Control Engineering Work Station Techniques

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Abstract

Control implementation logic definition has always been an important function of control engineers. The methodology of definition has changed through technology and market needs. These changes have included criteria such as complexity or simplicity of the instrumentation system, industrial standards and special requirements of the designer.

Distributed digital control (DDC) and personal microcomputers (PC) have introduced new terms in both defining and implementing process control requirements. Personal computer programs can use industrial instrumentation symbols to describe the control logic. After definition is completed, documentation can be fully automated. While these features are not revolutionary in terms of typical Computer Aided Drafting (CAD) features, translation of the "control picture" to a functional algorithm in the process distributed control hardware can be done automatically via communication links to the process controllers.

This paper discusses the available CAD technology and its typical implementation.

Introduction

Three important functions that process engineers perform are designing, documenting and implementing process control requirements or logic. New generations of microprocessor based control systems are extremely powerful and flexible. However, they are dependent on the process engineer to program or configure the equipment with the proper logic to control the process in the desired manner.

Programming or configuring control equipment is a time consuming process. The engineer must first write equations or draw a logical flow chart. The logic then is transformed into language that the control equipment understands. Finally, legible detailed documentation has to be created so that the process engineer has a permanent record of the logic that is programmed or configured in the equipment.

After start up of a process, there are usually problems or bugs in the control strategy that have to be solved in order for the process to run smoothly. This requires marking up the logic drawings and loading the debugged logic once again into the control equipment. Several iterations of this process may yield confusing documentation.

Mini or microcomputer based Computer Aided Drafting (CAD) packages have solved these problems. Control strategies can be implemented, altered and debugged quickly on the computer screen. Logic is compiled into machine language and downloaded directly into the control equipment. Process engineer configuration mistakes are flagged by the personal computer. Documentation is created at the push of a button utilizing an attached printer.

This paper illustrates the advantages of a CAD system using typical examples of combustion control logic requirements for a pusher type slab reheating furnace in the steel industry.

The basis for the discussions are algorithm control design using work stations and process testing for accuracy and completeness of logic. Specific areas to be covered are:

1) Control engineering CAD algorithm design
2) Summarize economic benefits of CAD design techniques

These po nts, comb ned can ead to h gh y successfu mp ementat on of s mp e or comp ex contro strateg es

Automated Algorithm Design.

Efforts to become more compet t ve and enhance nstrument contro des gn has ed to automated des gn of contro strateg es W th CAD software soph st cated og c deve opment and programm ng of m croprocessor contro ers can be entered n f owchart form (nstrument Soc ety of Amer ca type og c) more accurate y and qu ck y Data hand ng s performed by the computer free ng the eng neer to concentrate upon ' ogic des gn '

F GURE 1 (Typ ca B ockware Log c Conf gurat on Draw ng) shows an examp e of the og c a gor thm funct on b ock format used n CAD contro des gn

CAD software enab es the eng neer and manager to

a) Des gn og c and program s mu taneous y
b) Ed t and mach ne check for accuracy
c) E ectron ca y transfer programs d rect y to nstruments
d) Documentat on s sourced automat ca y as og c s created or changed
e) Eva uate og c w th ve data (spreadsheet/ graph ca y/ og ca y)
f) Check ex st ng contro og c vs documented and update automat ca y

Eng neer ng t me s enhanced by network ng nd v dua work stat ons to centra zed com puter nforma t on systems nd v dua work stat ons (m cro com puters) enab e the eng neer to save t me That s no onger does he need to wa t to access ma nframe computer t me Resu ts of contro work can be mmed ate y seen for cont nued mp ementat on Access to centra zed computers a so perm ts the nd v dua eng neer f ex b ty for project retr eva w thout paperwork thus cutt ng non product ve cost FIGURE 2 (Eng neer ng Des gn Network) shows a ren d t on of a ma n computer w th m cro computer workstat ons Th s enab es the ment oned contro nformat on shar ng W th g oba access and the speed of nd v dua work stat ons the eng neer ga ns the benef ts of both ma nframe and the PC wor d

