





# &RQWHQWV

---

&+\$37(5 ,1752'8&7,21

,1752'8&7,21  
385326(6 2) 7{(\$0  
7\$5\*(73238/\$7,2167\$1'\$5'

&+\$37(5 &/\$66,&\$/ ,7(0 67\$7,67,&6 67\$1'\$5'

,7(0' ,)),&8/7<  
,7(0' ,6&5,0,1\$7,21  
' ,6&5,0,1\$7,21' 2)),&8/76&\$77(3/27  
2%6(59\$7,216 \$117(535(7\$7,216

&+\$37(5 ,57 &\$/, %5\$7,216 (48\$7,1\* \$1' 6&\$/,1\* 67\$1'\$5'6 \$1'

' (6&5,37,21 2) 5\$6&+02'(/  
62)7:\$5( \$1'(67,0\$7,21/\*25,7+0  
,7(0' ,)),&8/7±678'(173(5)250\$1&(0\$3  
&+(&.,1\*5\$6&+\$668037,216

6&\$/,1\* 223(5\$7,21\$7(67)2506

&+\$37(5 5(/,\$%,/,7< 67\$1'\$5'

dB™

(9,'(1&(%\$6(' 217(67,1\*&216(48(1&(6  
6800\$5<

5()(5(1&(6

\$33(1',; \$ 23(5\$7,21\$/ 7(67 0\$3

\$33(1',; % 5\$:27+(7\$726&\$/( 6&25( &219(56,21 7\$%/(

\$33(1',; & ,7(0 :5,7,1\* \*8,'(/,1(6

## /LVW RI 7DEOHV

---

7\$%/( 727\$/678'(173238/\$7,21 ;81( 5\*(176(;\$0,1\$7,21 &+(0,675<

7\$%/( 0&,7(0 \$1\$/<6, 6800\$5<5\*(176(;\$0,1\$7,21 &+(0,675<

7\$%/( &5,7(0 \$1\$/<6, 6800\$5<5\*(176(;\$0,1\$7,21 &+(0,675<



FROOHFWLRQ V\WHP 7KHVH GDWD LQFOXGH DOO VWXGHQW UHH

1 < 5HJH

WFKQLFDO3UHSRUMG IRU 1<6(' E\ 3HDUVRQ

&KDSWHU & , QNDHVP/ 16 FADDOV L V W L F V 6 W D Q G D U G

---

7KLFVKDSWHU SURYLGHV DQ RYHUYLHZ ~~Q H W K H W W Z R W L R W W L F I D P R L E O V~~  
FODVVLFDO LWHPW D H P D G L V L F X O W \ D Q G L W H P G L V F U L P L Q D W L R Q 7  
RSHUDWLRQDO 5HJHQ & K H P L D P L Q P W L R Q L Q

,7(0 ',)),&8/7<

\$W WKH PRVW JHQHUDO OHYHO DQ LWHP V G L I L F X O W \ L V L Q G  
JURXS HJUDGH ~~D H Y F X O D W H G~~ DV IROORZV







,WH	6WXGH	0LQ 6FRU	0D 6FI	IDC	6'	S DOX	3RLQ\
-----	-------	-------------	-----------	-----	----	-------	-------

1 < 5HJH&KMP LV WFKQLFDO35JHSFUM G IRU 1 < 6 (' E\ 3HDUVRQ

7DEOH'HVFULSWLYH 6WYDOLXW3DFQ%LQV HULDO &RUUHODWLRQ 5HJHQWV (  
&KHPLVWU\

6WDWL	1	0HDC	0LQ	4	0HGL	4	0D[ai
-------	---	------	-----	---	------	---	-------

YDO





5DVFK PRGHOV DVVXPH WKDW RQH GRPLQDQW GLEWVXGLRQWGHW  
SHUIRUF3QLHQIRLSSDQDQDO\VLV 3&\$ FDQ EH XVHG WR DVVHVW W  
DVVXPSWLRQ 7KH SXUSRVHYRIUZHWWKHQDQDQWGRPWGDQW FRPSF  
H[LVW DPRQJ,WDLRMRMU GLPHQVLRQV DUH IRXQG WRXHOXQLGLP  
EH YLRODWHG

