

VPRNH RU KDYH DQ RSHQ IODPH DQG VRODU BHF R R N B UZ K M U H Y H U V W U X F W
WKHUH LV VXQOLJKW 7KH YDFXX P WXFH KDV D VHOI OIPIWI Q J IXQF
WLRQ DQG WKH WHP SHUDWXUH 7KH VXUIDFH VWD D FFRXNH B IFW R V L V R P
LV FRQVWDQW :KHQ KHDWHG W VXUIDFH SDUW DQG D UHIOHFWLYH P R O D U
FRRNHUV FDQ EH SODFHG RQ D S IDFH WKHUH DUD B R W D W L R S I O H S D F D
FDPSLQJ VLWHV RU SODFHV ZKH I FRQLFDO VXUIDFHV)UHVQHO J H O H F V
FDQ DOVR EH XVHG DW VHD 6DL OLQGULFDO VXUIDFHV DQG VR D E O H 7
WKDQ RWKHU HQUHU FRRNHUV GHQWV FUHDWLYH XVH DQG LV G H V L
SRUULGJH F R W H U V U B F W F N L O URWDWLQJ SDUDEROLF VWUXFWXUH
PHHW WKH QHGGV RI SHRSOH V G D \$ FFRUGLQJ WR WKH VKDSH RI VRODU
WLYH D[LV FRRNHUV SRVLWLYH FLUF
RII D[LV FRRNHUV UHFWDQJOH IDQ H
'HVLJQ LGHDV DQG RSH WKH VWUXFWXUH D R H V O M R V W R P O X G N U
SULQFLSOHV WZR WKUHH RU IRXU FRPELQHG VW
VDPSOH GHVLJQ FRQVLGHUV VLPSOLF
D SRVLWLYH D[LV VWRYH D Q G F W Z B V W
%DVHG RQ WKH WKHRUHWLFDO O L Q W L Y W L Q Z H S U W K P O S O H f
6RODU (QHUJ\ &RPSUHKHQVLYH 8WLQJ]DWLRQ 7HFKQRORJ\)
WKURXJK LQYHVW W L B W D R C R O D G W K M H P D G S K R W R D Q G W U D F N L Q J G H Y L
YROWDLF LQWHJUDWHG FRRNHU F R N H U J Q H G 7KH WKHRUHWLFDO F D C
FXODWLRQ IRUPXOD LV DV IROORZV
7KH VXSSRUW DQG WUDFNLQJ GHYLFH
LQWHUJUDWHG 7KH WUDFNLQJ GHYL
YLGHG LQWR PDQXDO WUDFNLQJ GHYL
YL F H D Q G D X W R P D W H O W K P F W X G O L G H Y
VRODU HOHYDWLRQ DQJOH K Q & K L Q D L W L V J H Q H U D O O \ X V H G
7KH VRODU HOHYDWLRQ DQJOH L :KHQ 2 S W L Y W L Q Z H S U W K P O S O H f
OLQH DQG WKH JURXQG SODQH ,
ZLWKLQ WKH UDQJH RI f f :KHQ 2 S W L Y W L Q Z H S U W K P O S O H f
WKH VRODU UDGLDWLRQ LV JUHDW O \ D W W H Q X D W H G D Q G W K H G L U H F W
GLDWLRQ YDOXH RI VXQOLJKW L 7KH FURVV VHFWRQ RI WKH V R O D U V
VRODU FRRNHU LV QRW JRRG 7K JUDWHG FRRNZDUN S O D E R G W U D M R O G
FRRNHU VKDOO R Q B E X O H R C K W O H J X X P W X E H L V W K H K H D W F R O O H F W L Q
SDQ ZLWKLQ WKH UDQJH RI WKH IW X E H L V O R F D W H G D W W K H I R F D O H S R L
KPD[DQG WKH PLQLXP VRODU HLQ)LJXUH 9DFXXP WXEHV DUH GLY
&DOFXODWLRQ IRUPXOD - KPD[RXWHU WXEHV D E H U R U S W L R Q 7 K L H B L O P
+PD[Ä f - +PLQ Ä 7 D N L O H Q J W K D U H V H O H F W H G D F F R U G L Q J W
7H[DV DV DQ H R D P S S K L E W V O B W L W H F W L Y H E X F N H W H D Q G U H E L D N V O D O E X F
PDWHO\ - f KPD[f + Y D F X X P W X E H 7 K H S U R W H F W L Y H E D U
f V W H H O W R S U H Y H Q W Z D W H U Y D S R U I U
IRU H[SORVLRQ 7KH EDNLQJ EXFNHW
WXUH ZLWK HJJ Q W L H O P H U K H S Y O D F X K P
ORFDWHG DW LWV IRFDO SRLQW DQG
XXP WXEH WKURXJK D IRFXVLQJ
ZDOOV RI WKH YDFXXP WXEH DUH FR
VHOHFWLYHO\ DEVRUEV PRUH WKDQ
UDWLR ,W FDQ FRQYHUW PRVW RI WK
DFKLHYH FRRNLQJ DQG EDNLQJ RI IR
WXEH 7KH PD[LPXP WHP SHUDWXUH L
f & 7KH YDFXXP LV SXP SHG
RXWHU WXEHV RI WKH YDFXXP WXEH
RU H[LW UHVXOWLQJ LQ JRRG O L G K W O
LQJ RI WKH IRRG LQVLGH WKH W W E R Q
XDOO\ URWDWHG DQG DGMXVWHG DFF
RI WKH VXQ PDNLQJ LW IOH[L P O F H W R
LW FDQ EH IL[HG WKURXJK D ORFNLQJ
WKH QHGGV RI GLIIHUHQW VRODU DQJ
HQG RI WKH VRODU YDFXXP W X E H L
ZKLFK LV QRUPDOO\ KHDWHG E P W K H
YDFXXP WXEH 7KH LQFOLQHG E R W W
HTXLSSHG ZLWK DQ HOHFWULF KHDW
SRZHU WKURXJK D VRODU FHOV PRGX
WKH YDFXXP WXEH \$ W W K H V P H W L F
DWHG E\ WKH EDWWHU\ FRPSRQH Q H Q W V
SDUDEROLF F I O L Q G U L F D O V R O D U F R K N H U F D Q E H U H G X F H G