Remote and mu t p e ocat on des gn (F GURE 2) and checkout of m croprocessor contro systems has add t ona y cut comm ss on ng t me and mproved accuracy of des gn data Commun cat on nks enab e des gners to mon tor and program contro systems wh e under more favorab e des gn cond t ons

The CAD d agram og c b ock approach r va s the ad der programm ng method of system programm ng Features of commerc a y ava ab e CAD systems have been nc uded such as text st ng magn f ca t on cut, paste and symbo brar es However th s on y represents a sma port on of features The t me sav ng features that app y un que y to ntegrated con tro systems are

- On ne mon tor ng (e rea t me power f ow
- On ne tun ng conf gurat on
- Cross reference
- Macros (groups of og c)
- Se f document ng
- Ut zat on factors
- Ver f cat on
- Draw ng nformat on by ayers
- Hardware cab ng and contro strategy nte grat on

Log c mp ementat on s performed on the screen by p ac ng shapes onto the screen that represent func t on b ocks (m n a gor thms) such as P Ds summers as we as advanced a gor thms L nes are then drawn between the symbo s to represent the nterconnect on of the var ous a gor thms The computer matches these nes to determ ne where nputs to each b ock come from or where outputs go f a change s made the CAD program changes nterna connect ons accord ng y f the CAD program has not found errors n the contro er conf guat on then t can be d rect y oaded to the contro er v a commun cat on networks

W th a PC eng neer ng work stat on connected to a d str buted contro system commun cat on h ghway og c draw ngs can be used to mon tor the outputs of a the b ocks on the screen That s a square root extractor or P D b ock ref ects current on ne rea pro cess va ues d rect y on the og c draw ng S m ar y og c gate status s represented by state (1 or 0)

Wh e construct ng the conf gurat on draw ng com mon y used oops can be made as macros (brary group ng) for ater reca An examp e wou d be a f ow oop w th square root extract on and ntegrator to be used 25 t mes dur ng a project The og c cou d be saved as a macro and reca ed for use n the con f gurat on of severa oops Th s t me sav ng feature becomes more benef c a the arger and more redun dant the og c

Un que y og c draw ngs can be made up of var ous ayers each w th t s own nformat on app cat on As an examp e conf gurat on can be on one ayer, f e d dev ces comp ete w th e ectr ca w r ng on another and descr pt on on another Thus t s poss b e for one draw ng to conta n a the nformat on requ red from pr mary nput dev ce (transm tter) through f na out put dev ce (contro actuator) nc ud ng deta og c conf gurat on When the draw ng s pr nted ayers requ red are def ned

F na y ver f cat on s necessary to assure the con tro strategy dep cted n the documentat on versus the strategy act a y be ng used by the processor pro cessor s the same Th s ver f cat on process ooks at the CAD contro er og c documentat on and the actua contro er memory and tab ates on y the d f ferences The mundane task of manua ly check ng actua vs eng neer ng og c s performed by the com puter the eng neer s eft respons b e for mak ng dec s ons on content and des gn S mp e tun ng parameters can be accepted automat ca y

Reheat Furnace Application:

As an examp e app cat on a furnace app cat on s summar zed then deta ed for CAD mp ementat on The project can be def ned as fo ows

The project s to modern ze fue management contro s of a s ab pusher reheat furnace by rep ac ng the o d pneumat c system w th the m croprocessor based system

A f ve zone s ab reheat furnace s used to heat s abs of stee to un form temperature The f ve zones con s st of a soak ng zones north and south two preheat zones top and bottom and two heat ng zones top and bottom Stee s abs are pushed through the f ve zones toward the ro ng m each zone has ndepen dent fue contro s governed by a setpo nt generated from the zone temperature The soak ng zone s fue ed by natura gas a one wh e the four heat ng zones from e ther coke oven gas or o

F GURE 3 (Reheat Superv sory Contro) shows an overa p cture of the contro strategy and the com bust on og c sect on s further deta ed n F GURE 4 (Furnace Combust on Strategy)

