

University of Twente

Twente House Cup Point Counter

Authors:

Egbert Dijkstra
s1700618
e.dijkstra@student.utwente.nl

Alain Jansen
s1694839
g.a.a.jansen@student.utwente.nl

Bob Oldengarm
s1859870
b.m.j.oldengarm@student.utwente.nl

Jesse Rengers
s1838989
j.j.rengers@student.utwente.nl

Supervisors:

Yeray Barrios Fleitas Msc
y.d.c.barriosfleitas@utwente.nl

Jeroen Klein Brinke Msc
j.kleinbrinke@utwente.nl

Department of EEMCS
Enschede
The Netherlands
November 6, 2020

UNIVERSITY OF TWENTE.

ABSTRACT

The number of students following the TCS program has been rapidly increasing over the past few years. A house system analogous to the system of Hogwarts has been introduced to give the students a sense of belonging and make everything more manageable. Of course, an integral part of the Hogwarts house system is the annual House Cup where the houses gather points over the course of a year. That is why our client asked us to design and implement a system to facilitate the TCS House Cup.

One part of the system is the online management tool. It is integrated with Canvas and is used to view and update the scores of the houses. In the Harry Potter books, the score is also represented by giant hourglasses filled with gems, which meant our system should also contain a physical representation of the scores. This has been implemented as tanks filled with water, where the amount of water represents the score of the house.

In this report, the system concept as well as their requirements will be laid out. Furthermore, the design choices that were made and how they were implemented will be discussed. Finally, an evaluation will be given of both the system and our process during implementation.

CONTENTS

- Abstract** **1**

- 1 Introduction** **4**

- 2 Concept** **5**

- 3 Requirements** **6**
 - 3.1 Software requirements 6
 - 3.1.1 Requirements 6
 - 3.1.2 Requirements 6
 - 3.1.3 Requirements 6
 - 3.1.4 Requirements 6
 - 3.2 Hardware requirements 7

- 4 Software design** **8**
 - 4.1 Global view 8
 - 4.2 Plugin 8
 - 4.3 LTI Protocol 8
 - 4.4 Data Server 9
 - 4.5 Privacy 9

- 5 Hardware design** **10**
 - 5.1 Main controller and retrieving the scores 10
 - 5.2 Monitoring the water level 10
 - 5.2.1 Potential sensing technologies 10
 - 5.2.2 Testing sensor candidates 12
 - 5.2.3 Final sensor choice 13
 - 5.3 Changing the water level 14
 - 5.3.1 Calibration sensor candidates 15
 - 5.3.2 Final calibration and changing water level choice 15
 - 5.4 Global hardware overview 16

- 6 Software Implementation** **18**
 - 6.1 Software implementation 18
 - 6.1.1 Plugin 18

- 7 Hardware implementation** **20**
 - 7.1 Software and libraries 20
 - 7.1.1 Used software 20
 - 7.1.2 Code 20
 - 7.2 Hardware components and set-up 20
 - 7.2.1 The pumps 20

'LVSOD\WDQN
&DOLEUDWLRQ WDQN
\$HVWKHWLFV

7HVWLQJ
3OXJLQ 7HVW
\$3, 7HVW
+DUGZDUH WHVWV
\$FFXUDF\
0DLQWDLQLQJ ZDWHU OHYHO
5HVHW IXQFWLRQ
)XOO V\WHP WHVW

6\WHP (YDOXDWLRQ
6RIWZDUH
7HVW DQDO\VLV
5HTXLUHPHQWV DQDO\VLV
+DUGZDUH
7HVW DQDO\VLV
5HTXLUHPHQWV DQDO\VLV

)XWXUH :RUN
&UHDWH PRUH UROHV
+RXVHNHSHUV
\$GPLQ
\$3, 6HFXULW\
\$3, 5HTXHVW +DQGOLQJ
6FDOLQJ XS WR IRXU WDQNV
\$HVWKHWLFV
3RZHU VRXUFH IRU SXPSV
\$GYDQFHG V\WHP VWDWH DQDO\VLV
)LQDOLVLQJ WKH SRLQW V\WHP

3URFHVV HYDOXDWLRQ
2UJDQLVDWLRQ
*OREDO RUJDQLVDWLRQ
6RIWZDUH RUJDQLVDWLRQ
+DUGZDUH RUJDQLVDWLRQ
:KDW ZHQW ZHOO DQG SLWIDOOV

&RQFOXVLRQ

\$ +DUGZDUH DSSHQGL[

, 1752'8 & 7, 21

:LWK WKH GHFLVLRQ WR PDNH WKH 7HFKQLFDO &RPSXWHU 6FLHQF
QXPEHUV VN\URFNHWHG 7KHEDFKHORUZHQWIURP WR VWXGH
REYLRXVO\FKDQJHG DORW RISRUFHVHV FRXUVHV QHHGHG WR
ZHUH EHLQJ JLYHQ VR WKDW HYHU\RQH KDG DJRRG H[SHULHQFH
8QLYHUVLW\RI7ZHQWH H[SHULHQFH ,QGXWFK ZHKDYHDVD\LQ
HDFK RWKHU 6WXGHQWV WR WHDFKHU EXW DOVR WHDFKHU WR V
VRPHWKLQJ QHHGHG WR FKDQJH EHFDXVH LW LV QRW SRVVLEOH Z

\$ QHZ V\VWHP ZDV LQYHQWHG RU ZHOO ZDV OHQGIURP +DUU\3RW
,W ZDV LQWURGXFHG LQ WKH FROOHJH\HDDQG ZDV DJUH
ZLWK GLVWLQFW FRORUV UHG EOXH JUHQDQG\HOORZ %XW
RILQWHUFDWLRQ RU JDPLILFDWLRQ)RU WKLVLQVSLUDWLRQ ZD
+DUU\3RWWHU %RRNV DQDQQXDO +RXVH &XS LV RUJDQLVHG :HV
RIFRQFHSW

& 2 1 & (3 7

7KH V\ VWHP FRQVLVWV RI WZR PDLQ SDUWV DQ RQOLQH PDQDJHP
WLRQ RI WKH VFRUHV

7KH PDQDJHPHQW V\ VWHP LV D &DQYDV SOXJLQ ,Q WKLV ZD\ WH
GHQWV FDQ HDVLO\ DFFHVV LW ZLWKRXW GRZQORDGLQJ RWKHU VR
PDQDJHPHQW V\ VWHP VKRZV WKH FXUUHQW VFRUHV RI WKH KR XVH
DUH DOVR DEOH WR LQFUHDVH RU GHFUHDVH WKH VFRUHV \$ ORJ
SDJH WR NHHS WUDFN RI DOO PXWDWLRQV

,Q WKH +DUU\ 3RWWHU ERRNV WKH VFRUHV DUH UHSUHVHQWHG E
7KLV LV RI FRXUVH D ELW GLIILFXOW WR LPSOHPHQW EXW D SK\VL
LQFOXGHG LQ D FRPSHWLWLRQ WKDW GUDZV LQVSLUDWLRQ IURP +
OLNH IRU WKH VFRUHV WR EH UHSUHVHQWHG E\ F\OLQGHUV ILOOH
WKH ZDWHU UHSUHVHQWV WKH FRORU RI WKH KR XVH WKH ZDWHU W

2XU WDVN ZDV WR FUHDWH D IXOO\ IXQFWLRQDO SURRI RI FRQFH
KR XVHV 7KH PDQDJHPHQW V\ VWHP DQG WKH SK\VLFDU UHSUHVH
WZR VHSUDUDWH V\ VWHPV 7KH\ DUH RQO\ OLQNHG E\ WKH IDFW WK
WR UHWULHYH WKH VFRUHV IURP WKH PDQDJHPHQW V\ VWHP 7KD
WZR SDUWV WKH VRIWZDUH SDUW IRU WKH PDQDJHPHQW V\ VWHP D
UHSUHVHQWDWLRQ RI WKH VFRUHV

5(48,5(0(176

\$V H[SODLQHG LQ WKH SUHYLRXV VHFWRU WKH SURMHFW ZDV G
VHFWRU \$V VXFK WKH UHTXLUHPHQWV IRU HDFK SDUW ZLOO EH

6RIWZDUH UHTXLUHPHQWV

7KH UHTXLUHPHQWV IRU WKH VRIWZDUH SDUW KDYH EHHQ DQDO
WHDFKHUV DQG VWXGHQWV VLQFH WKRVH DUH WKH PDLQ JURXS

\$V D VWXGHQW RU WHDFKHU , ZDQW WR EH DEOH WR DFFHVV W

5HTXLUHPHQWV

D 7KH PDQDJHPHQW V\VWHP VKRXOG EH DFFHVVLEOH WKURXJ
E 6WVXGHQWV DQG WHDFKHUV VKRXOG ERWK EH DXWKRULJHG V

\$V D VWXGHQW RU WHDFKHU , ZDQW WR EH DEOH WR VHH WKH V

5HTXLUHPHQWV

D 7KH FXUUHQW VFRUHV VKRXOG EH FOHDUO\ VWDWHG SHU K
E 7KH FXUUHQW VFRUHV VKRXOG EH VKRZQ JUDSKLFDOO\ UH
VFRUHV DUH VKRZQ E\ WKH SK\VLFDU UHSUHVHQWDWLRQ

2QO\ WHDFKHUV VKRXOG EH DEOH WR PXWDWH WKH VFRUHV RQ

5HTXLUHPHQWV

D 7HDFKHUV VKRXOG EH DXWKRULJHG WR PXWDWH WKH VFRUHV
E 0XWDWLQJ WKH VFRUHV VKRXOG EH LQWXLWLYH
F 6WVXGHQWV VKRXOG QRW EH DXWKRULJHG WR PXWDWH WKH V

\$V D VWXGHQW RU WHDFKHU , ZDQW WR EH DEOH WR VHH DOO P

5HTXLUHPHQWV

D 7KH SOXJLQ VKRXOG LQFOXGH D ORJERRN ZKHUH DOO PXWD
E 5RZV LQ WKH ORJERRN ZLWK QHJDWLYH PXWDWLRQV VKRXO
F 7KH ORJERRN VKRXOG KDYH FROXPQV IRU GDWH KR XVH PX

+DUGZDUH UHTXLUHPHQWV

,W ZDV KDUG WR FDSWXUH WKH UHTXLUHG IXQFWLRQDOLW\ RI WKH
7KHUHIRUH KDUGZDUH UHTXLUHPHQWV DUH UHSUHVHQWHG LQ OR

0867 +\$9(

D 7KH ZDWHU OHYHO LQ WKH WDQN PXVW UHSUHVHQW WKH VF
E 7KH V\|VWHP PXVW EH DEOH WR UDLVH WKH ZDWHU OHYHO
F 7KH V\|VWHP PXVW EH DEOH WR ORZHU WKH ZDWHU OHYHO
G 7KH V\|VWHP PXVW EH FRQWUROOHG E\ D 5DVSEHUU\ 3L RU D
H 7KH V\|VWHP PXVW EH DEOH WR UHWULHYH WKH VFRUH RID K
QHQW
I ,I WKH ZDWHU OHYHO FKDQJHV ZKLOH LW VKRXOG QRW WK
ZDWHU OHYHO EDFN WR WKH FRUUHFW OHYHO

