

\$GYDQFHV LQ 5RERWLFV *URVFKO HW DO \$XWRP DWL 5RERW \$

5HVHDFK \$UWLFOH

20,&6 ,QWH

" -JRVJE)BOEMJOH 3PCPU GPS 3PCVTU BOE 3F
4UBOEBSE BOE 2VBMJUZ \$POUSPM 4BNQMFT JC

0LFKDHO *URVFKO HW DO 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHU WKH
&HOHULRQ ,QF 6ZLW]HUODQG \$* \$OOPHQGVWUDVHV)HKUDOWRUI 6ZLW]HUODQG
)RUQD[7HFQRORJLHV *PE+ XQG &R .* ,P 6RQQHQODQG 1HXVWDGW :LHG *HUPDQ\
&RUUHVSRRGLQJ 0DFKDFURVFK&HOHULRQ]HUODQG \$OOPHQGVWUDVHV 6ZLW]HUODQG 7HO
PLFKDHO JURHVFKO#FHOHULRQ FRP
5HFHLYHG 1QDWH \$FFHSWHG- DQWH 3XEOLVKHG DQWH
&RSULJKW 0LFKDHO *URVFKO HW DO 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHU WKH
XQUHVWULFWHG XVH GLVWULEXWLRQ DQG UHSURGXFWLRQ LQ DQ\ PHGLXP SURYLGHG WKH RULJLQDO D

\$EVWUDFW
:H GHVFULEH D XQLTXH OLTXLG KDQGOLQJ SODWIRUP EDVHG RQ D 7HFDQ (92 V
RI DQDO\WLF FDOLEUDWRUV DQG TXDOLW\ FRQWURO VDP SOHV DFFRUGLQJ WR WK
*/3 7KH SODWIRUP XWLOL]HV D FRPELQDWLRQ RI RII WKH VKHOI VRIWZDUH 7HF
63..(7KH V\WHP FRQLQFHV ZLWK UREXVW DQG UHSURGXFWLRQ TXDOLW\ DQG
VHFUXLW\ UHTXLUHPHQWV DV SHU)\$ &)5SDUW ZHUH FRQVLGHUH G ZKHQ SURJL

.HIZRUGREXVW %LRDQDO\VLV /LTXLG SODWIRUP FRQWURO (PHQW \$ IXOO FRPS
DSSOLHG > @ EHIRUH VHWWLQJ WKH V\WHP

,QWURGXFWRQ

H SUHSDUDWLRQ RI DQDO\WLFDO VWDQGDUGV FDOLEUDWRUV DQG TXDOLW\
FRQWURO VDP SOHV 4&V LQ D */3 ODERUDWRU\ LV RQH RI WKH NH\ FKDOOHQJHV
GXULQJ WKH FRQGXFW RI SUHSDUDWLRQ VFDOLQFLDO VWXGLHV
RI */3 GHPDQG WKH LQGHSHQG HQ SUHSDUDWLRQ RI FDOLEUDWRUV DQG 4&V
ZKLFK EHLQJ PHDVXUH VLPXOWDQHRXVO\ VKDOO PDWFK HDFK RWKHU ZLWKLQ
VWUHQF\ QHGLWHUHV SUHSDUDWLRQV PD\ QHHG WR EH
UHSHDWHG LI WKH VWXG\ UXQV RYHU ORQJHU WLPH RU DQ XQH[SHFWHG QXPEHU
RI UHSHWLWLRQV OHDG WR IXUWKHU GHPDQG RI VWDQGDUG DQG 4& PDWHULDO

\$ PDQXDO DSSURDFK LV WLPH DQG ODERU LQWHQVLYH 0RUHRYHU
PLVPDWFKHV EHWZHHQ FDOLEUDWRUV DQG 4&V WHQG WR KDSSHQ ZLWK
FRQVHTXHQWO\ UHSHDWHG DSSURDFK DLRIWKHU
FRQVXPSWLRQ RI YDOXDEOH UHIHUHQFH VXEVDQFH XVHG VXFK DV VWRFN
PDWHULDO DQG EODQN PDWUL[H J DQDO\W IUHH VHXP DQG D ORQJHU OHDG
LQ XQWLO FDOLEUDWRUV DQG 4&V DUH DYDLODEOH IRU VDP SOHV PHDVXUHPHQW
)LJXUH 1 PLQL GHN OD\RXW IRU

\$ URERWLF DSSURDFK LQ FRQWUDVW FRQGLIUDWLRQV EHFN FRQYODQDQ\ UREXVW
GD\ E\ GD\ RU EXON SUHSDUDWLRQV RI FDOLEUDWRUV GLQWLF DQEN\DIRKHORSUF
WR RYHUFRPH ZDVWH R\SDSHU GHVFDLQV R\DXLQ\WR EH ORFDWHG RQ RQH UDF
OLTXLG KDQGOLQJ SODWIRUP DOORZLQJ FROLDQDWRU DQ 4&V SODWIRUPV IRO
IXOO\ DXWRPDWHG SURGXFWLRQ RI FDOLEUDWRUV EHFN FRQYODQDQ\ UREXVW
PDGHVZDSSOLFDFWLRQ EHLQJ LQ IXOO FRQGLIUDWLRQV EHFN FRQYODQDQ\ UREXVW
> @