F GURE 5 (Deta mp ementat on) shows the h gh ghted deta for the reheat furnace mp emen tat on v a funct on a gor thms w th CAD techn ques

To c ar fy the nterconnect on of CAD generated con tro og c and ts pos t on n contro ers F GURE 6 (Funct on B ock vs nput Output) s presented t shows the re at onsh p of f e d w r ng to contro er draw ngs and nterna connect ons Th s s the rea wor d /O connect ng po nt for the m cro processor contro

Economic Benefits Summary:

Computer added des gn has many hard to def ne (f nanc a y) benef ts Neverthe ess nformat on and contro des gn hand ng ncrease the product v ty of the nd v dua contro des gn eng neer The fo ow ng are some of the benef ts found through exper ence

Tang b e Benef ts

a) ncreased eng neer ng product v ty (up to 50% ess t me for des gn)

b) Centra zed management of og c des gn (don t recreate the whee)

c) Documentat on automat on and h gh accuracy

d) Tra n ng of new eng neers on tr cks of the trade s ncreased

e) Decreased t me dur ng startup (ess trave and process down t me)

f) ncreased transportab ty of ke og c (up to 80% reusab e)

g) Extens ve factory test ng

h) mproved comp ex contro re ab ty

) System comm ss on ng and as bu ts take ess effort

j) Many what f s tuat ons can be tested safe y

ntang b e Benef ts

a) ncreased opportun ty t me (do more eng neer ng)

b) Owner acceptance and a gor thm understan d ng s h gh

c) Cons stent documentat on mproves accep tance and the amount of t me spent on comp ex con tro des gn and de bugg ng

Conclusion

Computer a ded des gn s ava ab e and app cab e to process contro today Much has been done n con tro des gn automat on and a gro thm test ng w th regard to m croprocessor based systems Advantages of computer a ded des gn are both quant f ab e and not quant f ab e Comp ex and s mp e a gor thms can be des gned and de bugged much more qu ck y and eff c ent y us ng CAD systems

As a note future contro des gn w th CAD systems are current y ncorporat ng ru e based expert systems to generate contro deta og c Th s s the next horizon wh ch w be usefu to contro eng neers Based w th a f ex b e and econom c CAD contro des gn system the econom c benef ts are seen to mu t p y

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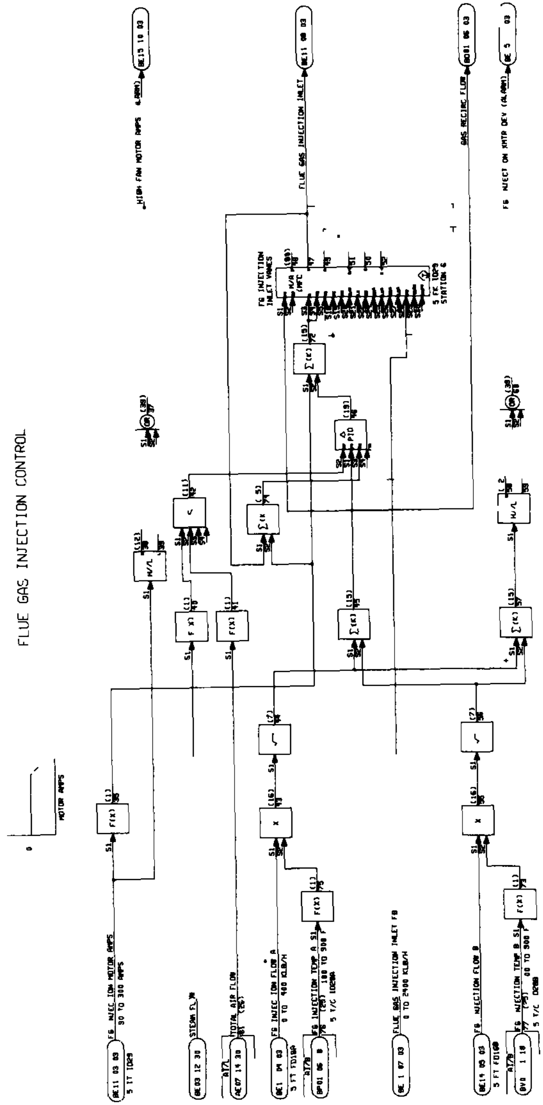