6+28/' +\$9(

D 7KH ZDWHU OHYHO LQ WKH WDQN VKRXOG EH SUHFLVH ZLWK
E 7KH VHQVRUV WKDW PHDVXUH WKH ZDWHU OHYHO VKRXOG Q
F 7KH ZDWHU VKRXOG EH FRORUHG LQ VXFK D ZD\ WKDW LW UHS
KRXVH
G 7KH VHQVRUV XVHG IRU WKH SURWRW\SH VKRXOG FRVW QR F

&28/' +\$9(

D 7KH WDQN WKDW GLVSOD\|V WKH VFRUH FRXOG ORRN OLNH D
E \$OO KDUGZDUH WKDW LV QRW WKH WDQN WKDW GLVSOD\|V W
F 7KH V\|VWHP FRXOG EH DEOH WR GHWHFW OHDNDJH
G ,I WKH VFRUH ZHQW IURP WKH PLQLPXP WR WKH PD\LPXP D
WKH VFRUH FRXOG EH ILOOHG ZLWKLQ ILYH PLQXWHV

:/ 127 +\$9(

D 7KH V\|VWHP ZLOO QRW EH GHVLJQHG LQ VXFK D ZD\ WKDW LW
E 7KH H\|WHULRU RI WKH SURWRW\SH RI WKH V\|VWHP ZLOO Q
ZRXOG EH XVHG IRU D UHDO YHUVLRQ

62)7:\$5(' (6,* 1

*OREDO YLHZ

\$ JOREDO RYHUYLHZ RI WKH VWUXFWXUH RI WKH VRIWZDUH FDQ E
VHUYLEFH RULHQWHG DUFKLWHFWXUH VHSUDUDWLQJ WKH SOXJLQ
PRGXODU ,Q WKLV ZD\ ZH FDQ PDNH FKDQJHV WR WKH SOXJLQ ZLV
YLFH YHUVD 7KH SOXJLQ LV RSHQHG LQVLGH D &DQYDV FRXUVH 2
IORZ WKDW DXWKHQWLFDFWHV WKH XVHU 0RUH GHWDLOV DERXW W
\$IWHU WKH /7, IORZ WKH SOXJLQ NQRZV ZKR WKH XVHU LV DQG ZK
7KH SOXJLQ XVHV WKLV LQIRUPDWLRQ WR UHQGHU WKH FRUUHFW
PXWDWH WKH VFRUHV ZKLOH QRUPDO XVHUV GRQ\W JHW WKLV RSV

30XJLQ

7KH SOXJLQ LV FUHDWHG XVLQJ ([SUHV V MV D EDFNHQG ZHE DSSC
SUHV V MV LV XVHG EHFDXVH LW LV D SRSXODU DQG ZLGHO\ XVHG -
XPHQWDWLRQ DQG WXWRULDOV DUH DYDLODEOH IRU WKLV IUDPHZ
DV VHUHU IUDPHZRUN IRU 1RGH MV 7KH IURQWHQG RI WKH SOXJ
WHPSODWLQJ IUDPHZRUN ZKLFK LV HDV\ WR XVH DQG LQWXLWLYH

7KH SOXJLQ VKRZV WZR PDLQ WKLQJ V IRXU EDUV WKDW UHSUHVH
ERRN 7KH KHLJKW RI WKH EDUV VKRZ KRZ PXFK SRLQV D KRXVH K
MXVW OLNH WKH SK\VLFD O SUHVHQWDWLRQ GRHV 7KH EDUV DUH F
OLVWV DOO PXWDWLRQV LQ D WDEOH ZLWK FROXPQV IRU PXWDWLR

7KURXJK WKH XVH RI ZHE VRFNHVV WKHVH LWHPV FDQ EH XSGDWH

/7, 3URWRFRO

7KH /HQUQLQJ 7RROV ,QWHURSHUDELOLW\ /7, SURWRFRO LV D S
FRPPXQLFDWLRQ EHWZHHQ OHDUQLQJ V\ VWHPV VXFK DV &DQYDV
OLNH RXU DSSOLFDWLRQ 7KH FXUUHQW YHUVLRQ RI /7, YHUVLR
2SHQ,' &RQQHFW IRU DXWKHQWLFDFWLRQ DQG -621 :HE 7RNHQ -:7
FHVV WRNHQV

:KHQ WKH SOXJLQ LV VWDUWHG WKH /7, IORZ VHGGV GDWD EDFN
VHUYLEFH DQG RXU DSSOLFDWLRQ \$IWHU WKDW RXU DSSOLFDWLR
GDWD LQFOXGHV WKH XVHUV QDPH DQG LW\U UROH LQ WKH FRXUV
WKHQ XVH WKLV UROH IRU DXWKRUL]DWLRQ

)LJXUH 2YHUYLHZ RI WKH VRIWZDUH SDUWV DQG WKHLU

'DWD 6HUYHU

1H[W WR WKH SOXJLQ ZH KDYH D GDWD VHUYHU ZLWK DQ \$3, WKDW V
GDWD VHUYHU LV DOVR FUHDWHG ZLWK ([SUHV V MV DQG VWRUHV L

3ULYDF\

7KH DSSOLFDWLRQ VWRUHV WZR WKLQJV LQ LWV GDWDEDVH WKH
WKH PXWDWLRQV WKDW DUH GRQH 7KH DPRXQW RI SRLQWV RI D K
VLQFH WKHVH DUH QRW UHODWHG WR D SHUVRQ GDWD VXEMHFW
\$OO PXWDWLRQV DUH ODEHOHG E\ WKH QDPH RIDQLVXHU 7KLV
DQG FDQ EH VHHQ DV SHUVRQDO GDWD 7R VDIHJDUG WKH SULYD
WKH *'35 DQG EHOLHYH WKDW ZH DGKHUH WR LW ZKHQ WKH LVVXHU

+ \$ 5 ' : \$ 5 (' (6 , * 1

7KH KDUGZDUH FRPSRQHQQW LV XVHG WR GLVSOD\ WKH VFRUH E\ P
ZDWHU WDQN 7KH DPRXQW RI ZDWHU LQ WKH WDQN UHSUHVHQWV
PDLQ WDVNV UHWULHYLQJ WKH SRLQW WRWDO RI D KRXXVH PRQL
ZDWHU OHYHO WR UHSUHVHQW WKH SRLQW WRWDO 7KH KDUGZDUH
5DVSEHUU\3LRUDVLPLODUGHYLFH 6HYHUDO GHVLJQ FKRLFHV K
LQ WKLW FKDSWHU

0DLQ FRQWUROOHU DQG UHWULHYLQJ WKH VFRUHV

2QH RI WKH UHTXLUHPHQWV ZDV WKDW WKH V\ VWHP LV FRQWUROO
GXLQR :KLOH WKH 5DVSEHUU\3L 53L LV EDVLFDOO\ DWLQ\ IXOO\
D PLFUR FRQWUROOHU 7KLV PHDQV WKH 5DVSEHUU\3L KDV D ORV
WKH WDVNV RI WKH V\ VWHP DUH RQO\ SHUIRUPHG SHULRGLFDOO\ D
PDWWHU DOO WKDW PFK 7REHDEOH WR SHUIRUP DOO WKUHH WD
SDUWV WKHERDUG ZLOO QHHG ERWK D *3,2 LQWHUIDFH DQG LQWH
RU PHJD DQG WKH 5DVSEHUU\3L PRGHO KDYH D *3,2 LQWHUIDFH
LQ :L)L PRGXOH ZKLOH WKH \$UGXLQR UHTXLUHV D :L)L VKLHOG W
)LQDOO\ WKH \$UGXLQR LV FKHDSHU WKDQ WKH 5DVSEHUU\3L PRG

%HFDXVH RI WKH EXLOW LQ :L)L FRQQHFWLYLW\ DQG WKH RSWLRQ
WKH 5DVSEHUU\3L PRGHO % KDV EHHQ FKRVHQ DV WKH FRQWUROO
7KH LQWHUQHWR FRQQHFWLYLW\ DOVR PDNHV UHWULHYLQJ WKH V
DQ \$3, FDOO WR WKH EDFN HQG RI WKH VRIWZDUH FRPSRQHQQW 7KH
VXFK D ZD\ WKDW WKH\ FDQ EH XVHG DV D UHIHUHQFH YDOXH WR IL

0RQLWRULQJ WKH ZDWHU OHYHO

3RWHQWLDO VHQLQJ WHFKQRORJLHV

'LIIHUHQW VHQLQJ RSWLRQV ZHUH FRQVLGHUHG IRU PRQLWRULQ
RSWLRQV ZLOO EH GLVFXVVG LQ WKLW FKDSWHU 7KHUH ZHUH RV
WRR H[SHQVLYH QHHGOHVVO\ FRPSOLFDPHQW RU QRW VXLWDEOH
VRUV KDYH EHHQ HYDOXDWHG RQ WKH IROORZLQJ PHWULFV

‡&RVW :KDW LV WKH SULFH RI WKH VHQVRU DSSUR[LPDWHO\ "

‡0RXQLQJ SODFH :KHUH ZLOO WKH VHQVRU EH SODFHG"

‡9LVLELQW\ ,V WKH VHQVRU YLVLEOH LQ WKH GLVSOD\ WDQN"

‡(DVH RILQVWDOODWLRQ +RZ GLILFXOW LV LW WR SODFH WKH
WR WKH WDQN"

‡3RWHQWLDO SUREOHPV :KDW DUH VRPH FRQFHUQV ZKHQ XVLQ
8OWUDVRXQG 6HQVRU
7KLV VHQVRU VHGGV DQ XOWUDVRXQG ZDYH ZKLFK ZLOO ERXQFH RI
WKH WLPH GLIIHUHQFH EHWZHHQ VHQGLQJ WKH ZDYH DQG UHFHLY
VHQVRU DQG WKH ZDWHU VXUIDFH FDQ EH FDOFXODWHG XVLQJ WK

‡([DPSOH VHQVRU

‡&RVW HXURV

‡0RXQWLQJ SODFH ,Q WKH OLG RI WKH WDQN

‡9LVLELOLW\ 1RW YLVLEOH

‡(DVH RILQVWDOODWLRQ (DV\ \$ KROH PXVW EH FUHDWHG LQ W
WKH ZLUHV LQ

‡3RWHQWLDO SUREOHPV 7KH VHQVRU ZLOO OLNHO\ KDYH DFFXU
LV VHGGV ZLOO GLYHUJH DQG XQOHVV D YHU\ ODUJH GLDPHW
RII WKH ZDOOV RI WKH WDQN DQG WKXV DIIHFW WKH UHVXOWLQ