6\WVHP 'HVFULSWLRQ

H URERWLF SODWIRUP FRQVLVWV RIGVFRVTHFRQVWHV DQ 92HG GRVHQRV
HTXLSSHG ZLWK DQ FKDQQHO OLTXLG KDQGOLQJ DQ PHVWRG EDUFRHFXU
VFDQQHU 3RV,' WZR RQ GHFN VKDNHUV DQG GLYHUVH FDUULHUV IRU WXEHV
DQG WURXJKV 7HFDQ *HPLQL VRZDUFKRYHO DV WKH URERWLF WKH 63
DGPLQLVWHULQJ WKH GHFN ODEZDUH DQG *HPLQLG VDWLQV DQ WKH 63
PDGH 63..()RUQD[DGPLQLVWHULQJ WKH GHFN ODEZDUH DQG *HPLQLG VDWLQV
GDWDEDVH DQG GULYLQJ WKH GHFN ODEZDUH DQG *HPLQLG VDWLQV DQ WKH 63
GDWDEDVH VZDSSOLFDFWLRQ UQV RQ :LQGRZY HSRUW DQG DQ IPSRUW PHWKRGV IURP RV
LQVWDOOHG RQ PXOWLSOH 3&V WR DOORZ IRU VHSUDWLRQ LQ D GHYHORSHPHQW

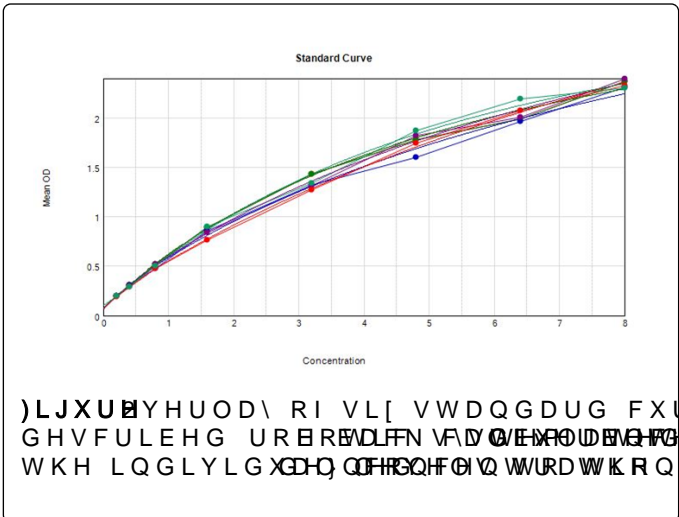
&LWDWLEBRVFKO 0 ODUNXV \$ /H\HUV 6 6FKLEOL 5 =HOSJ HLT KLGLHDVGHOL QJD QSECRDULR U5 5REXV
3UHSUDWLRQ RI 6WDQGDUG DQG 4XDOLWY\$G&R\$QVRRR \$QDPRD HV LQ %LRDQDO\VLV

3DJH RI

5HVXOWV

&RQFOXVLRQ

)RU ELRVLPLODUV DV DQ HPHUJLQJ PDUNHDXWRP DLWHGV RRAZDHHVGDHGEW B &MVHVVDV
LQGHSHQGHWQW\ SUHSDUHG VWDQGDUGWR XEJY HDV YDQXJDEB WURRPOVMR RFNPSD RYHQLQJ
IURP WKH RULJLQDWRU GUXH DQSDWLKHWVBLDVERPDDVU GQXJ TXDOLW\ FRPHWURRQGVDFP
YDULDELWLHV IURP WKH SUHSDUDWLRQVDPXFK BQVSRVNGEOWR LQKRUG B,U(WR N
WKH UHIHUHQFH VXEVDQGFHV WKH RQDQDXWKYDQWWR BWHDDVDIRFQRRUR GVEBR VLPWQ
(/,6\$ PHWKRQ ZH XVHG RXU URERWLFXQSSXR DFKD YDQJFSLQSDRISH WDKMVRQ ZLWK
VWDQGDUG FXUYHV YLD VHYHUDO GLORXWLRQ&HVVHSLRQDQZLWURUWRDQVWENP VLDQ
DOWHUQDWLQJ RUGHU RQ WKH DVVD\ SODVGLDWRWRRWRH&VHGLEH QDRELRQLLAWO IDT
> @H VWDQGDUG FXUYHV \LHOGHG IURPDSIOHV SURFENSHQGHEXW UDEVRWLREU WKH
SUHSDUDWLRQV ZHUH IRXQG WR EH ZHOULQJDFRKRUGDQGHLOWRI SDIFKRLQKADQORU
RQ\ ZLWKLQ WKH SUHSDUDWLRQV IURP RQH UHIHUHQFH VXEVDQGFH EXW DOVR
ZKHQ FXUYHV ZHUH FRPSDUHG EHWZHHGRIHULHQDWRV DQG ELRVLPLODU)LJXUH
H EDFN FDGEXDDEWHQZ HHQ WKH LQGLYLGXDO OHYHOV WR WKH
WDUJHW FRQFHQWUDWLRQ QHYHU H[FHHGHG &DLEUDWRUV DQG 4&V ZKLFK
VKDOO QRQLVH BQGH @ QHYHU H[FHHGHG *XLGDQFH FRPPQXWVQHWKRQ 9DOLGDWLRQ &(5 &90 SS



)'\$ (OHFWURQLF 5HFRUGV (OHFWURQLF 6LJQDWXUHV)LQD
&)5 3DUW *\$03 \$ 5LVN EDVH&SSURDPRKWRWRPSS
%DQ%DQDV %XVK (' +DPLWRQ 0 4&ZDUJF&RQO\WLFDO ,QVWUXPHQWV I
3KDUPDFHXWLF&R\HSSURDFK \$\$\$6 3KDUP 6FL7HFK
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EHWZHHQ D ELRVLPLODU DQG D UHIHUHQFH ELRWKHUSSHXWLF FRPPLWVHH UH
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)LJXUH YHUOD\ RI VL[VWDQGDUG FXUYHV VHSUDWHO\ SUHSDUHG E\ WKH
GHVFULEHG URREDFN VXEVDQGFH HHQ
WKH LQGLYLGXDO OHYHOV WR WKH WURDWKRQ QHYHU H[FHHGV