\$ SDUDOOHO DQDO\VLV +RUQ ZDV FRQGXFWHG WR KHOS GL  
FRPSRQHQWVWKHUDDOGRPHO DQDO\VLWVGRHWVHFKZQEDHIDFWRUV  
H[LVW LQ SRPSHQSDQW WKH SDUDOOHO DQDO\VLV VHTXDOGRPVGHW  
RULJLQDZOHGDWDHWHG )RU HDFK UDQSRPHGRDQDQW WKH DUH B&\$ZD  
HLJHQYDOXHIRUWIRUKGRPSRQHQW WKH XSSHU WK SHUFHQWLOH  
HLJHQYDOXHV IURP WKH WDKGRPWGDQD\*LVWVQGDWVJHQIRUWKH  
IRU WKH SDUDOOHO DQDO\VLV WKH UHIHUHQFH OLQH LV HVVHQ  
DQ HLJHQYDOXH RI

)LJXUHSUHVHVKH\$DQG SDUDOOHUVXQDQWVIRUWKH ([DPLQDWLRQ  
&KHPLVWV\UHVXOWV LQFOXGH WKH HLJHQYDOXHV DQG WKH SHU  
ILUVWVHLYH Fa"àÀ@PVW IJHQYDu`ÿ PZOHOO V TmPpKH FVUHH HOa'FQ 0



0DUDLV DQG \$QGULFK

SRLQW RXW WRX9•50W-XP0DPPL5 LPY',©

1 < 5HJH&KMP LV WFKQLFDO35HSDUM G IRU 1 < 6 (' E\ 3HDUVRQ



\$Q LPSRUWDQW DVVXPSWLRQ RI WKH 5DVFK PRGHORLGHWKDW V  
:,167(36 SURYLGLRHS LWHE

1 < 5HJHQMP LV WFKQLFD035HSDUMG IRU 1 < 6(' E\ 3HDUVRQ

R E O Q P E D M C O P D U R B F E W S B C O P E W W H E

7KHH5JHQWV ([DPL&KMP LKOWLQFHW VFZKHFKV DWHDKH VFDOH VFRUH  
DQG\$SULPDU\ FRQVLGHUDWLRQ GXULQJ WHVW FRQVWUXFW

1 < 5HJH&KMP LVWFKQLFDO3HHSFUMG IRU 1 < 6(' E\ 3HDUVRQ





5HOLDELOLW\ LV PRVW RIWHQ HVWRFDWRFHSQVZIKQFKW&URMRLGFMO  
SUDFWQFDHJQDO FRQVLRWMLHEDNSFDGHEH FRQFHSWXDOLJHG DV W  
ZKLFK DQ H[FKDQJHDEOH VHW RI LWHPV IURP WKH VDPH GRPDLQ  
RI VWXSHQDWLYH HUURU LV UHIOHFWHG LQQWKLXGLHGGH[SH[URUV  
IURP RQH VDPSON RI LWHPV WR WKH QH[W VKRXOG EH RI SDUW  
XVHU \$ JHQHUDO FRPSXFRDMLRQSDRUPXVDRIRZV

ZKHUHV WKH QXSDHWWRE<sup>6</sup>LV WKH YDRLDQF REVHUYHG WRWDO WH  
6<sup>6</sup>JLV WKH YDSDDWFH RI

67\$1'\$5' (5525 2) 0(\$685(0(17 67\$1'\$5'6  
5HOLDELOLW\ FRHILFLHQWV EHVW UHIOHFW WKH H[WHQW WR 2  
SUHVHQW RU DEVHQW 7KH VWDQG(DULG/ HDLQRRAUKRU RLRQGLXDMRHLQW  
SUHFLVLRQ WKDW LV EHVWHU VXLWHG PRQVGLQFRBQVQVQJHQRKHHV  
VFRUHV REWDLQHG E\ LQGLYLGXDO H[DFLQHHV 7KLV LV SDUWLF











7 DE OH SUHVHQWV W

1 < 5HJH&KMP LV WFKQLFDO35HSDUM G IRU 1 < 6 (' E\ 3HDUVRQ



1 < 5 H J H Q M P L V W E K Q L F D O 3 5 H S P U M G \_ I R U 1 < 6 ( ' E \ 3 H D U V R Q



,QLWLDO LWHP GHYHORSPHQW LV FRQGXFWHG XQGHU WKH FUL  
GRFXPHQWV LQFOXGLQJ WKH EOXHDSUFROWHQWHFHZULWFLQWLFUQW  
0&DQ&5LWHPV DUHRLQFOXGHSDRQVXUH DSSURSULDWH FRYHUDJH  
GRPDLQLWHP ZULWLQJ JXLGHOLQHV X@QG P€W000H'0e0