• 0DQXDOO\ DGMXVW WKH D]VXQOLJKW RQWR D YDFXXP WXEH FRF
 PDQQHU DLP DW WKH VXQ DQG DQJOH RI WKH VSRWOLJKW LVKDHG MCV
 VXODWLRQ ER[LV EDVLFDOO\ PD XVH 7KH ZLGHU UDQJH RI XVH LQF
 SUR[LDPWHO\ RI WKH UHICVWHDPLQJ LV DQRWKHU PDMRU EUH
 IOHFWHG RQWR WKH YDFXXP WXIFRRNHU HQGXVWUFWLYH SDQHO DUHD
 LV DSSURSULDWVHWHQFHUDDXKHG WVK LGH WKH RYHQ
 FDQ UHDFK • :KHQ WKHUH LV QP VVQ WKH SKRWRYROWDLF
 FRQWUROOHU FDQ EH DFWLYDWHV \$FNQRZOHGJ JPHQWV
 HUDO KHDWLQJ WXEHV DUH HYHG 7KLV SDSHU LV RQH RI WKH DFKLHYHQ
 RI WKH LQVXODWLRQ ER[DQG V 6WXGHQW ,QQRYDWLRQ DQG (QWUHSU
 WKH SKRWRYROWDLF SRZHU JHG 'HVLJQ DQG 'HYHORSPHQW WKH 6RO
 LQWR KHDW HQHUJ\ WR FRQLQX 3KRWRYROWDLF ,QWHJUDWHG &RRNZD
 VXODWLRQ ER[

