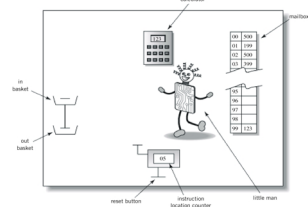# The Little Man Computer

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The Little Man Computer: Components & Physical Layout

Englander: The Architecture of Computer Hardware and Systems Software, 2nd edition
Chapter 6, Figure 06-01

- 100 mailboxes
  - address 00 - 99
  - Each holds 3-digit decimal number
- Calculator
  - Enter number
  - Temporarily hold number
  - Add and Subtraction
  - Display 3 digits
- Hand counter
  - Reset button
  - Instruction counter
- Little Man
- In/Out Basket

The Little Man Computer: Components & Physical Layout

Start Button:

The operator of the LMC (not the Little Man) presses the START BUTTON to zero the Instruction Counter and ring a bell which wakes up the Little Man so he can start executing the program which has previously been stored in the mailboxes

Instruction Counter:

This display contains the number of the mailbox in which the NEXT instruction is stored. The Little Man can change the number in the instruction counter (usually by incrementing but sometimes by replacement), and the user of the LMC can reset the Instruction Counter to 00 using the start button

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The Little Man Computer: Components & Physical Layout

Calculator:

Performs simple arithmetic (addition and subtraction only)

Used for temporary storage of a single three digit number. The display is limited to three digits.

The calculator has ten numerical keys (0-9) and two operation keys (+ and -).

The calculator also has two lights which can be seen by the Little Man.

One of these lights turns on whenever the number being displayed is exactly zero.

The other light turns on whenever the number being displayed is positive (the number ZERO is considered a positive number). Thus when ZERO is displayed on the calculator, both lights will be on.

These lights are sometimes referred to as flags

## The Little Man Computer: Components & Physical Layout

Mailboxes:

Mailboxes are identified using two-digit numbers (00 99) and each can hold a single slip of paper containing a single three digit number.

The Little Man Computer: Communication with outside World

- A user outside the mailroom communicate with the little man by

  - Putting a 3-digit into the in basket
  - Retrieving a 3-digit from the out basket

- Apart from the reset button, all communication between the LMC and the outside world takes place using 3-digit numbers
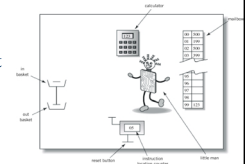

Englander: The Architecture of Computer Hardware and Systems Software, 2nd edition
Chapter 6, Figure 06-01

The Little Man Computer: Operation

- ✪ A small group of instructions, each consists of a single digit
- ✪ The first digit of a 3-digit number is used to tell the Little Man which operation to perform.
- ✪ In some cases, the Little Man is required to use a particular mailbox to store or retrieve data
- ✪ The 3 digits can be used to give instructions to the Little Man according to

Operation Code (Op-Code)

3	25
Instruction	mailbox address
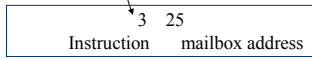
The Little Man Computer: Instruction Set

FORMAT	MNEMONIC	MEANING
3xx	STO xx	Stores the calculator value into mailbox xx.
4xx	STA xx	Stores the address portion of the calculator value (last 2 digits) into the address portion of the instruction in mailbox xx.
5xx	LOAD xx	Loads the contents of mailbox xx into the calculator.

The Little Man Computer: Instruction Set

FORMAT	MNEMONIC	MEANING
1xx	ADD xx	Adds the contents of mailbox xx to the calculator display.
2xx	SUB xx	Subtracts the contents of mailbox xx from the calculator display.

The Little Man Computer: Instruction Set

FORMAT	MNEMONIC	MEANING
000	STOP	Stops the Computer - the Little Man rests.
6xx	B xx	This instruction sets the instruction counter to the number xx, thus effectively branching to mailbox xx
7xx	BZ xx	IF the calculator value is zero, THEN set the instruction counter to the number xx, thus effectively branching to mailbox xx.
8xx	BP xx	IF the calculator value is positive, THEN set the instruction counter to the number xx, thus effectively branching to mailbox xx. NOTE: zero is considered positive.