\$GKHUHQFH WR VWDQGDUGLJHG DGPLQLWURU DWK HRYQD SU B EWG XU HWH  
DQG WKHLU LQDWHUWUFXFKW SUWLRHQGXUHV DOORZ IRU DGHTXDWH D  
FRQGLWLRQV IRU VFRULQJ WKH ZRUN RI HYHU\ VWXGHQW ZKR V  
JXLGHODLFRQWDLQHG LQ WKH KWWSV\_ZZZ\_Q\VHG\_JRY\_V  
DVVHVVPHQDQWDKDW H EHQ GHYHORSHG DWGFRQSDUWPHQWVHJHQ\$VO  
([DPLQDWURDQVPLQLVWHUHG XQGHU WKHVH VWDQGDUG FRQGLWLR  
VWXGHQWV 7KHH SURFHGXUHV DOVR FRZKHUWH\$WRQJGHGXVHQ  
DFFRPPRGDWLRQV FRQVLVWHQW ZLWK WKHLUV, QBUYGFXWRQHG  
\$FFRPPRGDWLRQ 3ODQV 3ODQV )XOO WHVW DGPLQLVWU



'XULQJ WKHL DGGQH DQG FRHQG JWSURF HVVHV LW LV LPSRUWDQW  
YDULDWLRQ 2QHRSRUEQH VRXUFH 25 VFRULQW L RQH QH DWDVU  
DVVRF LZWKGLWHPWX GEGAS RQH H WUDWHU LV RIWHQ XQVRLVH RI V  
WISH RI YDLD DWHK HQ PRVW FKDOOHQJLQJ VRXUFH RI YDULDWLR  
PHDVXUDHWHLD VHQ DSSNDY HULW\ RLQDHSLOHQRJWQH UXEULF %LD  
LQFOXGHV SKHQR VHKDORXHWKIDFWWZK HQ JRRG RU SRRU SHUIRUPDG  
HOHPHQW RI WKH UXEULF HQFRXUDJHV LQDFFXUDWH VFRULQJ RI  
FDQ EH FRQWDLQLQJ GSBD FWL FHV ZLWK D VWULFW IRFXV RQ UXEULF

7KH WUDLQLQJ SURFHVV IRU 1<5HJH8QMP LV WFKQLFD035HHSRUMG IRU 1<6(' E\ 3HDUVRQ  
GLVFXVVRQ RI DFWXD05 MWWK BWHQYKIZRUKHRSV UDWHUV XQGHUVV  
FKDUDFWHULV VWXGUMOSLFD035HHSRUMG NLQGV RI PLVWDNHV VWXGHQWV  
7KLV LQIRUPDWLRQ LV XVHG WR WUDLQ UDWHUV RQ KRZ WR FRG  
UXEULFV DFKR GRPDLQ RI VWXGHQW UHVSQRVHV

5DWHUV WKHQ UHFHLYH WUDLQLQJ FRQVLVWHQW ZLWK WKH JXL  
WHVWLQJ DQG DUH DOORZHG WR SUDFWLFH VFRULQJ SULRU WR V  
SURFHVV WSHRUFWDQW ISURFHGXUHV IRU FRUUMFWLQJ \$SOLFRQWLRQ  
RI VFRULQJ &XELWFRVIR:K HQ PRQLWRULQJ DQG FRUHFWRQ GR  
FRQVLVXUHFWDHYDQW YDULDWLRQ PD\ EH LQWURGXFVGLJ\$FFR WGR LQ  
UHYLHZ WKH FRQVLVWHQW IRVGLRQLQJ VWDUI DJDLQVWPRGHO UH  
DYDLODEOH IRU FRQVXOWDWLRQ WKURXJKRXW WKH VFRULQJ SU

\$WWHQWLRQ WR WKH UXEULF GHVLJQ D035HHSRUMG H BWH F7KWR W  
UXEULF VSHFLM WXGHQW VWR SURYLGH DV HYLGHQFH RI OHDUQL  
DVNHG 7KH PRUH H[SOLFV WKH UHVLKHFUD035HHSRUMG H BWH F7KWR W  
VWXGHQW DFLQWLV W BWH F7KWR W R6(' WUDLQLQJ IRU  
LQFOXGHV VSHFLILF DWWHQWLRQ R035HHSRUMG UXEULF GHYHORSPHQW

