



INTERNATIONAL ATOMIC ENERGY AGENCY
 UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
 I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE: CENTRATOM TRIESTE



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION



INTERNATIONAL CENTRE FOR SCIENCE AND HIGH TECHNOLOGY

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS 34100 TRIESTE (ITALY) VIA GRIGNANO, 9 (ADRIATICO PALACE) P.O. BOX 586 TELEPHONE 040-224572 TELEFAX 040-224575 TELEX 460449 APH I

SMR/474 - 2

**COLLEGE ON
 "THE DESIGN OF REAL-TIME CONTROL SYSTEMS"
 1 - 26 October**

COURSE OVERVIEW

C. VERKERK
 Computing and Networks Division
 CERN
 Geneva CH-1211
 Switzerland

These are preliminary lecture notes, intended only for distribution to participants.

Course Overview.

September 19, 1990

C. Verkerk
CERN
Geneva

Real time College, Trieste 1 – 27 October 1990

Course Overview.

- College on "**Design of real-time control systems**" is a follow-up of the basic microprocessor course.
- It is aimed at teaching the participants how to design a system to control instruments or an experiment, making use of techniques, more advanced and more convenient than assembly language programming.
- We will therefore teach to build a *real-time control system on top of a suitable, existing operating system* and to use – as far as possible – a *high-level language*.

September 19, 1990

Real time College, Trieste 1 – 27 October 1990 1

Course Overview.

- This means that we will teach *how to integrate specialized peripherals* into a control or data-acquisition system.
- We will **not** treat hardware interface design as such, or the programming of the hardware functions. We will avoid spending time on "bit flipping" in a controller chip. This is in general the easier part of the job, once the *controller (chip) is well understood*.

September 19, 1990

Real time College, Trieste 1 – 27 October 1990 2

Course Overview.

Course Overview.

- In many instances during the course and during the exercises we will take basic things for granted. We will adopt a **high-level view**, in which these **details are hidden**.
- We will try to teach you how to make your special device look as a normal peripheral, supported by the operating system. The applications programmer then does not need to know about the nitty-gritty details and *he can concentrate on the essentials of the application*.
- The real-time aspect will receive all necessary attention in the course.

September 19, 1990

Real time College, Trieste 1 – 27 October 1990 3

Course Overview.

Course Overview.

- The College will be structured with lectures in the mornings and laboratory work in the afternoons and evenings.
- In the laboratory the participant will first write simple programs in C language and then gain some experience with problems typical of real-time systems. He will then work on a project, in collaboration with other participants.

September 19, 1990

Real time College, Trieste 1 – 27 October 1990

Choices made for the course:

- For financial reasons it was decided to base the lab sessions on the use of **ROSY Jr**, enhanced with a **ROM-RAM disk board**.
- **OS-9** was chosen as the **operating system** to use.
- **C** was selected as the main **programming language**. High-level and well suited for systems programming.
- The choice of OS-9 was motivated by a number of arguments:
 - it was originally developed for the 6809,

Course Overview.

Choices made for the course:

- Concerning the choice of ROSY Jr, we want to emphasize:
 - the course aims at teaching **principles**, which hold for any (reasonable) machine and any (reasonable) operating system. *The combination ROSY Jr/IOS-9/C form an ideal basis for teaching these principles.*
 - the tendency in computing is to **hide the underlying hardware and basic software layers**, so that you do not have to know in which machine your programs are running. *The course aims also at achieving this.*

Choices made for the course:

- it has been enhanced and expanded to run on a large variety of 68000 based configurations (including personal computers, e.g. Atari ST)
- a new version, written in C, has been released recently. OS-9000 runs also on 80386-based systems.
- OS-9 (the 68K version, which is very similar to the original OS-9) has become very popular for data-acquisition and control in physics.
- OS-9 is sufficiently simple and small to make its use feasible in a four week course.

Course Overview.

Choices made for the course:

- The present configuration is sufficiently **fast and powerful** so as not to impose any serious constraint, neither in the development phase, nor in the performance of the final control system.

Lecture Programme.

- During the first two weeks, we will essentially lay the basis of the knowledge needed to work on the project during the final two weeks.

September 19, 1990

Real time College, Trieste 1 - 27 October 1990 9

Course Overview.

Laboratory.

- Practical exercises will start on the third day. You will:
 - get accustomed to working with OS-9.
 - write small programs in C and execute them. This will make you acquainted with the basics of C.
 - write programs to make use of a special "peripheral": the ICTP board. This will be an occasion to learn more of C, of interfacing to OS-9 and of real-time systems.
 - start to work on the project(s).
- During the last two weeks, the lectures will cover topics of importance for real-time control systems:

September 19, 1990

Real time College, Trieste 1 - 27 October 1990 11

Lecture Programme.

- Thus the following lectures have been scheduled for the first two weeks:

C.S.ANG	RECALL OF 6809, ROSY, ASSEMBLY LANGUAGE, ETC.	6HRS
A.NOBILE	PROGRAMMING IN C	9HRS
C.VERKERK	REAL-TIME OPERATING SYSTEM	9HRS
P.BARTHOLDI	STRUCTURED DESIGN	4HRS
L.CARCIONE, P.EGGARTER	HARDWARE AND SOFTWARE FOR THE MULTI BOARD	2HRS
D.CROSETTO	D-A AND A-D CONVERSION	2HRS

September 19, 1990

Real time College, Trieste 1 - 27 October 1990 10

Course Overview.

Lecture Programme.

A.COLAVITA	INTEGRATING PERIPHERAL INTO IBM PCs.	4HRS
U.RAICH	UNIX AS A REFERENCE OPERATING SYSTEM.	3HRS
M.REIS	MINIX AS AN ALTERNATIVE FOR PC COMPATIBLES.	2HRS
H.VON DER SCHMIDT	EXTENSIONS OF OS-9 AND DISTRIBUTED SYSTEMS.	4HRS
A.BARTHOLDI	EXPLOITATION AND VISUALISATION OF RESULTS.	3HRS
I.WILLERS	PARALLEL PROCESSING.	4HRS
D.CROSETTO	DIGITAL SIGNAL PROCESSORS VS. OTHER MICROS.	2HRS
A.KUMAR	EXAMPLES AND CASE STUDY.	2HRS
C.S.ANG	EXAMPLES AND CASE STUDY.	2HRS

September 19, 1990

Real time College, Trieste 1 - 27 October 1990

Laboratory.

- During the last two weeks you will work on a project in the laboratory. A multipurpose board, developed in the Microprocessor Laboratory will be used.
- The "multi"board has several possibilities of use:
 - analog-to-digital converter
 - digital-to-analog converter
 - multichannel analyzer
 - digital oscilloscope
 - waveform analyzer

Laboratory.

- The multiboard contains a 6809 and new applications can be programmed on it.
- In the project, we will try to satisfy the people who would like to work in close contact with the operating system, as well as people who feel at home with application programs.
- During the laboratory sessions, as an extra bonus, you will have the occasion to try MINIX during two afternoons, and may be longer.

Course Overview.

Laboratory.

- In the laboratory you will be assisted by the following people:

C.S.ANG, BANDARA, L.CARCIONE, A.COLAVITA,
P.EGGARTER, GAO ZHON-REN, M.GONCALVES,
A.S.INDURUWA, KARNAD, S.A.KUMAR, M.REIS,
C.ROSALES, M.TRUJILLO, C.VERKERK, WU GENG FENG.