FIGURE 1 Typical Blockware Logic Configuration Drawing

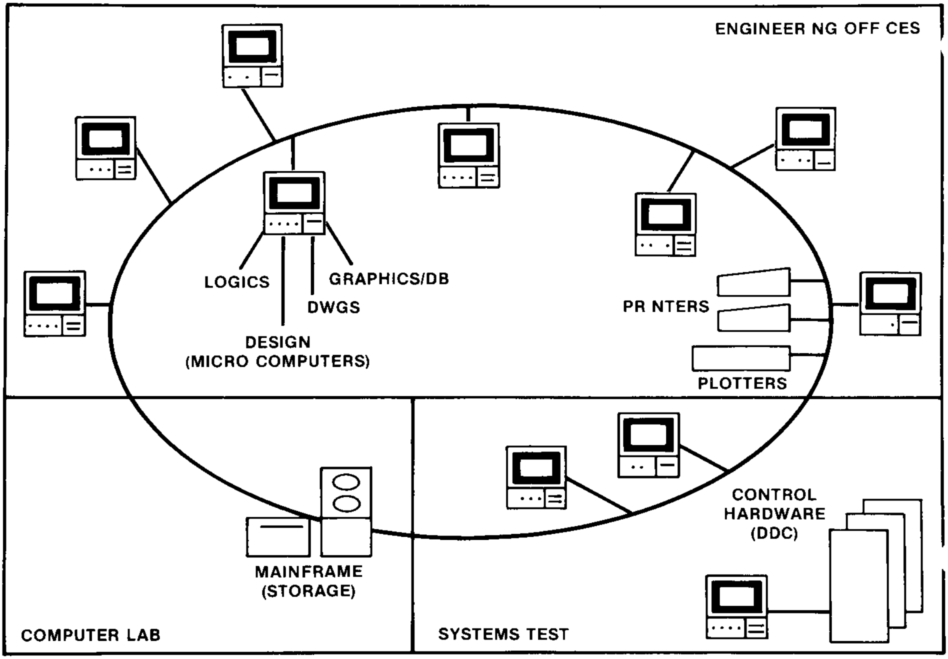

FIGURE 2 Engineering Design Network

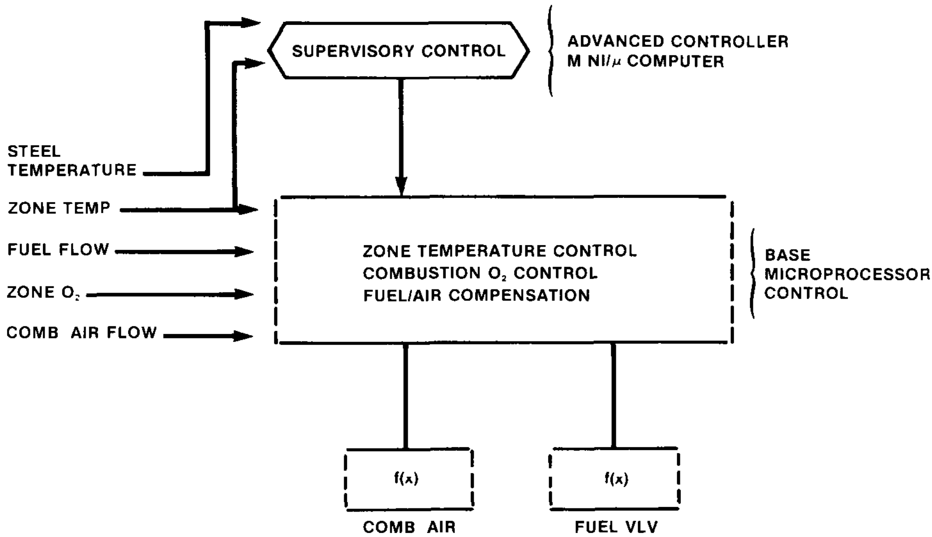