7KH UXEULF VKRXOG FOHDUO\ VSHFLI\ WKH FULWHULD IRU D  
7KH UXEULF VKRXOG EH DOLJQHG WR ZKDW LV DVNHG IRU  
NQRZOHGJHE HRLQYDLV035HHSRUMG  
:KHQHYHU SRVLEOH WKH UXEULF VKRXOG EH ZULWWHQ W  
RWKHU OHJLWLPDWH PHWKRGV

,Q VXSSRUW RI WDKLGRVDFR URH LQWHUSVHWGDWMLKQ V FIRUL QJD FKW D L  
SURFHGXUH DUH LPSOHPHQWHG IRU 2 BWH F7KWR W U(DWFLQD W L  
EDVHG RQ RQH LQ FRQJ L RQVH DOBU G

ZDLQ ZKWKK LWHP GQWHOSVHCZQ DEOHWSRLELW HFLDHO DDLRQ  
IRU GLVWUDFWRWVPLVQDVOHDSBJHDWLWR EH FQRGH FDRV B UWKIDW  
PRVW SDXGDIQWQRW EHLQJ GUDZQ WR DQ XQLQWHQG HG FRQVWL

(9,'(1&( % \$6(' 21 (57\$/ 6758&785(  
7KH WKLUG VRXUFH RI YDOLGLW\ HYLGHQFH FRPDQGHUTXPLWKH LC  
WKDW WHVW GHYMOVSHUWVVMYDXFXDXUHMWIR QHWXRQLWJ DW LQWHQ  
DQ HYDOXDWLRQ PD\ LQFQDQWHUDDVMMLEW VRIQGWRIQWHRQDOLW\ RI  
WHVW ELDV IRU RU DJDLQVHCWQRXSV BRUWHFWHG E\ GLIIHUHQWL  
' ,) DQDO\VLV (YDOXDWLRQ RI LQWHUQDO WHVW VWFQDFWALFH DO  
LWHP DQDO\VVH WHVW UHOLDELOLW\ 7RGI ROKR ZLQJ FDDLOQV HD  
FRQGXFWHGISHUHQWV ([BRIHQDWWRQ LQ

,WHQ IILFXOW\  
,WHQ VFULPLQDWLRQ LVFUPÀHPFHPQD  
'BHNSUHQVLDQ







# 5HIHUFHV

---

\$PHULFDQ (GXFDWLRQDO 5\$V\$D\$PKH\$VFDQ\$LDWLRQ\$ORRQ\$FDO \$VVR  
\$3\$ 1DWLRQDO &RXQFLO RQ 0HDMXU HPHQW LQ (GXFDWLRQ  
\$(5\$

