISIT TO DEC SRC FRIDAY 18 OCTOBER

We visited the Western Research Laboratory in Palo Alto. This is a new facility, set up by DEC, and is run by Bob Taylor, who left Xerox PARC because of dissatisfaction with the way in which the research was not being exploited. He took several of the people who had been working at Xerox with him over the first few months.

Initially we met with Mike Shroeder. The "charter" for WRL was broadly 'How should DEC, and the rest of the world be doing computing in 5-10 years time?' The way in which they relate to the parent company is quite loosely defined. They try to maintain a model of what DEC is doing, and try and fit themselves into this model. They are, however independent of the rest of DEC, reporting to Sam Fuller "back East".

Within the Lab, people can schedule their own time vis a vis research versus development. The main fields of activity are languages; tools; security; naming; communications and protocols. There is also some purely theoretical work, but there is no activity into Performance; queueing; functional language nor AI technology. DEC have bought into the AI programme at MCC.

DEC had set up the WRL as a direct result of seeing other firms doing (and presumably benefiting from) software research. (It is likely that the availability and 'salesmanship' of Bob Taylor also contributed to the decision to set up WRL). They now have some 55 staff, after being in existence for some 18 months, and there are 15 researchers in a sister Lab (DEC PARC?). They expect to eventually have 80 people. Recruits had to already have demonstrated their research ability, and intellect, but they did not specifically have to have had a computery background.

Individuals can choose the problems they wish to work on, but the Lab as a whole ensures that the pieces of work all fit together in some way. Apart from this 'integration' the Lab research environment is similar to that at a University.

We then heard about a current theme, that of lifting the work station from the 60's into the 80's. (ie the technology and concepts behind current work stations were based on ideas demonstrated i n the 60's). They were using H/W and S/W facilities together to produce their concept for the 80's, known as Firefly. The first of the 80 or so they intended to produce would be available by the end of the year. Firefly would use 5 microvax 2 processors per work station; would communicate over Ethernet, and use remote procedure calls, viewed at the presentation layer. Firefly is viewed as being inside the security perimeter, and will it provide security compartmentation. To go outside the perimeter it will have DES chips. Firefly is based on standard DEC equipment, except for a few special boards. They (WRL) believed that the primitives that would be available to the work station users would cater for all the multiprocessing facilities they might need, including integrity.

We then spoke to Jim Horning and John Guttag whose main interest was in Specification Technology. They were disappointed that Specification had not taken off as fast as they had anticipated, since the benefits were clear. One problem appeared to be that researchers often did not know initially what they were going to produce, and so were reluctant to use Specs at all.

The use of Specs would remove ambiguity in a project. Currently formal methods could not be used cost effectively, so good support tools are required. They were concentrating on Syntax directed editors; a 'library system', and a theorem prover for checking equational theories for consistency (ie not the B-M type of prover). They had come away from the idea of being able to define a universal specification approach, and anticipated that there would be a family of specifications, checkers etc related to the languages being used. Some parts of a specification can be independent of the target language.

This they call the Shared Language part (eg the function multiply is independent of language. For a specific program language there would be an interface language for the specification (the handling of overflow on multiplication would be language dependant). They were very pessimisti(about automatic programming, because of the need for a size improvement for specification vs actual programming. They quoted the square root problem as an example. On the subject of animation they was a need for "direct implementation" ie running a specification/program with specific values. They used theorem provers only for validation in this case.

We then had a few brief words with Bob Taylor, the head of WRL.

The Lab was out to produce technical transfer: If you can use what you build, and show it off, then this works well as a means of transfer. In response to the point that to achieve this then the hearts and minds of a lot of people needed to be won, Dr Taylor replied that there are some 6000 engineers in DEC, who are sophisticated in software and the use of tools and therefore should take on the new tools from SRC. He was not worried about competitors "stealing" the ideas. The work of SRC is published, and so what are they trying to protect. He did not believe that people could build the output from SRC, even if they read the documents and saw the "products".

He agreed that the walls between the areas at MCC could be a problem, at SRC there were deliberately no such barriers. We asked if he felt that with MCC, SEI etc were there still good people available. The reply was very few. It would be harder to recruit the remaining staff to the 80 level. They were interested in quality not quantity. The point was made that San Francisco was a better location than was Austin as far as staff were concerned. The discussion then moved on to the area of university work in software. DEC still has a University grants programme, roughly equivalent to SRC. The existence of initiatives such as MCC etc did no harm to universities apart from their own recruitment. University training was not seen as being very good. It had declined from the 60s, but was possibly picking up again now. Dr Taylor did not think that the complexity of systems research now put it beyond a universities resources, but he would like to see more systems research done in universities (the

comparison with high energy physics was made). The Lab did not have a policy of using Industrial Fellows. (We had learned through discussions over lunch, that SRC had a close relationship with Cambridge University (not Massachusetts) and saw them as a useful recruiting ground).