7LPH RI)OLJKW 7R) ODVHU VHQVRU
:RUNV RQ WKH VDPH EDVLF SULQFLSOH DV WKH XOWUDVRXQG VHQ
ERXQFH RII WKH ZDWHU 7R VROYH WKLV D IORDWLQJ SODVWLF GL

‡([DPSOH / ;

‡&RVW HXURV

‡0RXQWLQJ SODFH ,Q WKH OLG RI WKH WDQN

‡9LVLELOLW\ 7KH VHQVRU LVVHOILV QRW YLVLEOH +RZHYHU
ZDWHU IRU WKH OLJKW WR UHIOHFW RQ

‡(DVH RILQVWDOODWLRQ (DV\ \$ KROH PXVW EH FUHDWHG LQ W

‡3RWHQWLDO SUREOHPV 7KH VDPH SUREOHPV DV ZLWK WKH XO
HYHU WKH H[SHFWDWLRQ LV WKDW WKLV ZLOO RFFXU WR D OH
VHGGV KDV D ORZHU GHJUHH RI GLYHUJHQFH

/RDG FHOO
\$ ORDG FHOO FDQ EH XVHG WR PHDVXUH ZHLJKW ,W ZRXOG EH SO
WDQN %\ XVLQJ WKH NQRZQ ZHLJKW RI WKH ZDWHU WDQN DQG WK
RI ZDWHU LQ WKH WDQN FDQ EH FDOFXODWHG

‡([DPSOH / NJ ORDG FHOO

‡&RVW HXURV

‡0RXQWLQJ SODFH ,Q D FRQVWUXFWLRQ XQGHU WKH GLVSOD\ V

‡9LVLELOLW\ 1RW YLVLEOH

‡(DVH RILQVWDOODWLRQ 'LILFXOW 7R XVH LV D FXVWRP ZHL
ZHLJKW RI WKH GLVSOD\ WDQN LV QLFHO\ GLVWULEXWHG

‡3RWHQWLDO SUREOHPV 7KH DFFXUDF\ RI WKH VHQVRU PXVW E
LV GLIILFXOW WR XVH

*DXJH SUHVXUH VHQVRU
0HDVXUHV WKH GLIIHUHQFH LQ DLU SUHVXUH 6RPH DLU ZLOO EH
WDQN ZKLFK WKH ZDWHU FDQ DOVR HQWHU 2QH HQG RI WKH VHQV
HQG WR WKH DLU RXWVLGH RI WKH WDQN :KHQ WKH ZDWHU OHYHO
LQFUHDVHV WKH SUHVXUH LQ WKH WXE 7KH VHQVRU FDQ XVH
DQG WKH DWPRVSKHULF SUHVXUH WR FDOFXODWH WKH ZDWHU O

‡([DPSO] ; *3

‡&RVW HXURV

‡0RXQWLQJ SODFH 1HDU WKH OLG RI WKH GLVSOD\ WDQN

‡9LVLELOLW\ 9LVLEOH EHFDXVH RI WKH H[WUD WXE LQ WKH G

‡(DVH RILQVWDOODWLRQ 'LILFXOW \$QH[WUD WXEHPXVWEH
EHFRPSOHWHO\ YHUWLFDOO\ VWUDLJKW RWKHUZLVH WKH F
VHQVRU QHHGV WR EH FRQQHFWHG WR WKH DLU RXWVLGH RI W
KROH VRPHZKHUH WKDW FRXOG EH PLVXVHG LIRPHRQH GHFLC

‡3RWHQWLDO SUREOHPV 'LILFXOW WR XVH XQNQRZQ DFFXUDI

0LQLDWXUH %DURPHWHU
0HDVXUHV WKH DEVROXWH SUHVXUH ZKLOH VXEPHUUHG LQ ZDWH
FDQ EH GHULYHG IURP WKLW

‡([DPSO] &

‡&RVW HXURV

‡0RXQWLQJ SODFH 2Q WKH ERWRP RI WKH WDQN

‡9LVLELOLW\ ,IWDNHQ LQWR DFFRXQW IRU WKH GHVLJQ QRW Y

‡(DVH RILQVWDOODWLRQ \$OLWWHOGLILFXOW 7KH VHQVRU L
KROHV KDYH WR EH FUHDWHG LQ WKH GLVSOD\ IRU WKH ZLUHV \

‡3RWHQWLDO SUREOHPV ([WUD KROHV KDYH WR EH FUHDWHG L
FXUDF\

7HVWLQJ VHQVRU FDQGLGDWHV

)RU WKH ILUVV VHQVRU WHVW WKH VHQVRUV ZLWK WKH HDVLHV
QDPHO\WKH XOWUDVRXQG 7R) ODVHUHQ /RDG &HOO VHQVRUV)
VHQVRU SURYLGHG LQ WKH H[DPSOHV \$IWHU PDNLQJ DSSURSULDV
PHQWLRQHGXPRXQWLQJORFDWLRQV)RUWKH7R) DQG XOWUDVRXQ
FPLQKHLJKWZLWKDGLDPHWHURI FPKDVEHHQXVHG)RUWKHO
ZHLJKWV XQGHU NJZDV XVHG EHFDXVH LWZDV OHVV WLPHFRQVX
VFDOH 7KH VHQVRU KDYH EHHQ HYDOXDWHG EDVHG RQ WKH IROO

‡\$FFXUDF\ +RZ FORVH ZDV WKH PHDVXUHG YDOXH WR WKH DFW

‡3UHFLVLRQ +RZ FORVH ZHUH LQGLYLGXDO PHDVXUHPHQWV WF

‡(DVH RIXVH +RZ HDV\ZDV LW WR XVH WKH VHQVRU"

8OWUDVRXQG VHQVRU

‡\$FFXUDF\ 7KH VHQVRU UHSRUWHG GLVWDQFHV RI DSSUR[LPD
IXUWKHU DZD\WKH ZDWHU ZDV IURP WKH VHQVRU WKH OHVV D

‡3UHFLVLRQ 7KH VHQVRU ZDV YHU\ SUHFLVH 0HDVXUHPHQWV
RWKHU

‡(DVH RIXVH 9HU\HDV\

7R) VHQVRU

‡\$FFXUDF\ 5HSRUWHG GLVWDQFHV ZHUH DSSUR[LPDWHO\ W
ZDWHU ZDV WR WKH VHQVRU WKH PRUH DFFXUDWH WKH UHVXO

‡3UHFLVLRQ 7KH VHQVRU ZDV OHVV SUHFLVH WKDQ WKH XOWUD
ZLWKLQ PPIURP RQH DQRWKHU

‡(DVH RIXVH 6OLJKWO\PRUH GLIILFXOW WR XVH WKDQ WKH XO
WKH XVH RID IORDWLQJ REMHFW

/RDG FHOO

‡\$FFXUDF\ \$OO WKH ZHLJKWV XVHG ZHUH OHVV WKDQ NJ ZKL
DURXQG .*ZKHQ IXOO\ILOOHG 7KH PHDVXUHPHQWV IHOO ZL

‡3UHFLVLRQ /HV SUHFLVH WKDQ WKH RWKHU WZR VHQVRUV Z
SRUWLQJ GLIIHUHQFHV RI J

‡(DVH RIXVH 0DNLQJ WKH OLWWOH WHVW VHW XS EDVLFDOO
FRQVXPLQJ 7KLV ZDV EHFDXVH LW KDG WREH YHU\ VWDEOH R
RQLW ZRXOG QRW EHSURSHUO\GLVWULEXWHG ,Q WKH HQG
WKHORZ SUHFLVLRQRIWKH VHQVRU ,ILW ZHUH WREH XVHG
³SK\VLFD´GHVLJQRIWKH GLVSOD\WDQN ZRXOG UHYROYH DU
VKRUW WKLV VHQVRU LV PRUH GLIILFXOW WR XVH IRU WKLV SU

)LQDO VHQVRU FKRLFH

7KH XOWUDVRXQG DQG 7R) VHQVRUV ZHUH LPPHGLDWHO\FKRVLHQ
VLPSOHU WR XVH DQG LQVWDOO %HWZH HQ WKH WZR WKH 7R) VH
WKH XOWUDVRXQG VHQVRU EXWERWK VHQVRUV ZHUH QRW VXIILFI
VHQVRU UHSRUWHG YHU\ SUHFLVH PHDVXUHPHQWV 7KLV PHDQV L
VRUE\XVLQJDGLVFUHWHSRLQW VFDOH 7KLV EDVLFDOO\PHDQV
FRXOG EHG LVSOD\HG DQG WKH XOWUDVRXQG VHQVRU ZRXOG EHF
ZD\PRUH DFFXUDWH WKDQ WU\LQJ WR KDYH DFRQWLQRRXV SRLQV
ELWLQDFFXUDWH VHQVRUV

)LJXUH VKRZV D VFKHPDWLF RYHUYLHZ RI WKH GLVSOD\WDQN
LQVWDOOHGRIWKH OLGRIWKHWDQN 7KH VHQVRU LV FRQQHFHWHG
WR WKH ZDWHU VXUIDFH

)LJXUH 6FKHPDWLF RYHUYLHZ RI WKH GLVSOD\ WD

&KDQJLQJ WKH ZDWHU OHYHO

7KH ZDWHU OHYHO ZLOO EH FKDQJHG E\ PHDQV RI D SXPS 7KH Y S
EHHQ FKR VHQ 7KH PDLQ DGYDQWDJHV RI WKLV SXPS DUH WKDW LW
LQJ GLUHFWRQ FDQ EH FKDQJHG E\ LQYHUWLQJ WKH FXUUHQW GL
PDLQ GLVDGYDQWDJH LV WKDW WKH SXPSLQJ LWVHOI LV YHU\ VOR
WKH GRFXPHQDWLRQ 7KLV ZDV QRW GHHPHG WR EH D ELJ SUR
HLWKHU XSGDWH SHULRGLFDOO\ ZKHQ QR RQH LV SUHVHQW RU W
EHWWHU SXPSV LI D ILQDO YHUVLRQ ZHUH WR EH EXLOW

)RU PRQLWRULQJ WKH ZDWHU OHYHO WKH XOWUDVRXQG VHQVRU
WKDW WKH VHQVRU ZRXOG EH FDOLEUDWHG IRU HDFK SRLQW OHYI
PRYLQJ DYHUDJH RI PHDVXUHPHQWV IDOOV ZLWKLQ D FHUWDLQ UD
SRLQW OHYHO 7KLV ZRUNHG SUHWW\ ZHOODIWHU WHVWLQJ ZLWK
VWLOO EH ILQH WXQH G WR EH PRUH DFFXUDWH