The Little Man Computer: Instruction Set

FORMAT	MNEMONIC	MEANING
901	INPUT	Read a number from the IN basket and key it into the calculator.
902	OUTPUT	Copy the number in the calculator onto a slip of paper and place it into the OUT basket.

The Little Man Computer: Execute Program

To actually run an LMC program we must carry out the following steps.

- ✪ Load the instructions into the mailboxes, starting with mailbox 00.
- ✪ Place the data to be used by the program in the IN basket, in the order in which the program will use these data.
- ✪ Press the RESET BUTTON to set the Instruction Counter to 00 and to also wakeup the Little Man. Then

1. The Little Man looks into the Instruction Counter
2. The Little Man find the mailbox whose address has the value in the Instruction Counter and fetches the 3-digit number from the mailbox.
3. The Little Man executes the instruction found in the mailbox
4. The Little Man go over to increase the instruction counter by 1
5. The Little Man repeat the by going to 1

The Little Man Computer: Program Example

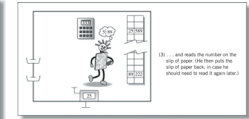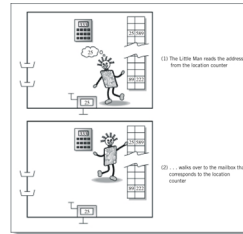Write a LMC program which adds two numbers together

Mailbox	Code	Instruction Description
00	901	**INPUT**
01	399	**STORE DATA (to mailbox no 99)**
02	901	**INPUT**
03	199	**ADD the 1st number to 2nd number**
04	902	**OUTPUT RESULT**
05	000	**The Little Man rest**
99		**Data**

The Little Man Computer: The Instruction Cycle

(1) The Little Man reads the address from the location counter

(2) . . . walks over to the mailbox that corresponds to the location counter

(3) . . . and reads the number on the slip of paper. (He then puts the slip of paper back, in case he should need to read it again later.)

Englander: The Architecture of Computer Hardware and Systems Software, 2nd edition Chapter 6, Figure 06-05a

(Figure continues on next slide)

Englander: The Architecture of Computer Hardware and Systems Software, 2nd edition Chapter 6, Figure 06-05a continued

The fetch portion of the instruction cycle (LOAD Instruction)

The Little Man Computer: The Instruction Cycle

(1) The Little Man goes to the mailbox address specified in the instruction he previously fetched

(2) . . . he reads the number in that mailbox (he remembers to replace it in case it's needed again)

(Figure continues on next slide)

Englander: The Architecture of Computer Hardware and Systems Software, 2nd edition Chapter 6, Figure 06-05b

The execute portion of the instruction cycle (LOAD instruction)

The Little Man Computer: The Instruction Cycle

(3) . . . he walks over to the calculator and punches the number in

(4) . . . finally, he walks over to the location counter and clicks it, which gets him ready to fetch the next instruction.

Englander: The Architecture of Computer Hardware and Systems Software, 2nd edition Chapter 6, Figure 06-05b continued

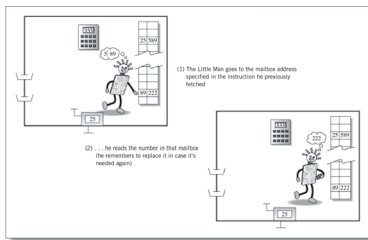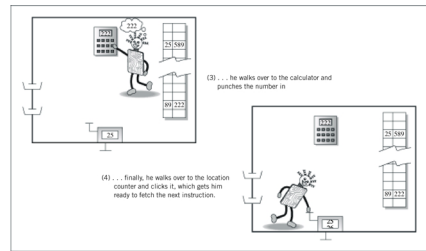The execute portion of the instruction cycle (LOAD instruction)

Some Observations Regarding Computer Architecture

- ✪ Between 1945 and 1951, von Neumann architecture
- ✪ Other experimental architectures have been developed and built
- ✪ von Neumann architecture continues to be the standard architecture for computer
- ✪ No other architecture has had any commercial success so far
- ✪ It is significant that in a field where technological changes happens almost overnight, the architecture of computers is virtually unchanged since 1951

- ✪ Key concepts of von Neumann architecture include
  - ✪ Stored program concept
  - ✪ Memory is addressed linearly
  - ✪ Memory addressed by the location number without regard to the contents
  - ✪ Instructions executed in sequence unless an instruction or outside events cause branch