%DUNDRXL (IIHFWV RI PDUNLQJ PHWKRG DQG UDWHU H[SHULHQF  
UDWU SHUIRUPDQFH

%UHQQDQ 5 /

,RZD &RPSXWHU VRIWZDUH@ 9HUVLRQ

&KHQ : + 7KLVVHQ ' /RFDO GSHQGHQFH LQGH[HV IRU  
UHVSRQVH WKHRU\ ±

&RQJGRQ 3 - 0F4XHHQH -VWDELOLW\ RI UDWLQVH VFDQW\ LQ  
SURJUDPV ±

&RRN ' \$ %HFNPDQ 'RHV VFDOH OHQJWK PDWWHVHU\$VFRPSDUL  
ILYSRLQW UDWLQJ &(FDOHV IRU PLQL ±

&URQEDFK / - &RHIILFLHQW DOSKD DQG WKH LQWHUQDO  
±

&URQEDFK / - S )LYH



0F'RQDOG 5 3 7KH VWUXFWXUDO DQDO\VLV RI PXOWLYDU  
WKHRU\ ±

0F4XHHQ - &RQJGRQ 3 - 0DUFK  
3DSHU SUHVHQWHG DW WKH \$QQXDO 0HHWLQJ RI WKH  
5HVHDUFK \$VVRFLDWLRQ &KLFDJR ,/

0HUR 1 3 0RWRZLGQRIFW-V RI UDWHU DFFRXQWDELOLW\ RQ  
IDYRUDELOLW\ RI SHUIRUPDQFH UDWLQJV ±

0HVVLFN 6 6YDOLGLW\ RI VWDQGDUGV





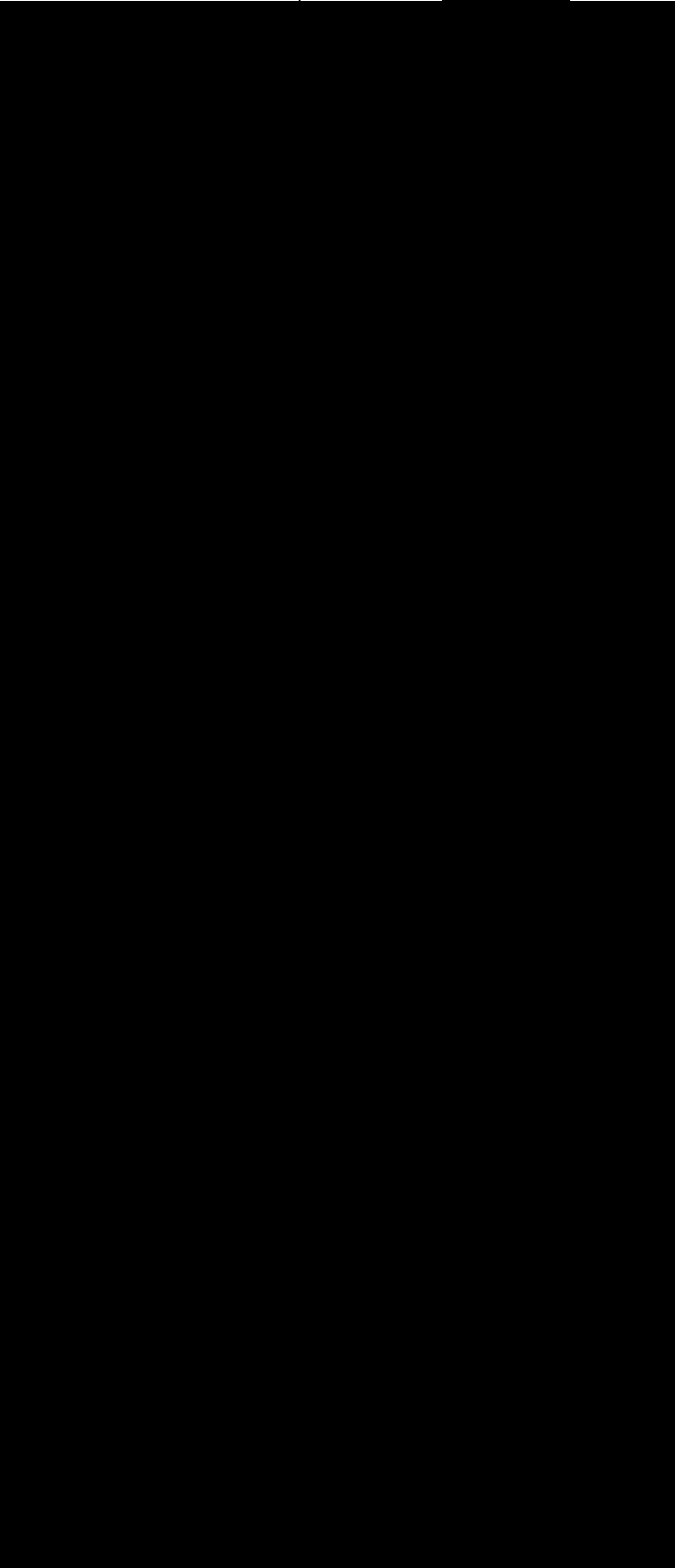
\$SSHQGL[S\$UDWLRQDOODS

---

7DEH-XQH 7HVW ODS

3R\WI	,WHRS	0D[ 3RLQ\	:HLJK	&OXV\	0HD	3RLQ' %LWUL	5DVFK 'LILFX	,1),7
	0& 0&							

3R\WI	,WHRS	0D[ 3RLQ\	:HLJK	&OXV\	0HD	3RLQ\ %LWUL	5DVFK 'LILFX	,1),7
	0&							
	0&							
	0&							
	0&							
	0&							









\$SSHQGL[ & ,WHP :ULWLQJ \*X

1 < 5HJH&KMP LV WFKQLFDO 5HSRUW \_