+RZHYHU ZKHQ ORRNQJ DW IXWXUH SURRILQJ WKH V\ VWHP WKH
IRU DOO WDNV IRU DOO KR XVH 7KLV LV YHU\ WLPH FRQVXPLQJ
WKHUH ZRXOG EH QR WHOOLQJ ZKHQ HDFK VHQVRU ZRXOG KDYH W
FDOLEUDWLRQ IXQFWLRQ ZRXOG WKXV EH D QLFH DGGLWLRQ WR W
UHOLDQW RYHU D ORQJHU SHULRG RI WLPH

7R FDOLEUDWH WKH VHQVRU DXWRPDWLFDOO\ WKH DPRXQW RI ZD
PXVW FRUUVSRQG H[DFWO\ WR RQH SRLQW OHYHO :H FRQVLGHU
ZKLFK ZLOO EH VKRUWO\ GLVFXVHG EH ORZ)RU PRVW RI WKHVH F
ZLOO EH XVHG 7KH EDVLF LGHD EHKLQG WKLV LV D VPDOO WDN
PDLQ WDN 7KLV WDN ZLOO EH XVHG WR PHDVXUH H[DFWO\ RQH
WDN KDV WR EH ILOOHG WKH FDOLEUDWLRQ WDN ZLOO EH ILOOH
LWV FRQWHQWV ZLOO EH WUDQVIHUHG WR WKH GLVSOD\ WDN ,
WKH FDOLEUDWLRQ WDN ZKLFK ZLOO WKHQ EH HPSWLHG LQWR W

&DOLEUDWLRQ VHQVRU FDQGLGDWHV

)ORZ VHQVRU

7KH ILUVW RSWLRQ ZRXOG EH WR XVH D IORZ VHQVRU ZKLFK FDQ F
DGGHG WR WKH GLVSOD\WDQN 7KH PDLQ SUREOHP ZKHQ XVLQJ WH
WR EH YHU\ DFFXUDWH VR WKLV LV QRW D SUHIHUHQWLDO RSWLRQ

,QIUDUHG SUR[LPLW\ VHQVRU

7KH EDVLF LGHD EHKLQG WKLV VHQVRU LV WKDW LQIUDUHG SUR[LPL
HQW KHLJKWV RI WKH FDOLEUDWLRQ WDQN 7KH DPRXQW RI ZDWHU
H[DFWO\ WR RQH SRLQW OHYHO \$ IORDWLQJ REMHFW ZLOO EH SOD
ZLOO EH QRWLFHG E\ D VHQVRU ZKHQ LW SDVVHV LW 7KH EDVLF LG
VHQVRU QRWLFHV LW DQG GUDLQ XQWLO WKH ORZHU VHQVRU QRW
SRLQW OHYHO ZLOO EH SXPSHG LQWR RU GUDLQH IURP WKH GLVS

1RQ FRQWDFW OLTXLG OHYHO VHQVRU

7KH LGHD KHUH LV WKH VDPH DV WKH LQIUDUHG SUR[LPLW\ VHQVR
RI D IORDWLQJ REMHFW 2QFH DJDLQ WZR VHQVRUV DUH SODFHG
WKH FDOLEUDWLRQ WDQN %\ PHDVXULQJ WKH FDSDFLWDQFH WK
WKH WDQN UHDFKHV LW OHYHO)URP KHUH WKH SURFHGXUH LV W
VHQVRUV

)LQDO FDOLEUDWLRQ DQG FKDQJLQJ ZDWHU OHYHO FKRLFH

\$V GLVFXVVHG HDUOLHU WKH IORZ VHQVRU ZRXOG RQO\ EH XVH
XQIHDLVLEOH 7KH QRQ FRQWDFW OLTXLG OHYHO VHQVRU ZDV WKH
HXURVDSLHFH 7KH LQIUDUHG SUR[LPLW\ VHQVRU RQO\ FRVW D
D ZD\ FKHD SHU RSWLRQ WKDW VKRXOG KDYH D VLPLODU SHUIRUPD

)LJXUH 6FKHPDWLF RYHUYLHZ RI WKH FDOLEUDWLRQ

)LJXUH VKRZV D VFKHPDWLF RYHUYLHZ RI WKH FDOLEUDWLRQ WD
LQVWDOOHG DW GLIIHUHQW KHLJKWV VXFK WKDW WKDW WKH\ FRQV

)LJXUH 2YHUYLHZ RI WKH GLIIHUHQW PDLQ SDUWV RI WK

FRQWDLQV D IORDW ZKLFK WKH ,5 VHQVRUV FDQ GHWHFW ,I LW UH
ZLOO NQRZ WKH FDOLEUDWLRQ WDQN LV HPSW\ ,I LW UHDFKHV WK
WKH WDQN QRZ FRQWDLQV H[DFWO\ RQH SRLQW OHYHO\ V ZRUWK R
WKH ZDWHU UHVHUYRLU IRU ILOOLQJ WKH GLVSOD\ WDQN RU IURP

*OREDO KDUGZDUH RYHUYLHZ

1RZ DOO WKH LQGLYLGXDO SDUWV RI WKH KDUGZDUH V\VWHP DUH
WKHVH SLHFHV FRPH WRJHWKHU ,Q WKLV SDUW WKH FRPSOHWH S
WKH ZDWHU OHYHO ZLOO EH H[SODLQH

)LJXUH JLYHV DJHQHUDO RYHUYLHZ RI WKH FRPSRQHQWV RI WKH
LQGLFDWH WKDW D SDUW LV FRQWUROOHG E\ WKH 5DVSEHUU\ SL
LQGLFDWH WKH ZDWHU IORZ \$TXLFN RYHUYLHZ RI WKH V\VWHP SD

‡:DWHU UHVHUYRLU &RQWDLQV ZDWHU UHVHUYHV

‡3XPS 3XPSV ZDWHU EHWZHHQ WKH UHVHUYRLU DQG WKH FDO

‡&DOLEUDWLRQ WDQN 8VHG WR PHDVXUH RQH SRLQW OHYHO RI

‡3XPS 3XPSV ZDWHU EHWZHHQ WKH FDOLEUDWLRQ WDQN DQG

‡'LVSOD\ WDQN 8VHG WR GLVSOD\ WKH VFRUH

7KH SURFHGXUH IRU ILOOLQJ WKH GLVSOD\ WDQN LV DV IROORZV

3XPS ZDWHU IURP WKH ZDWHU UHVHUYRLU WR WKH FDOLEUDWL

3XPS ZDWHU IURP WKH FDOLEUDWLRQ WDQN LQWR WKH GLVSOD

5HSHDW WKLV XQWLO WKH GHVLUHG DPRXQW RI SRLQW OHYHO

7KH SURFHGXUH IRU GUDLQLQJ WKH GLVSOD\ WDQN LV WKH VDPH V
ILUVW IURP GLVSOD\ WDQN WR FDOLEUDWLRQ WDQN WKDQ IURP W
\$IWHU WKH WDQN KDV EHHQ ILOOHG WR WKH GHVLUHG DPRXQW WK
SURFHGXUH LV DV IROORZV

7KH XOWUDVRXQG ZLOO WDNH PHDVXUHPHQWV 7KH DYHUDJ
WKH UHIHUUHQFH YDOXH

(YHU\ VHFRQGV PHDVXUHPHQWV ZLOO EH WDNHQ ,IWKH DY
IDOO ZLWKLQ PP RI WKH UHIHUUHQFH YDOXH QRWKLQJ KDSSH
LQWHUYDO WKH V\ VWHP ZLOO EH UHVHW

7KH UHVHW SURFHGXUH WULJJHUV ZKHQ WKH ZDWHU OHYHO FKDQ
GLVSOD\ WDNH ZLOO EH GUDLQHG LQWR WKH FDOLEUDWLRQ WDNH
ZLOO QRW FRQWDLQ HQRXJK ZDWHU WR FRPSOHWHO\ ILOO WKH FD
ZLOO RFFXU EHFDXVH WKH FDOLEUDWLRQ WDNH KDV QRW EHHQ II
GLVSOD\ WDNH LV FRPSOHWHO\ HPSW\)LQDOO\ WKH V\ VWHP ZL
ZDWHU UHDFKHV WKH FRUHFHWH OHYHO

62)7:\$5(,03/(0(17\$7,21

6RIWZDUH LPSOHPHQWDWLRQ

+HUH ZH ZLOO FRYHU WKH GLIIHUHQW SDUWV RI WKH VRIWZDUH DQ
WR JHW WKH SURGXFW WKDW LV GHVFULEHG LQ WKH &RQFHSW FKD

30XJLQ

)URQW HQG
\$V PHQWLRQH G LQ RXU GHVLJQ FKRLFHV WKH IURQW HQG LV FUH
+DQGOHEDUV 7KHUH DUH IRXU ILOHV WKH IURQW HQG LV FUH
YLHZV OD\RXWV PDLQ KDQGOHEDUV DUUWHU RQH ZRQW EH GLVFXVH
D VLP SOH FVV ILOH WKDW GRHV WKH VW\OLQJ RI WKH DSSOLFDWLRQ

YLHZV OD\RXW PDLQ KDQGOHEDUV
LV WKH ZUDSSHU DURXQG HYHU\WKLQJ LQ WKH DSSOLFDWLRQ ,W
EH DGGHG IRU WKH SDJH WR UHQGHU FRUHFVW\ W\XHZV\DWKH K
RXW PDLQ KDQGOHEDUV DLQV WKH QDYLJDWLRQ EDU DW WKH WRS
DQG WKH SRSRYHU WKDW GLVSOD\V ZKHQ D WHDFKHU ZDQWV WR
WKH QDYEDU DQG WKH PRGDO DUH QDWLYH %RRWVWUDS FRPSRQH
DUH DOVR DGGHG WR WKH DSSOLFDWLRQ LQKQDQGOHEDUV

YLHZV KRPH KDQGOHEDUV
LV G\QDPLFDOO\ UHQGHULQJ +70/ FRGH ,W JHWV LQKQDQGOHEDUV
UHQGHUV WKH FRUHFVSRQGLQJ +70/ FRGH WR GLVSOD\ DOO HOHP
PXWDWLRQV DUUD\

%DFN HQG
LQGH\WKH EDFN HQG ILOH IRU WKH SOXJLQ ,W UHVSRRQV WR W
ZKHQ WKH XVHU RSHQV WKH SOXJLQ DQG LW UHTXHVWV GDWD IURP
2QFH WKH GDWD LV FROOHFWHG YWKZV KRPH EDFN HQG EDU WRGLV
SOD\HG