12. VISIT TO XEROX PARC

The last visit of the day was a short one to Bob Richie at Xerox PARC.

Xerox PARC was large, with 6 Labs all generally concerned with the theme of research into systems in large businesses for the future, aiming at automation of the entire corporate business. The six were:

1. Computer Science Lab, run by Bob Richie. There were some 50 staff. They were interested in distribution, graphics, S/W systems, Database etc, and were designing a multiprocessor work station. They were studying computer integrated information; was there a new form of electronic document? what new ways could ideas be recorded and modified? How did 3D and colour fit in, particularly to the needs of secretaries and executives?; how could these ideas be articulated to the outside world?

2. Intelligent Systems Lab, 40 staff, looking at AI and MMI.

3. System Concepts Lab. The 30 staff here were investigating computers as tools for collaboration and interaction. The core of this Lab was the group who had produced Smalltalk. There was a small outstation Lab at Portland Oregon, to see if the techniques they were looking at would enable research work to be done with remote interaction (of people), like development is done now. The goals of this group may not be well specified. (Later, on a tour of some of the Labs, we saw a Star Trek like briefing room with an enormous electronic blackboard).

   These 3 Labs worked quite closely together, and had few support staff, the intention being to force the moving out of ideas into the company. About 2/3 of the researchers were at PhD level.

4. Integrated circuits (ie process, material science). The purpose of this Lab was to enable Xerox to stay just ahead of what was commercially available, so as to be ready to take up the techniques etc when they were available. Currently they were investigating 2 micron CMOs, as this was not reliably available in Silicon Valley. They were experimenting with 1-1.5 microns.

5. Basic Physics.

6. Exploratory Development. This was the newest Lab, and was coupled to company short term products.

In a brief discussion on more general themes, we learned that it was difficult to persuade people to move out of the PARC into Xerox proper for a year or 6 months, because of the excellent location and conditions of work at the PARC. It was possible to get people from the company to come to San Francisco for the reverse process. In Xerox the products were based in the North East, and systems in SF and LA. The Lab had many visitors at any one time, some from universities on a 9 month sabbatical, other just having technical discussions. BR felt that initially these latter academics should be left alone, and then build ties with them to specific products, to which they had been party. Publication of about a quarter of the papers produced in the PARC were published in the public domain.

The visit concluded with a short walk around the facility. Not much could be seen in action (as it was quite late on a Friday evening), but it was clear that there was no shortage of facilities available on an individual basis to the staff!

13. VISIT TO BOEING AEROSPACE MONDAY 21 OCTOBER

13.1 Boeing

We wanted to talk to Edith Martin who joined Boeing after being Assistant Sec in the DoD in the office of the Under Secretary of Defence and who caused the major software initiatives to take place. She was unavailable the day we called. She is now in Bellvue part of Seattle starting up some new High Tech empire for Boeing.

Our host was Dennis Doe who is responsible for the development of all mission critical, embedded software for all of Boeing.

Boeing employs 100,000 people at sites across the USA, with a massive complex in Seattle.

Boeing has several parts:
- Commercial Aircraft
- Military Aircraft
- Helicopters
- Electronics
- Computer Services

Boeing's software development process is enshrined in 3 large manuals laying down standards, guidelines and advice for all aspects of the life cycle. This has been a major undertaking. These standards are used on all new projects and have to be followed by subcontractors who do the bulk of the work. (Boeing has 2,000 software development staff "a small staff"). These standards enable Boeing to act as system integrators.

13.2 Training

Boeing have a large training programme to implement the above standards. Dennis viewed training as very important. Four classes of training are undertaking for the Standards:

1. Executives : 1 day, 8 hours course in why standards needed (run once per Q).

2. Software Managers :

3. non software managers :

4. software engineers : 3-4 days (run one per month for 30 people).

The above are all in-house. They also run other job specific courses such as Ada programming. They make available non taught (ie video etc) course. Training is popular with employees.

Employees are allowed/encouraged to do Masters degrees with the Un of Washington. This can be done entirely on the Boeing site/at home. Some candidates can get day release. Employees are encouraged to do spare time education and training.

13.3 BASE

Having got the company life cycle standards developed Dennis' medium term strategy is to build automated, tool support for it. This is BASE - Boeing Automated Software Engineering. BASE will have an Ada focus but will not be Ada exclusive because of historical commitments to Jovial, Fortran etc which need support for their existing toolkits and projects.

Integrating these existing toolkits is seen as the short term benefit of BASE. These will run on existing mainframes. The medium term benefit will come from, you guessed it, an integrated network of single user workstations. (Apollos, MicroVAXII). Boeing has 3 main centres of software development in Seattle, Witchataw, Hunstville Alabama. The integration will need to pull together various disparate activities within a large organisation.