FIGURE 3 Reheat Supervisory Control

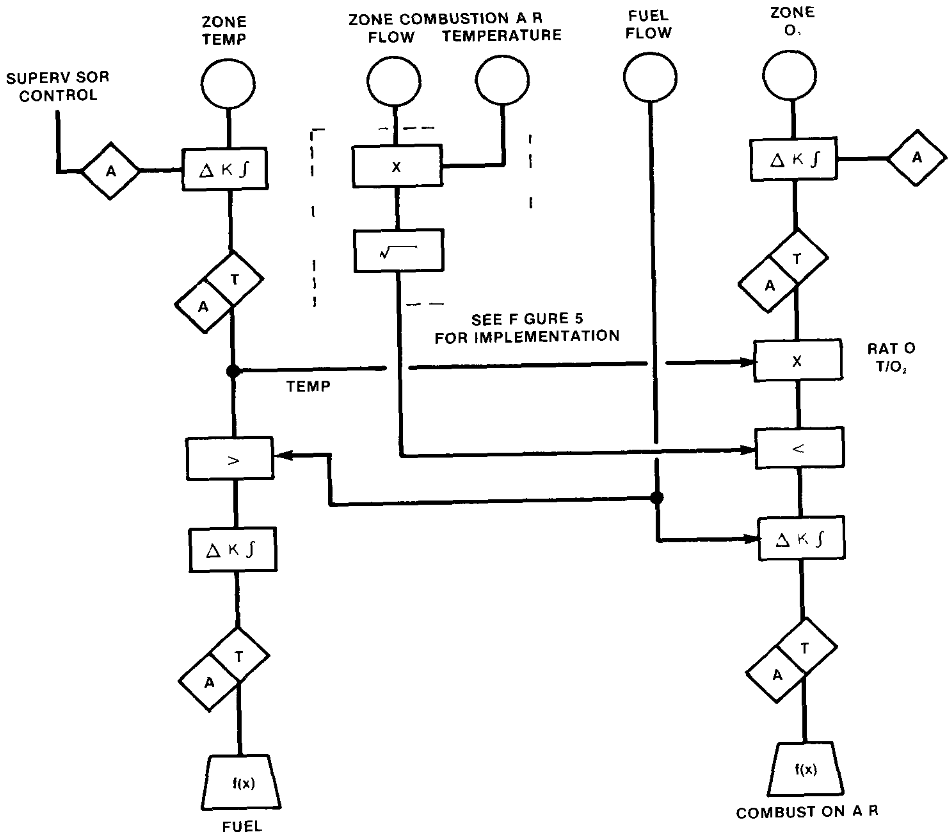

FIGURE 4   Furnace Combustion Strategy (prior to function block logic)