\$XWKHQWLFDWLRQ DQG \$XWKRULJDWLRQ
'XULQJ WKH /7, IORZ GDWD LV EHLQJ VHQQ EDFN DQG IRUWK EHWZH
DSSOLFDWLRQ \$IWHU WKLW WKH XVHU LV DXWKHQWLFDWHG :H W
LQ ZKLFK WKH SOXJLQ LV RSHQHG :H WKHQ PDNH XVH RI WKH UROH
ZKR DUH WHDFKHUV FDQ PXWDWH VFRUHV DQG QRUPDO VWXGHQW
PDNH VXUH WKDW RQO\ WHDFKHUV FDQ PXWDWH VFRUHV E\ RQO\ U
WR PXWDWH VFRUHV 7KLV QHGHU RQO\ FDQ WLRQ GHU WKH ULJKW F
XVHU LV D WHDFKHU LW VHQQV WKH FRGH WR PXWDWH VFRUHV WR
WKHQ LW GRHVQ\W UHQGHU WKLW FRGH %\GRLQJ WKLW DFOHYHU
FRGH DQG XVH KLGGHQ HOHPHQWV WR VWLOO PXWDWH VFRUHV

7\SH \$GGUHV 3DUDPHWHUV 5HWXUQ 'HVFULSWL
3RVW DSL Y VFRUHV KRXVHBQDPH VXFHV VWDWXV PHVVDJH
VFRUHBWRBEHBDGGHG WR WKH KRXVH
LVVXHU
UHDVRQ

*HW DSL Y VFRUHV DUUD\RIKRXVH REMHFWV JHWV
DERXW WKH KRXVHV

*HW DSL Y VFRUHV PXWDWLRQV DUUD\RI PXWDWLRQV REMHFW

7DEOH \$3, FDOOV DQG WKHLU UHWXUQ YDOXH

5(67 \$3,
7KH \$SSOLFDWLRQ 3URJUDPPLQJ, QWHUIDFH \$3, LV WKH OLQNEH
7DEOH OLVWV DOO \$3, UHTXHVWV WKDW FDQ EH XVHG WR JHWK
UHVSRQVHV RI *(7 DSL Y VFRUHV DQG *(7 DSL Y VFRUHV PXWDW
WDWLRQ REMHFWV UHVSHFWLYHO\ 7KHVH REMHFWV DQG WKHLU S
UHVSHFWLYHO\

\$W WKH PRPHQW WKDW D XVHU RSHQV WKH SOXJLQ WKH *(7 UHTX
PXWDWLRQV LV GRQH VR WKH VFRUHV FDQ EH VKRZQ :KHQ D WHD
3267 UHTXHVW ZLOO EH XVHG WR LQFUHDVH RU GHFUHDVH WKH VF
7KH 5DVSEHUU\ 3L DOVR PDNHV XVH IURP WKH 5(67 \$3, WR JHW WKH

3URSHUW\ 7\SH 'HVFULSWLRQ
BLG VWULQJ ,GHQWLILHU JLYHQ WR WKLW PXWDWLRQ
PXWDWLRQ LQWHJHU \$PRXQW RI SRLQWV WKH VFRUH LV LQFU
KRXVH1DPH VWULQJ 1DPH RI WKH KRXVH
UHDVRQ VWULQJ 5HDVRQ WKDW WKH LVVXHU JDYH IRU WKL
LVVXHU VWULQJ 7HDFKHU RU KRXVHNHSHU WKDW GLG WK
VFRUH%HIRUH LQWHJHU 6FRUH EHIRUH WKLW PXWDWLRQ
VFRUH\$IWHU LQWHJHU 6FRUH DIWHU WKLW PXWDWLRQ
FUHDWHG\$W VWULQJ 'DWH DW ZKLFK WKLW PXWDWLRQ LV FU
XSGDWHG\$W VWULQJ 'DWH DW ZKLFK WKLW PXWDWLRQ ZDV XS

7DEOH 0XWDWLRQ REMHFW DQG LWV SURSHUWL

3URSHUW\ 7\SH 'HVFULSWLRQ
BLG VWULQJ ,GHQWLILHU JLYHQ WR WKLW PXWDWLRQ
KRXVH1DPH VWULQJ 1DPH RI WKH KRXVH
VFRUH LQWHJHU DPRXQW RI SRLQWV DW WKLW PRPHQW
FRORU VWULQJ FRORU DVVRFLDWHG ZLWK WKH KRXVH
FUHDWHG\$W VWULQJ 'DWH DW ZKLFK WKLW PXWDWLRQ LV FU
XSGDWHG\$W VWULQJ 'DWH DW ZKLFK WKLW PXWDWLRQ ZDV XS

7DEOH 6FRUH REMHFW DQG LWV SURSHUWLHV

+ \$5' : \$5 (, 03 / (0 (17 \$ 7 , 21

\$V IRU WKH KDUGZDUH LPSOHPHQWDWLRQ WKH XVHG VRIWZDUH D
WKH PDWHULDOV XVHG IRU WKH DHVWKHWLF RI WKH V\ VWHP ZLOO

6RIWZDUH DQG OLEUDULHV

8VHG VRIWZDUH

7KH 5DVSEHUU\ 3L UXQV WKH ODWHVW YHUVLRQ RI 5DVSEHUU\ 3L 2
V\ VWHP LV UXQ E\ D VLQJOH SURJUDP ZULWWHQ LQ S\ WKRQ 7KH 5
WKH *3,2 SLQV 7KLV DOORZV IRU WKH XVH RI WKH VHQRUV DQG D

&RGH

7KH FRGH LV XVHG WR FRQWURO WKH SXPSV DQG UHDG WKH VHQRV
FROV GHVFULEHG LQ WKH GHVLJQ VHFWRQ

7KH VFRUH UHSUHVHQWDWLRQ WKDW LV LPSOHPHQWHG LV WKH UH
WRWDO DPRXQW RI SRLQWV RI DOO KR XVH)RU H[DPSOH LI WKH E
WKHLU WDQN ZLOO EH ILOOHG IRU SRLQW OHYHOV

+DUGZDUH FRPSRQHQWV DQG VHW XS

,Q WKLV FKDSWHU WKH PRVW LPSRUWDQW SDUWV RI WKH KDUGZD
WKH SXPSV WKH GLVSOD\ WDQN DQG WKH FDOLEUDWLRQ WDQN \$
WKH LPSRUWDQW KDUGZDUH FRPSRQHQWV WKDW DUH XVHG DV ZH
ZLUHV DUH FRQQHFWHG

7KH SXPSV

7KH V\ VWHP FRQWDLQV WZR SXPSV RQH IRU SXPSLQJ ZDWHU EHW
FDOLEUDWLRQ WDQN DQG RQH IRU SXPSLQJ ZDWHU EHWZHHQ WKH
7KH SXPSV DUH QRW GLUHFWO\ FRQQHFWHG WR WKH 5DVSEHUU\ S
OV G PRWRU GULYHU 7KH PRWRU GULYHU FDQ EH XVHG WR WXU
DOVR EH XVHG WR GHWHUPLQH WKH PRWRU GLUHFWLRQ RI D SXPS
)LJXUH VKRZV DVFKHPDWLF RYHUYLHZ RI WKH SXPSLQJ V\ VWHP
HUHG E\ WKH 5DVSEHUU\ 3L ,I WKH 5DVSEHUU\ 3L VHGGV D VLJQD
EH SRZHUHG E\ WKH Y EDWWHU\ SDFN WKDW LV DOVR FRQQHFWHG

)LJXUH 2YHUYLHZ RI WKH SXPSLQJ V\ VWHP

'LVSOD\WDQN

)LJXUH 3KRWR RI WKH GLVSOD\WDQN

\$ YDVH LV WKH ZDWHU FRQWDLQHU RI WKH GLVSOD\WDQN ,W LV
FP RI WKH WDQN LV XVHG WR GLVSOD\WKH VFRUH ZKLFK PHDQV

RI PP

\$ KROH LQ WKH OLG RI WKH YDVH ZDV FUHDWHG VXFK WKDW WKH V
VRXQG VHQVRU ILW WKURXJK LW EXW WKDW WKH EDFN RI WKH VHC
UHVWV RQ WKH OLG 7KH XOWUDVRXQG VHQVRU LV GLUHFWO\ FRQ
DQG VKRZ WKH WRS DQG ERWWRP RI WKH OLG UHVSHFWLYHO\ Z
LW

)LJXUH 3KRWR RI WKH WRS RI WKH OLG RI WKH GLVSOD\ WDO

)LJXUH 3KRWR RI WKH ERWWRP RI WKH OLG RI WKH GLVSOD\ W

&DOLEUDWLRQ WDQN

7KH SDUW RI WKH GLVSOD\ WDQN WKDW LV UHVHUYHG WR EH ILOOH
PHDQV WKDW RQH SRLQW OHYHO KDV D YROXPH RI OLWHU RU
FDOLEUDWLRQ WDQN VKRXOG EHDW OHDVW P/ EXW SUHIHUEO\
HQFDVLQJ RID VDOW PLOO ZDV FKR VHQ
7KHQ LW ZDV FDOFXODWHG KRZ IDU WKH VHQVRUV VKRXOG EH DSI
EHWZHHQ WKHP)LQDOO\ WKH VHQVRUV ZKHUH PRXQWHG LQ D SLI
GLVWDQFH EHWZHHQ WKHP 7KH IORDW RI WKH GLVSOD\ WDQN LV D

)LJXUH 3KRWR RI FDOLEUDWLRQ WDQN ZLWK WKH WZR ,5

7KH ,5 SUR[LPLW\ VHQVRUV DUH DOVR GLUHFWO\ FRQQHFWHG WR D
IURP WKH ZLUHV IRU SRZHU DQG JURXQG WKH\ HDFK KDYH RQH ZLU
SUR[LPLW\ RI WKH VHQVRU , IRQH RI WKH VHQVRUV VHQVHV VRPH
UHSRUWV YDOXH RI]HUR RWKHUZLVH

\$HVWKHWLHV

2QH RI WKH UHTXLUHPHQWV ZDV WKDW WKH ZDWHU VKRXOG EH FRO
LQJ VRPH /(' OLJKWV EHQHDWK WKH GLVSOD\ WDQN 7KHVH OLJKWV
3L ,QVWHDG WKH\ DUH FRQWUROOHG E\ DQ H[WHUQDO UHPRWH