6RFLDO %HQHILW \$QDO\VLV 5HIHUUHQFHV

3DQFKDO + 3DWHO - &KDXGKDU\
 &RRNLQJ LV D EDVLF KXPdq QHhg VUHYLHZ RI VRODU FRRNHU ZGWK Vh
 XVLQJ D YDULHW\ RI DSSOLDQFHV VWRUDJH PDWHULDQV ,QWHUQDWL
 GLUHFw RU LQGLUHFw XVH RI IRVV (QHUJ\ ;HUDWH \$V D UHVXO
 LW SURGXFWV ODUJH DPRXQWV RI &KDJKXD 6 0HLQDQ : /RQJLQDQ
 DGGLWLRQ WR RWKHU GDPDJH WR 6WXG\ RQ WKH 3HUIRUPDQFH RI +LJ
 KHDOWK > @ 6RFLDO\ FRRNLQJ WUDGLWLRQV (QHUJ\ \$FFXP HQDFWLRQ 67FLFKQROR.
 VROYH GDLO\ FRRNLQJ WUDGLWLRQV OHWLQ WVV
 VXFK DV ILUHQFHV DQGRFXVWLRQ /L\LQJ / ;LDR + 4L : HWF ;HYHORS
 \$FFRUGLQJ WR GLIIHUUHQW VSHFLSRUWDEOH FRPELQHG RII DLVWERQ
 NLWFKHQ KDV D KHDW FROOHFWLRQ -RXUQDO RI 6KHQ\ DQJ ,QVWLWXWH
 VTXDUH PHWHUV ,I ZH SURPRWH D 6FLHQFH (GLWLRQ DULUR
 NLWFKHQ LW FDQ VDYH N:K RI H ;LDRIX & <XDQJZHL 5 NJ RI
 VWDQGDUG FRDO UHGXFH NJ RI ;LDRIX & <XDQJZHL 5 7HFKQ
 RI FDUERQ GLR[LGH HPLVVLRQV UHSURJUHVV DQG DSSOLFDFWLRQ RI VR
 HPLVVLRQV DQG UHGXFH NJ RI IQHZDEOH (QHUJ\ ,GH &XU
 UHQWO\ WKH SURPRWLRQ RI PRUH =KLFKHQJ : *XDQJZHL : ;XFRQJ
 MHFWV LV DERXW VTXDUH PHW7DL & 'HVLJQ RI D SRUWDEOH VRO
 WRQV RI VWDQGDUG FRDO UHGXFH DQG SRZHU JHQHUJ\ WRZRUQMHQURFD
 HPLVVLRQV DQG UHGXFH WRQVDQG 7HFKQLFDO 1RUPDO 8QLYHU
 VLRQV
 7KH PDVV SURGXFWLRQ DQG XVH 6DQJODUG % /DQDLJL UG W & DUC
 SODFH WUDGLWLRQV DQGRFXVWLRQ /LIH F\FOH DVVHVPHQW RI D SDUD
 FKDUFRDO DQG HOHFWULFLW\ DO FRPSDULVRQ ZLWK FRQYHQWLRQDQ
 WKH VXIIHULQJ RI FRRNLQJ \$IWH 6XVWDLQDEOH 3URGXFWLRQ DQG 8
 EUHDNWKURXJKV DQG WHQV RI WKR 5V RI XQUHPLWVWLQJ H\SHU
 LPHQWV DIWHU PXOWLSOH SURGXFW XS GDWHV WKH SHUIRUPDQFH RI
 VRODU FRRNHUV KDV UHDFKHG DQ XQSUFHGHQWHG OHYHO DQG FDQ
 HYHQ WUXO\ UHSURFHQW PDGHVLRQV DQF KLHYLQJ
 UHO\LQJ RQ WKHZZMDKXKMUFDV R VHDW DLU SROOX
 WLRQ DQG HQHUJ\ ZDVWH

&RQFOXVLRQ

7KH VRODU WKHUPDO SKRWRYROWDLF LQWHJUDWHG FRRNHU LV PDGH
 RI KLJK UHIOHFWLYLW\ DOXPLQXP SODWHV ZLWK D WURXJK VWUXF
 WXUH DQG D SDUDEROLF SULQFLSOH 7KH OLJKW FRQYHUJHV RQWR D
 YDFXXP WXEH SURGXFLQJ D KLJK WHPHUDWXUH VXLWDEOH IRU
 EDUEHFXH DQG VWHZLQJ 7KH VRODU WKHUPDO WHFKQRORJ\ LV
 XVHG WR KHDW IRRG DQG WKH WURXJK FRQFHQWUDWLRQ WHFKQRORJ\
 LV XVHG WR LQFUHDVH WKH XWLOLJDWLRQ UDWI RI VRODU HQHUJ\ ,Q
 RUGHU WR UHGXFH WKH GHSHQGHHQH RQ WKH ZHDWKHU WKH GHYLFH
 LV DOVR HTXLSSHG ZLWK SKRWRYROWDLF SDQHOV ZKLFK XVH SKR
 WRHOHFWULF FRQYHUJHWRQV DQGRORJ\ WR
 KHDW IRRG LQ EDG ZHDWKHU %\ XVLQJ D VSRWOLJKW WR JDWKHU