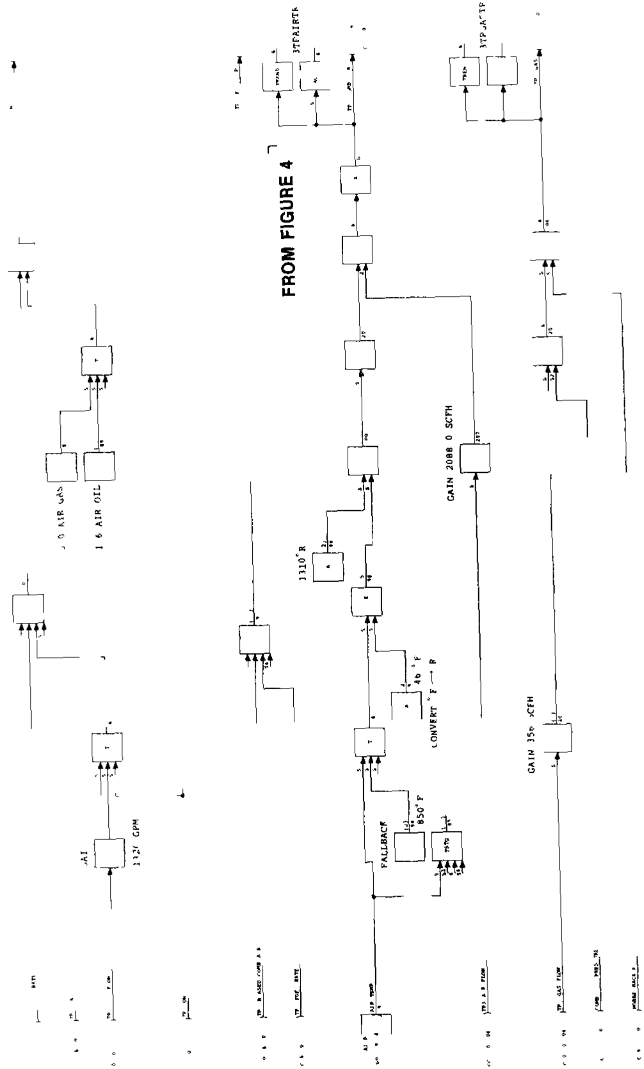

FIGURE 5 Detail Implementation

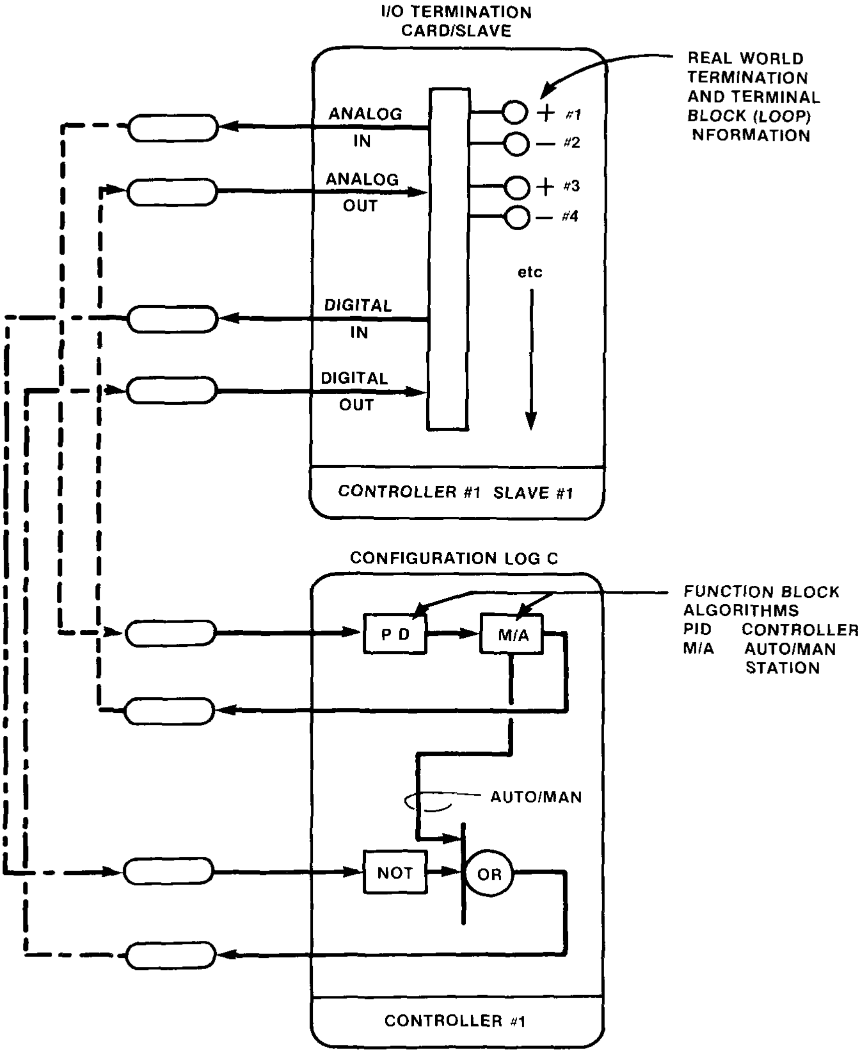

FIGURE 6 Function Block Logic vs Input Output

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