)LQDOO\ WR JLYH WKH GLVSOD\ WDQN D ILQLVKHG ORRN D ZRRGH

7(67,1*

30XJLQ 7HVW

7KXVH WHVWV DUH WDVNV WKDW YHULI\ D FRUUHFW ZRUNLQJ RI W

7DVN\$FFHVV WKH SOXJLQ ZLWK D VWXGHQW UROH
(IIHF WKH SOXJLQ RSHQV DQG WKH ¶DGG PXWDWLRQ¶ EXWWRQ C

7DVN\$FFHVV WKH SOXJLQ ZLWK D WHDFKHU UROH
(IIHF WKH SOXJLQ RSHQV DQG WKH ¶DGG PXWDWLRQ¶ EXWWRQ V

7DVN\$V D WHDFKHU DGG D SRVLWLYH QXPEHU [WR D KRXXVH WK
(IIHF

‡7KLV KRXXVH QRZ KDV \ [SRLQWV

‡\$ QHZ PXWDWLRQ VKRZV XS LQ WKH ORJERRN ZLWK [SRLQWV
DQG WKH FXUUHQW GDWH

7DVN\$V D WHDFKHU DGG D QHJDWLYH QXPEHU [WR D KRXXVH WK
(IIHF

‡7KLV KRXXVH QRZ KDV \ [SRLQWV

‡\$ QHZ PXWDWLRQ VKRZV XS LQ WKH ORJERRN ZLWK [SRLQWV
DQG WKH FXUUHQW GDWH 7KH FRORU RI WKLV URZ LV UHG

7DVN\$V D WHDFKHU DGG D QHJDWLYH QXPEHU [WR D KRXXVH WK
WKDW<[\
(IIHF WKH WHDFKHU LV QRW DEOH WR GR WKLV DQG JHWV DQ HUU

\$3, 7HVW

7KXVH WHVWV DUH WDVNV WKDW YHULI\ WKH FRUUHFW ZRUNLQJ R

7DVN&DOO *HW DSL Y VFRUHV
(IIHF HW DQ DUUD\ RI KRXXVH REMHFWV DV UHVSQRVH

7DVN&DOO *HW DSL Y VFRUHV PXWDWLRQV
(IIHF HW DQ DUUD\ RI KRXXVH REMHFWV DV UHVSQRVH

7DVN&DOO 3RVW DSL Y VFRUHV SRVLWLYH QXPEHU [WR D KRXXVH WK
ZKLFK LV D SRVLWLYH QXPEHU
(IIHF WKH VFRUH RI WKH FKRVDHQ KRXXVH JHWV LQFUHDVHG E\ WK

7DVN&DOO 3RVW DSL Y VFRUHV SRVLWLYH QXPEHU [WR D KRXXVH WK
ZKLFK LV D QHJDWLYH QXPEHU DQG FDQ SRVVLEOH PDNH WKH V
(IIHF WKH VFRUH JHWV GHFUHDVHG E\ WKDW QXPEHU SRVVLEO

7DVM&DOO3RVW DSL Y VFRUH ZLWK YDOLG SDUDPHWHUV EXW
ZKLFK LV QRW D QXPEHU EXW D VWULQJ RI WH[W
(IIHFV\$ Q HUURU LV VHQG EDFN OHWWLQJ \RX NQRZQ WKDW WKH

7DVM&DOO3RVW DSL Y VFRUH ZLWK YDOLG SDUDPHWHUV EXW
ZKLFK LV DQ\ QXPEHU SRVVLEO\ QHJDWLYH
(IIHFV\$ QHZ KRXXVH JHWV FUHDWHG ZLWK WKH FKR VHQ KRXXVH
SRVVLEO\ QHJDWLYH 7KH QHZ KRXXVH ZLOO DOVR EH VKRZQ LQ

7DVM&DOO3RVW DSL Y VFRUH ZLWK YDOLG SDUDPHWHUV EXW
(IIHFV\$ WKH \$3, UHVS RQGV ZLWK \VXFFHVV \ DQG DGGV WKH VFR
ORJERRN LV XQGHILQHG

7DVM&DOO3RVW DSL Y VFRUH ZLWK YDOLG SDUDPHWHUV EXW
(IIHFV\$ WKH \$3, UHVS RQGV ZLWK DQ HUURU EXW DGGV WKH VFRUH
WKH ORJERRN

7KH HIIHFV RI VRPH RI WKH \$3, UHTXHVW WR JHWKHU ZLWK GLIIH
DQG FDXVH SUREOHPV 7R RYHUFRPH WKLW ZH FRQVLGHU WKH SUP
)XWXUH :RUN FKDSWHU

+DUGZDUH WHVWV

:KHQ WKH KDUGZDUH FRPSRQH QW ZDV ILQLVKHG PXOWLSOH WHV
IDFHVV RI WKH IXQFWLRQDOLW\ RI WKH V\ VWHP , Q WKH ILUVW WK
SXW LQWR WKH V\ VWHP E\ KDQG)RU WKH ILQDO WHVW WKH SRLQW

\$FFXUDF\

)RU WKLW WHVW RQH SRLQW OHYHO ZDV DGGHG DW D WLPH \$IWH
WKH ZDWHU OHYHO UH DG IURP WKH PHDVXULQJ WDSH DQG WKH KH
QRWHG GRZQ 7KH GLIIHUHQFH EHWZHHQ WKHP LV KRZ PFXK WKH S
LQWHQGHG OHYHO

)LJXUH VKRZV WKH UHVXOWV RI WKH WHVW 7KH FROXPQ SHUFH
OHYHOV WKH WDQN ZDV ILOOHG WKH FROXPQ FP VKRZV KRZ KLJK
FROXPQ GLII VKRZV WKH GLIIHUHQFH EHWZHHQ WKH DFWXDO ZDV

)URP WKH UHVXOWV LW IROORZV WKDW WKH GHYLDWLRQ ZDV PP
GLIIHUHQFH LQFUHDVHG WR PP DW WKH WK SRLQW OHYHO

ODLQWDLQLQJ ZDWHU OHYHO

, I WKH V\ VWHP ZHUH WR EH DFWXDOO\ GHSOR\HG WKH ZDWHU OHY
ORQJHU SHULRG RI WLPH 7KLV WHVW VHUYHG WR VHH WKDW LI WKH
DOVR UHSRUWV QR FKDQJHV , W EDVLFDOO\ HYDOXDWHV WKH VW
VHQVRU 7KLV KDV EHHQ WHVWHG IRUDORZ FP PHGLXP FP D
LQ WKH GLVSOD\ WDQN , GHDOO\ WKH WHVW VKRXOG VHH LI WKH V
RIGD\ V 'XH WR WLPH FRQVWUDLQWV HDFK ZDWHU OHYHO ZDV WH

\$OO WHVWV UHSRUWHG JHUR WLPHV WKDW WKH ZDWHU OHYHO ZDV
VHQVRU ZDV LQGHG YHU\ VWDEOH

)LJXUH 5HVXOWV RI WKH DFFXUDF\ WHVW

5HVHW IXQFWLRQ

:KLOH WKH SUHYLRXV WHVW WULHG WR VHH LI WKH V\VWHP UHSRU
WKLW WHVW HYDOXDWHV LI WKH V\VWHP QRWLFHV D FKDQJH LQ ZD
OHYHO DJDLQ 7KLV KDV EHHQ WHVWHG E\ OLIWLQJ WKH OLG ZLWK
PP

7KH WDQN ZDV ILOOHG DW WKH VWDUW RI WKH WHVW ZLWK ILYH S
XOWUDVRXQG VHQRU WKH GLVSOD\ WDQN ZDV GUDLQHG DQG IL
ZDV H[DFWO\ WKH LQWHQG HG EHKDYLRXU ZKLFK PHDQV WKH UHV

)XOO V\VWHP WHVW

7KLV WHVW VHUYHG WR WHVW WKH FRQQHFWLRQ ZLWK WKH \$3, ED
GLYLGHG LQ VXFK D ZD\ WKDW WKH EOXH KRXXH KDG WHQ SHUFHQW
WKLW VFRUH ZDV FRUHFWO\ GLVSOD\HG LQ WKH GLVSOD\ WDQN V
FKDQJHG WR VHYHQ SHUFHQW VHYHQ SRLQW OHYHOV

7KH WHVW VWDUWHG ZLWK WKH ZDWHU OHYHO DW SRLQWV OHYH
ZDWHU OHYHO ZDV UDLVHG WR WHQ SRLQW OHYHOV \$IWHU WKH V
ORZHUHG WR VHYHQ SRLQW OHYHOV \$OO RI WKLW FRUHVSRQGHG
WKH SURFHVVLQJ RI WKH SRLQWV UHSRUWHG E\ WKH \$3, IXQFWLRQ

6 < 6 7 (0 (9 \$ / 8 \$ 7 , 2 1

6RIWZDUH

7HVW DQDO\VLV

7KH WHVWV ZHUH GHVLJQHG WR VHH LI ZH KDYH LPSOHPHQWHG DCO
LV WKH FDVH +RZHYHU IRU WKH \$3, WKHUH DUH VRPH XQZDQWHC
EHIRUH WKH V\ VWHP JHWV GHSOR\HG 5HFRPPHQGDWLRQV WR VR
LQ FKDSWHU DERXW IXWXUH ZRUN

5HTXLUHPHQWV DQDO\VLV

:HKDYH XVHG WKH UHTXLUHPHQWV DV VHW RXW LQ FKDSWHU WR G
PHQWV KDYH EHHQ DGGUHVHVG LQ WKH VRIWZDUH 7KLV LV WHVW

+DUGZDUH

7HVW DQDO\VLV

\$OO WKH WHVWV IXQFWLRQHG DFFRUGLQJ WR WKHLU LQWHQG HG
ZDWHU OHYHO ZDV RII E\ PP LQ WKH ZRUVW FDVH :KLOH WKLV LV
QR GHYLDWLRQ IURP ZKDW LW VKRXOG EH LW IHOO ZLWKLQ WKH U
WKH PPOHYHO)XUWKHUPRUH WKLV FRXOG OLNHO\ EH LPSURYH
FDOLEUDWLRQ WDQN

5HTXLUHPHQWV DQDO\VLV

\$OO WKH PXVW DQG VKRXOG UHTXLUHPHQWV KDYH EHHQ LPSOHPH
KDYH QRW EHHQ LPSOHPHQWHG DUH WKDW WKH V\ VWHP VKRXOG EH
ZDUH EHKLQG WKH GLVSOD\WDQN VKRXOG EH KLGGHQ IURP VLJKW
D FHUWDLQ DPRXQW RI WLP

7KH ILUVW WZR SRLQWV ZLOO EH DGGUHVHVG LQ WKH IXWXUH ZRUN
IXOILOOHG EHFDXVH WKH SXPSV ZH ERXJKW ZHUH UHODWLYHO\ FK
,W WDNHV DSSUR[LPDWHO\ PLQXWHV WR DGG RU UHPRYH RQH SF
GRHV QRW QHFHVVDULO\ KDYH WR EH D SUREOHP ,I WKH V\ VWHP Z
VD\ RQFH D GD\ DW WKH SXPSLQJ VSHHG LV QRW D SUREOHP
EH XSGDWHG LQ UHDO WLP WKH FXUUHQW SXPSV ZRXOG KDYH WF
PRUH WKURXJKSXW

)LQDOO\ WKH ZLOO QRW UHTXLUHPHQWV ZHUH LQGHHG QRW LPS
IXWXUH ZRUN VHFWRQ

) 8785 (: 25 .