BASE is internally funded at $5m per year. By 1990 the target is to have 2 SUS between 3 engineers.

Current facilities include lots of VAX 780s, VAX 8600, Apollos, SUNs, IBM PCs. The whole Aerospace complex is already connected by a broadband LAN.

Dennis said that all the managers in Boeing wanted BASE 'yesterday' so he had no technology transfer problems.
(Comment: tools first approach again. We got the impression that the Standards contained no methods!)

13.4 Other

1. Dennis also gets $400k per year Boeing's own money to spend on research. Boeing are working on Reusability and Prototyping. Some links with the Un of Washington and CMU. He is also responsible for AI in Boeing - no details given.

2. Dennis is not involved in the Rolls Royce type of integration ie integrating subcontractors CAD/CAM for design and maintenance of 'hard' components such as aero engines.

3. "Boeing is not involved in General Motors MAP".

13.5 Software Productivity Consortium

The idea began in 1983 with the main planning in 1984. Twelve companies now involved including

Boeing	Ford Aerospace
TRW	United Technologies
Lockheed Missiles	McDonald Douglass
Vitro	Grumann
General Dynamics	SAIC
Martin Marietta	

The Harris Corporation is applying to join.

A Business Plan and a Technical Plan have been produced. Dennis is chairman of the Technical Planning Committee.

The 12 companies have signed up for 3 years. One year's notice is required to withdraw. SPC is intended to run for a long time.

The SPC partners are all from the aerospace world (horizontal grouping) because they all understand the 'systems problems'. Vertical grouping partners (hardware suppliers, software houses, and users etc) were rejected because "they do not understand the application". "IBM not allowed to join".

All members pay the same contribution ($1m pa + $75k up front). SPC has a total budget of $15m/year in 1985. Late entrants will have to pay more (this is detailed in the business plan). Staff in SPC are either hired directly or seconded from partners but secondees are hired too really because SPC can refuse to take them and SPC pays their salaries during secondment. Only things like pensions, perks and a job back home when the secondment is over is covered by the seconding partner.

SPC's charter is to seek Productivity gains. Quality improvements are supposed to be a side effect. Its focus is mission critical embedded systems. SPC will be trying to measure its impact on the productivity of the partners. (Dennis was realistic about the state of metrics!).

SPC has decided

1. To do research not product development (but see below)

2. Outputs to be tools and methods prototypes which the companies can adapt for themselves.

3. Not to build its own IPSE but instead it will purchase "off the shelf" a state of the art environment. This might be similar to BASE. (Dennis is angling to make it identical to BASE - ho ho!).

SPC will have 135 technical staff plus 40 support staff (175).

SPC has decided to concentrate its research onto things which potentially have a big payback if successful. These are deemed to include :

1. Reusability
2. Prototyping
3. IKBS for Software development and natural language MMI.
+
4. Systems engineering as an all pervasive aspect of 1-3. (including metrics).

All researchers will be colocated in Fairfax, Virginnia (ie Washington DC) to stop researcher being pulled out to "fire fight production problems".

one third people will secondees - 3 per company
one third people will be academics - summer jobs, consultancy
one third people will be direct hires.

SPC will do research in-house and will let research contracts outside.

SPC has now got a building but no director (still headhunting) and therefore hardly any staff yet.

Technology transfer will be by member companies ie their own responsibility. Doe will keep his Boeing research going and not rely on SPC until SPC has settled down and proved itself. Also some hint of using the Boeing team as a 'shadow team' in the Japanese sense which seems to be an effective technology transfer mechanism.

The SPC Technical Committee will act as a 'customer' for research and SPC staff as the 'contractor'.

"SPC will be much more focussed than MCC". All the IPR will be owned by the member companies. Dennis said Boeing not too concerned about IPR on SE things because

"a. Boeing feels that a head start is all that is needed and
b. they are in aerospace not software development business".

DoD can only get data rights to tools used on Boeing projects so the SPC prototypes cannot be claimed by DoD.

A highly competitive race to host the SPC went on, just like MCC and SEI. (free box at big football games etc!). Dennis wanted San Diego (nice place) or Seattle (Boeing dominates). Other places like Austin and Pittsburgh seem to have bid but in the end all the geographical managerial and technical issues were ignored and Fairfax was chosen "because of its political closeness to Washington".

"SPC intends to work with STARS, SEI, other consortia, industry and academia".

13.6 Other

1. Boeing is going to send someone to SEI as an Affiliate.

2. SESSE, the joint services software engineering environment, is the subject of STARS study contracts. Boeing has a contract - work is based on BASE. Dennis hinted that inter service rivalry was splitting up the 'joint service' element.

3. Boeing has won a $2-6m contract to put BASE into an Air Force Division in Boston to do an AWACS improvement job.

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