2YHU WKH FRXUVH RI WKL V SURMHFW ZH KDYH LPSOHPHQWHG DV P
JLYHQ WKDW RXU SURGXFW LV DRQO\ D SURRIRIFRQFHSW WKHUH
WR FUHDWH 7KH IROORZLQJ LV D OLVW RI IHDWXUHV WKDW ZLOO F
WR ORRN DW RU DUH YLWDO WR EH LPSOHPHQWHG ZKHQ WKH V\VWH

&UHDWH PRUH UROHV

\$W WKH WLPH WKHUH DUH RQO\ WZR UROHV WKDW D XVHU FDQ EH LG
LV SRVVLEOH WR DGMXVW WKHVH JURXS E\ FUHDWLQJ D FXVWRP F
WHDFKHUV +RZHYHU WKL V LV QRW DQ RSWLPDO VROXWLRQ 7KHU

+RXVHNHSHUV

(YHU\KRXVHKDV RQH KRXVHNHSHU DV DOUHDG\ LPSOHPHQWHG I
, W ZRXOG EH QLFH LI WKHVH KRXVHNHSHU FDQ DOVR KDQG RXW S

\$GPLQ

7KH FRPSOHWH V\VWHP VKRXOG EH DEOH WR EH RYHUORRNHG E\ D
DGGLWLRQDO RSWLRQV VXFK DV FUHDWLQJ HYHQWV XSGDWLQJ F
DKRXVH 7KH DGPLQ VKRXOG DOVR EH DEOH WR FKDQJH WKH ZD\ LQ
RU FKDQJH WKH PD[LPDO DPRXQW RI SRLQWV 6HWWLQJ WKH JURX
DOVR VRPHWKLQJ WKDW WKH DGPLQ KDV WR EH DEOH WR GR

, I WKHVH UROHV DUH LPSOHPHQWHG WKH DSSOLFDWLRQ EFRPI
FKDQJH DOO VHWWLQJV DQG PDQDJH WKH JURXS RI WHDFKHUV DG
DSSOLFDWLRQ ZLWKRXW ZRUNDURXQGV

:KLOH WKHUH LV QR VWDQGDUG FDQYDV UROH IRU DGPLQ RU KRXV
EH FUHDWHG RXUVHOYHV :H VKRXOG DOVR EH NHHSLQJ WUDFN R
WKDW DIWHU WKH XVHU KDV DXWKHQWLFDFWHV LWVHOI ZH VKRXO
DSSOLFDWLRQ 7KLV FDQ EH GRQHE\ FKHFNLQJ WKH FDQYDV WRNH

\$3, 6HFXULW\

\$W WKH PRPHQW ZH KDYH QRW LPSOHPHQWHG DQ\ VHFUXULW\ PHDV
WKDW DQ\ RQH FRXOG PDNH \$3, FDOOV 7KLV FDXVHV QR SUREOHP
EHLQJ *(7 VFRUHV DQG *(7 PXWDWLRQV 2Q WKH RWKHU KDQG SR
VKRXOG RQO\ EH GRQHE\ DXWKRULJHG SHRSOH

5LJKW QRZ WKH 3267 VFRUHV DSS FDQ RQO\ EH GRQH IURP ZLWKLQ F
XVHU LV WHDFKHU ZLWKLQ WKH FRXUVH IURP ZKLFK WKH SOXJLQ LV
WKHQ WHDFKHU WKH FRGH WR KDQGOH WKH 3267 VFRUH UHTXHV
DOO 7KLV PHDQV WKDW WKHUH LV QR ZD\ LQ ZKLFK D FOHYHU VWXO
LQWR WKH VRXUFH FRGH +RZHYHU RQFH VRPHRQH NQRZV WKH DG
WKH 3267 UHTXHVW IRU VXFK D UHTXHVW LW FDQ VWLOO EH GRQH Z
LV FXUUHQWO\ QR DXWKRUL]DWLRQ QHHGHG WR GR WKL

7KH VROXWLRQ WR IL[WKLW ZRXOG EH WR UHTXLUH D IRUP RI DX
VHUYHU VKRXOG WKHQ ORRN LI WKH SHUVRQ LV LQGHG D WHDFKH
RWKHUZZLVH WKH VHUYHU FDQ UHVSQRVH ZLWK VWDWXV FRGH

\$3, 5HTXHVW +DQGOLQJ

\$V FDQ EH VHHQ LQ WKH FKDSWHU 7HVWLQJ WKHUH DUH VRPH XQZ
SHUIRUPHG 7R SUHYHQW WKLW WKH \$3, VHUYHU VKRXOG KDQGO
7KUHH SUREOHPV WKDW DUH WDNHQ IURP WKH 7HVWLQJ FKDSWHU
VROXWLRQ LV JLYHQ 7KH QXPEHUV FRUUHVSRQG ZLWK WKH WHVW

3UREOHPH VFRUH RI D KRXXVH FDQEH VHW ORZHU WKHQ
6ROXWLRQ FDQ FDOFXODWLRQ VKRXOG ILUVW EH PDGH DQG LI WKH V
JR XQGHU WKH VHUYHU VKRXOG UHVSQRG ZLWK DQ HUURU V
7KH VFRUH RI WKDW KRXXVH VKRXOG WKHQ EH OHIW XQFKDQJHG

3UREOHPH Z KRXXVH FDQ DFFLGHQWDOO\ EH FURHHW DGH ZKHU LK
QRW VHW FRUUHFWO\
6ROXWLRQ VHUYHU VKRXOG FKHFNDKDPKHVHU PDWFKHV ZLWK D
KRXXVH DQG RWKHUZZLVH UHVSQRG ZLWK DQ HUURU VWDWXV FRO
HQU\ SRLQW VKRXOG EH FUHDWHG ZKLFK VROH SXUSRVH LV W

3UREOHPH XWDWLRQ FDQ EH GRQH ZLWKRXW VSHFLI\LQJ D UH
6ROXWLRQ \$3, VHUYHU VKRXOG FKHFNDKDPKHVHU LQ SXW DQG WKURZ
VSHFLILHG

3UREOHPH XWDWLRQ FDQ EH GRQH ZLWKRXW VSHFLI\LQJ DQ LVV
6ROXWLRQ \$3, VHUYHU VKRXOG FKHFNDKDPKHVHU LQ SXW DQG WKURZ
VSHFLILHG

6FDOLQJ XS WR IRXU WDNV

7KH SURWRW\SH ZH PDGH ZDV FUHDWHG IRU RQO\ RQH KRXXVH ,I W
WKHUH ZRXOG EH IRXU WDNV 7KHU DUH VHYHUDO RSWLRQV WR

7KH ILUVW RSWLRQ LV WR VLP SO\ WDNH WKH LGHDV EHKLQG WKH S
WKH HDVLHVW EXW DOVR WKH PRVW H[SHQVLYH RSWLRQ

2WKHU SUREDEO\ FKHDSHU DQG PRUH HIILFLHQW RSWLRQV ZRXO
WRW\SH IRU PXOWLSOH WDNV)RUH[DPSOH RQH FDOLEUDWLRQ
WKH DPRXQW RI ZDWHU DGGHG WR WKH WDNV LV WKH VDPH IRU F
EH WR XVH RQH 5DVSEHUU\ 3L IRU PXOWLSOH WDNV :KLOH WKH
PDNH WKH V\ VWHP DUFKLWHFWXUH PRUH FRPSOH[EHFDXVH WKH
FDOLEUDWLRQ WDN RU RQH 5DVSEHUU\ 3L ZRXOG KDYH WR EH GL

\$HVWKHWLFV

5LJKW NQRZ RQO\WKH GLVSOD\WDQN KDV D SROLVKHG GHVLJQ \$
RSHQ :HKDYH WZR SRVVLEOH GHVLJQ UHFRPPHQGDWLRQV WKDW

7KH ILUVW LV SXWWLQJ DOO WKH RWKHU KDUGZDUH LQ DER[EKHL
WR SXW WKH GLVSOD\WDQN RQ D WDEOH \$OO WKH RWKHU KDUGZ
SXW LQVLGH DER[EKHLQG WKH GLVSOD\WDQN 7KH ZDWHU UHVHU

7KH FXUUHQW ZDWHU FRQWDLQHU RI WKH GLVSOD\WDQN LV D YDV
F\OLQGHU LI WKH ILQDO V\WHP ZKHUH WR EH EXLOG VR WKDW D
WXEH WKDW FRQQHFVV WKH FDOLEUDWLRQ DQG GLVSOD\WDQNV
RI WKH GLVSOD\WDQNV WR ZKHUH WKH SRLQW OHYHOV EHJLQ

)LQDOO\ WKH /('V WKDW JLYH FRORU WR WKH ZDWHU DUH EDVLF
WUROOHG E\ D UHPRWH ,I WKH V\WHP ZHUH WR EH EXLOW WKH \\
3L

3RZHU VRXUFH IRU SXPSV

7KH SXPSV DUH SRZHUHG E\ EDWWHULHV IRU WKLW SURWRW\SH 2I
WLPH VR LW PLJKW EH EHWWHU LI WKH\ ZHUH WR EH SRZHUHG E\ D

\$GYDQFHG V\WHP VWDWH DQDO\VLV

7KH FXUUHQW YHUVLRQ RI WKH V\WHP RQO\ GHWHFWV LI WKH ZD
LV \$OHDN IRU H[DPSOH ZRXOG SURYH WR EH SUREOHPDWLF EHF
RYHU DQG RYHU DJDLQ)XUWKHUPRUH VRPHRQH FRXOG ZDON LQV
ZDWHU WR PRYH DURXQG DQG IRUFH D UHVHW ZKLOH LW PLJKW QR

7KLV DOO ZRXOG PHDQ WKDW WKH V\WHP ZRXOG EH QHILW IURP Q
PRQLWRU WKH ZDWHU OHYHO EXW DOVR XVH LW WR WU\ DQG GHW
OHYHO)RU H[DPSOH D GHFUHDVH LQ ZDWHU OHYHO LV OLNHO\FD
WR GHWHFW WKLW LW FRXOG QRWLI\WKH PDLQWDLQHU RI WKH V\

)LQDOLVLQJ WKH SRLQW V\WHP

5LJKW QRZ WKH EDUV RI WKH FDQYDV SOXJ LQ DQG WKH GLVSOD
KRXVH FRPSDUHG WR WKH RWKHU KRXVHV 2QH RI WKH VXSHUYLVR
LQ PLQG EXW ZH GLG QRW KDYH WKH WLPH WR LPSOHPHQW WKLW
ILQDOLVHG LW VKRXOG VWLOO EH LPSOHPHQWHG LQ ERWK WKH V\

352 & (66 (9\$/8\$7,21

2UJDQLVDWLRQ

*OREDO RUJDQLVDWLRQ

7KH EDVLF LGHD RI WKH RUJDQLVDWLRQ ZDV WKDW ZH IROORZHGV
GLYLGHG LQ D GHVLJQ SKDVH RI ZHHNV DQG VSULQW DOVR ZHH
SURGXFW ZDV ODLG GRZQ ZKLFK ZLOO EH GLVFXVVHG LQ WKHLU UH

:H PHW GDLO\ RU RQFH HYHU\ RWKHU GD\ GHSHQGLQJ RQ KRZ PXF
VWDUWHG ZLWK D 7UHOOR ERDUG WR WUDFN RXU SURJUHVV EXW
7R'R↑V IRU HDFK VSULQW ZKLFK ZH NHSW WUDFN RI LQ RXU GLVFRU

%HFDXVH WKH ZKROH V\ VWHP FRXOG EH GLYLGHG LQ D VRIWZDUH
DOVR VSOLW LQ WZR WR IRFXV RQ WKHVH SDUWV (JEHUW DQG -HV
ZKLOH \$ODLQ DQG %RE ZRUNHG RQ WKH KDUGZDUH FRPSRQH

\$V IRU WKH 'JOREDO' UHVSQRVLELOLWLHV \$ODLQ ZDV UHVSQRV
VDJHV WR RXU VXSHUYLVRUV DQG -HVH ZDV UHVSQRVLEOH IRU F
FUHDWLQJ GDWH SLFNHUV WR SLFN D GDWH (JEHUW ZDV UHVSQR
(JEHUW DQG \$ODLQ ZHUH UHVSQRVLEOH IRU JLYLQJ ERWK WKH SRV

6RIWZDUH RUJDQLVDWLRQ

:KHUH WKH FRPSOHWH SURGXFW ZDV GLYLGHG LQWR VRIWZDUH DO
IXUWKHU LQ WKH IURQW HQG DQG EDFN HQG 2XU LQLWLDO SODQQ
H[SHULHQFHG SURJUDPPHU (JEHUW VWDUWHG ZLWK WKH FUHDWL
ZLWK D QHZ 5HDFW SDJH \$IWHU D IHZ VSULQWV ZKHQ WKH 5HDFW
ZHUH EXV\ ZLWK LPSOHPHQWLQJ /7, WR JHW WKH SDJH LQVLGH &DQ
GLIIHUHQW DUFKLWHFWXUH 7KH 5HDFW SDJH FRXOG QRW EH VHU
QHZ YHUVLRQ RI WKH DSSOLFDWLRQ WKLW WLPH ZLWKRXW 5HDFW
EH LPSOHPHQWHG DQG WKH SOXJLQ ZDV DYDLODEOH IURP ZLWKLQ

'XULQJ WKH SURMHFW ZH PRVWO\ FRPPXQLFDWHG WKURXJK :KDWV
WDFW ZDV HDVLHU :H DOVR KDG FRQWDFW ZLWK \$UG .RVWHU ZK
SURWRFRQ :HERWK KDG D SK\VLFDOPHHWLQJ ZLWK \$UG DV ZHOO
(JEHUW WUDFN HQG FUHDWLQJ \$3, GHVLJQ /7, LPSOHPHQWDWLRQ

-HVV)URQW HQG GHVLJQ IURQW HQG FUHDWLQJ LQ 5HDFW UHSRU

3KDVH :HHN HQG GDWH *RDO
'HVLJQ SHULRG :HHN 0RFN XS VNHWFKHV IRU ZHE DSSOLFDWLRQ
,QIRUPDWLRQ FRPPXQLFDWLRQ VFKHPHV
6SULQW :HHN)LQLVKHG VHWLQJ XS ZHE VHUYHU GDWDEDVH DQG
%DVLF ZHE DSSOLFDWLRQ DEOH WR FRQQHFW WR WK
6SULQW :HHN)LQLVKHG WKH LQWHUDFWLRQ EHWZHHQ &DQYDV 1 \$3
&UHDWHG D ZHE DSSOLFDWLRQ WKDW FDQ EH WHVWH
6SULQW :HHN)LQLVKHG WKH FRPSOHWH FDQYDV SOXJ LQ

7DEOH VRIWZDUH 3ODQQLQJ

+DUGZDUH RUJDQLVDWLRQ

:RUNLQJ RQ WKH KH KDUGZDUH SDUW ZDV PDGH PRUH FRPSOH[GX
YLUXV ZKLFK EDVLFDOO\ PHDQW ZH FRXOG QRW ZRUN RQ WKH V\
WKH EHJLQQLQJ ZHERWK ZRUNHG RQ WKH DQDO\VLV RI ZDWHU OH
SRWHQWLDO VHQVRU FDQGLGDWHV \$IWHUZDUGV \$ODLQ ZDV PR
SOHV EHKLQG WKH KDUGZDUH FRPSRQHGW DQDO\VLQJ SRWHQWL
VROXWLRQV WR WKHP DQG VHWLQJ XS WKH V\WHP WHVWV %RE
ZRUNDQG ZURWH WKH FRGH IRU WKH V\WHP +H LQ WXUQ DOVR O
SUREOHPV ZHUH IHDVLEOH +H DOVR PDGH WKH V\WHP ORRN QLF
PDU\ RI WKH UHVSQRVLELOLWLHV LV WKH IROORZLQJ

\$ODLQWHUDWXUH DQDO\VLV VHQVRU WHVWLQJ V\WHP GHVLJQ
VFULSW GRFXPHQDWLRQ

%RE/LWHUDWXUH DQDO\VLV VHQVRU WHVWLQJ V\WHP LPSOHPH
LQJ WHVWV VKRRWLQJ YLGHR

3KDVH :HHN HQG GDWH *RDO
'HVLJQ SHULRG :HHN 'HVLJQ IRU WKH ZDWHU WDQN
'HFLGH RQ ZKLFK VHQVRUV WR XVH
'HFLGHG KRZ WR DGMXVW WKH ZDWHU OHYHO
6SULQW :HHN 3URRIRI FRQFHSW YHUVLRQ RI WKH V\WHP ZLWK PDQ
6SULQW :HHN 3URRIRI WKH ILQDO YHUVLRQ ZLWK FRUHFWD PD
DQG FRQQHFWHG WR WKH VRIWZDUH FRPSRQHGW
6SULQW :HHN)LQLVKHG WKH ILQDO YHUVLRQ RI WKH KDUGZDUH FRP

7DEOH +DUGZDUH SODQQLQJ

7DEOH VKRZV WKH SODQQLQJ RI WKH KDUGZDUH SDUW ZKLFK Z
FRPPXQLFDWHG XVLQJ :KDWV \$SS DQG WKURXJK YRLFH FKDW

:KDW ZHQW ZHOODQG SLWIDOOV

2YHUDOO ZH DUH KDSS\ ZLWK RXU SURFHVV 7KH DPELDQFH LQ W
PHHWLQJ ZKHUH IXQDQG SURGXFWLYH &RPPXQLFDWLRQ EHWZHH
JRRG :KLOH WKH FRPPXQLFDWLRQ ZDV JRRG ZHEHOLHYH WKDW

HIILFLHQW LI ZH FRXOG ZRUN LQ SHUVRQ ZLWK HDFK RWKHU

)LQDOO\ WKH FRQWDFW ZLWK RXU VWDUWHG JUHDW DQG YHU\ HQW
FRPPXQLFDWLRQ KLW DURXJK SDWFK 2XU VXSHUYLVRUV KDG VRP
E\ LOOQHVV :H DUH QRW VXUH LI ZH PD\EH VKRXOG KDYH SXVKHG
WKDW KDSSHQHG 1HDU WKH HQG RI WKH SURMHFW ZH KDG UHJXO

'XULQJ WKH SHULRG RI ORZ FRPPXQLFDWLRQ ZH FRQWLQXHG ZRU
WKH V\ VWHP VKRXOG EH /XFNLO\ RXU VXSHUYLVRUV KDG WKH VD
QDWHO\ DIWHU ZH KDG HVWDEOLVKHG FRQWDFW DJDLQ ZH FRXO
WKDW WKH\ ZDQWHG VXFK DV D GLIIHUHQW VFRULQJ V\ VWHP

& 2 1 & / 8 6 , 2 1

:H L P S O H P H Q W H G D V \ V W H P W K D W F R X O G I D F L O L W D W H D + R X V H & X
F R Q V L V W V R I W Z R P D L Q S D U W V D F D Q Y D V S O X J L Q W K D W V H U Y H V
D K D U G Z D U H V \ V W H P W K D W L V X V H G W R S K \ V L F D O O \ U H S U H V H Q W W
Z D W H U

% H F D X V H W K H V R I W Z D U H D Q G W K H K D U G Z D U H F R P S R Q H Q W V D U H V
S U R M H F W Z D V D O V R G L Y L G H G L Q W Z R S D U W V 7 Z R S H R S O H Z R U N H
Z R U N H G R Q W K H K D U G Z D U H S D U W % H F D X V H W K H Z K R O H V \ V W H P Z D
P R G X O D U S D U W V W K H U H V S R Q V L E L O L W L H V F R X O G E H F O H D U O \ G

' H V S L W H K D Y L Q J W R Z R U N U H P R W H O \ I U R P H D F K R W K H U G X H W R V
Q H D U O \ D O O U H T X L U H P H Q W V W K D W Z H U H O D L G R X W L Q W K H E H J L G
W K D W Z H U H Q R W V D W L V I L H G R U R W K H U I O D Z V L Q W K H V \ V W H P U H
W K H \ F R X O G E H L P S O H P H Q W H G R U V R O Y H G

\$ + \$5' : \$5 (\$33 (1' , ;

7KLV DSSHQGL[VKRZV WKH KDUGZDUH FRPSRQH QWV LQFOXGLQJ V
QHFWLRQV RI WKH FRPSRQH QWV WR HDFK RWKHU DQG WR WKH 5DV

5DVSEHUU\ 3L 0RGHO %
KWWSV ZZZ NLZL HOHFWURQLFV QO UDVSEHUU\ SL PRGHO E

+ & 65
KWWSV ZZZ NLZL HOHFWURQLFV QO XOWUDVURQLF VHQRU KF

0RWRU GULYHU / '
KWWSV ZZZ KREE\HOHFWURQLFD QO SURGXFW O G PRWRU GU

,QIUDUHG 3UR[LPLW\ 6HQVRU
KWWSV ZZZ KREE\HOHFWURQLFD QO SURGXFW LQIUDURRG REV

3HULVWDOWLF 3XPS 9
KWWSV ZZZ KREE\HOHFWURQLFD QO SURGXFW SHULVWDOWLF

